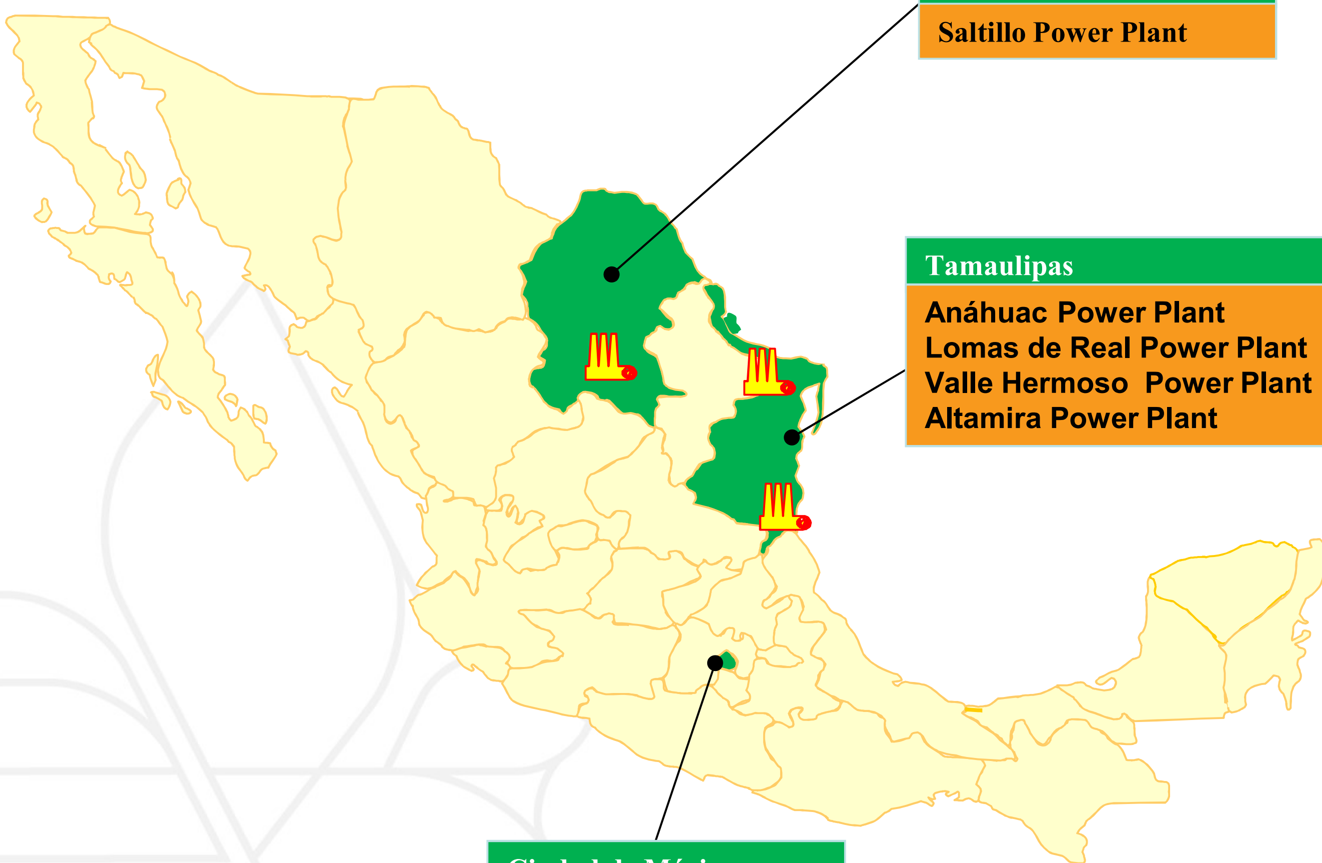
Central Valle Hermoso

ACC Windscreens Project

October 2019

MT Falcon's Power Plants



Coahuila

Saltillo Power Plant

Tamaulipas

Anáhuac Power Plant
Lomas de Real Power Plant
Valle Hermoso Power Plant
Altamira Power Plant

Ciudad de México

Torre Mayor -
Corporate offices-
Mitsui & Co Power
Development &
Management Americas

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Rio Bravo Energy Park-1490MW

Rio Bravo Site

Generation

Río Bravo II – Central Anahuac	495 MW		
Río Bravo III – Central Lomas del Real	495 MW	1,490 MW	
Río Bravo IV – Central Valle Hermoso	500 MW		

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ACC ORIGINAL DESIGN

- Designed by Balcke Durr.

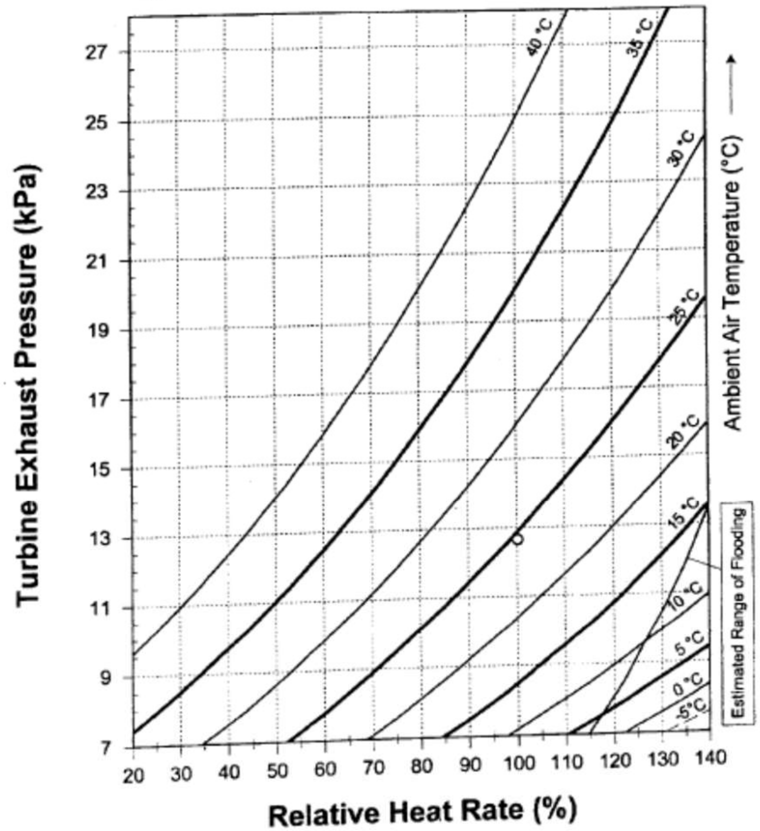
2.41 Design Data

Application:	Air Cooled Condenser	
Medium	Turbine–Exhaust Steam	
Flow	kg/s	143
Turbine exhaust pressure	mbar	126
Steam enthalpy	kJ/kg	2492
Design pressure	bar,g	0.5
Design temperature	°C	120
Ambient air temperature	°C	24.7
Ambient air pressure	mbar	1011.5
Number of fans		32
Fan shaft power consumption (per fan)	kW	82
Motor capacity (per fan)	HP	150 (112 kW)

Design Case

Design Released Heat	:	327.7 (MW) = 100 %
Design Turbine Exhaust Pressure	:	12,6 (kPa)
Design Steam Enthalpy	:	2492 (kJ/kg)
Design Atmospheric Pressure	:	1011,5 (mbar)
Design Air Temperature	:	24,7 (°Cel)

All Fans at Full Speed
Applicable without lateral wind or other interference factors



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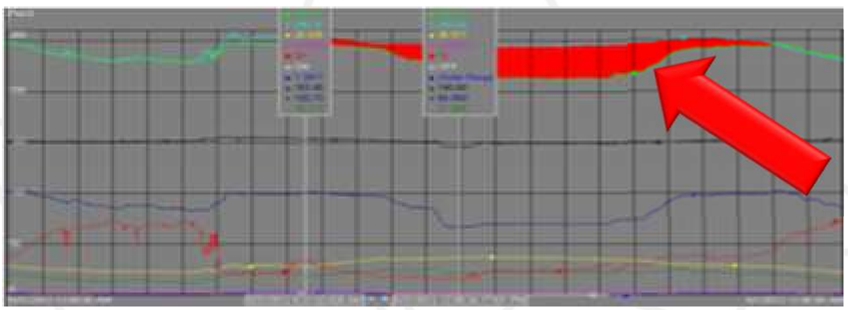
BACKGROUND

- Contract Power Output demanded by customer was unattainable during the summer months due to steam turbine high backpressure from the main condenser, which implied limiting both duct burner (auxiliary firing) – including turning it off entirely – as well as sometimes even reducing combustion turbines output, to avoid a steam turbine trip on high backpressure.
- This significant power output reduction due to steam condensing limitations, was due to ACC under-performance in summer and windy conditions.
- Even though condensers were originally correctly sized, specified and supplied, there has been ACC degradation through the years (severe fouling, tube damage).
- Performance is affected more by higher temperatures and winds.



CLEAR OBJECTIVE:
Meet Customer demand, and thus comply with the Contract, at minimum investment cost, by maximizing current asset usage.

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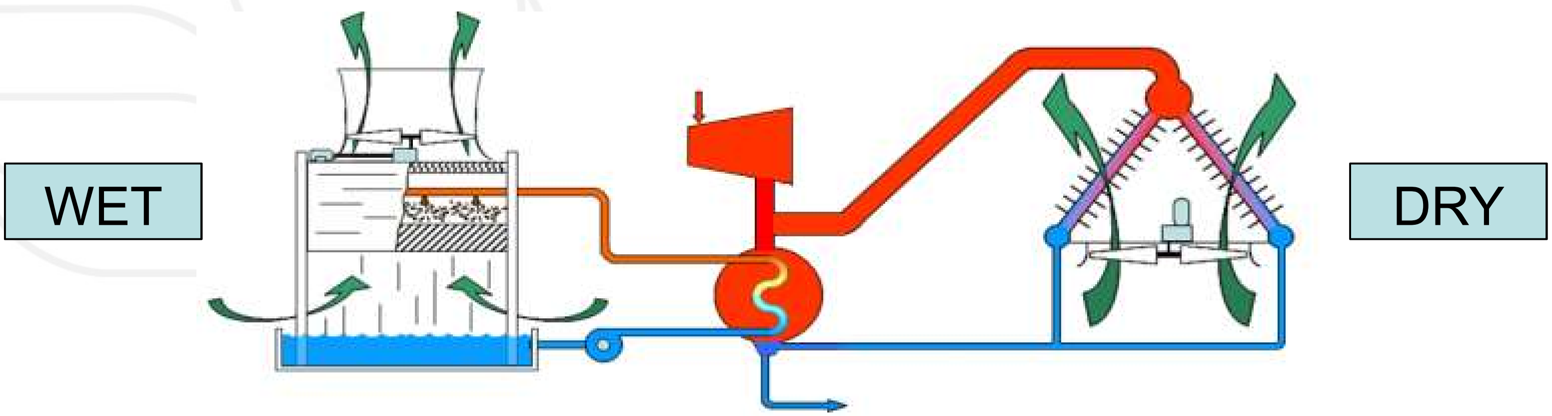
BACKGROUND

- Through several years and some expense, many options were evaluated, as well as several suppliers with aftermarket services.
- The chosen solution took into account:
  - There were additional water sources near the plants.
  - ACC enlargement was a very expensive option.
- With the support of SPIG USA, a Parallel Condensing System (PCS) was chosen as final solution: A system in which exhaust steam is simultaneously condensed in both a wet evaporative (SSC) and in the existing dry cooling systems (ACC):



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BACKGROUND

- Goal: Remove the steam turbine backpressure limitation during all periods with ambient temperature higher than 30°C (86°F, approximately 1,000 hours per year), by adding enough wet cooling capacity to the existing 32 cell ACC.
- Advantages of the Parallel Condensing System:
  - Combines performance of an SSC with water savings of an ACC.
  - Optimize water use to minimize condensing system costs.
  - Sized to meet limited cooling water availability.

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ACC WINDSCREENS PROJECT TO IMPROVE PERFORMANCE DURIGN HIGH WIND SPEED PERIODS.

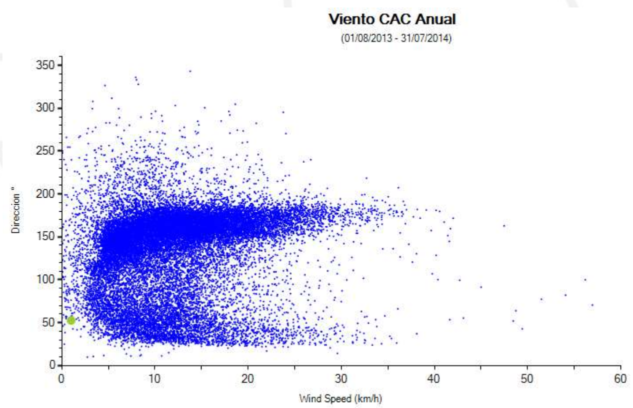
- Although the PCS solved the issue to meet the customer demand during high ambient temperature and high wind speed, the ACC windscreen project was evaluated in order to improve the ACC performance during these periods.

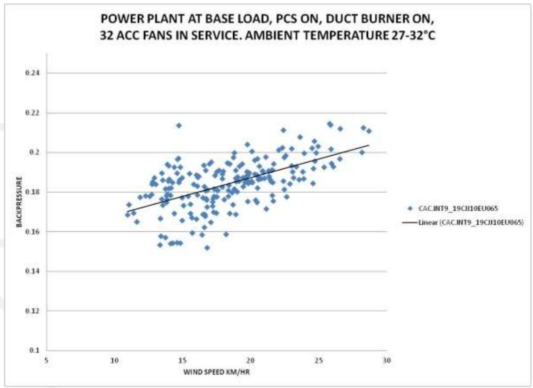
- In SRB the ACCs are affected by wind speed and specially mixed with wind direction of south-southeast:

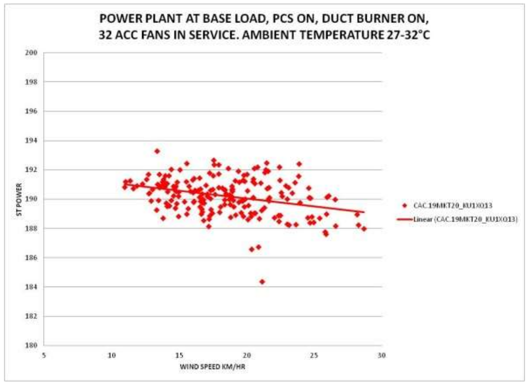
    - Condenser pressure increase ~ 15 – 30 mBar.

    - ST Power decrease ~3 to 4 MW.

- This effect occurs with wind speed above 15 Km/h (1800 Hr/year) and is very significant when the wind reaches speeds about 25 – 40 Km/hr (300 Hr/year).







For this issue, the solution was to install Wind Screens in the ACC to reduce affecting the fans operation due to wind speed and crosswind.

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SELECTION OF WIND SCREENS LOCATION FOR SRB ACC´S

Wind Screen (Cruciform)

Wind Screen One Bay Back

Rolling System on the outside

Wind Screen on the Outside combined with Wind Wall (Cruciform)

Wind Screen on the Outside combined with Wind Shield (Cruciform)

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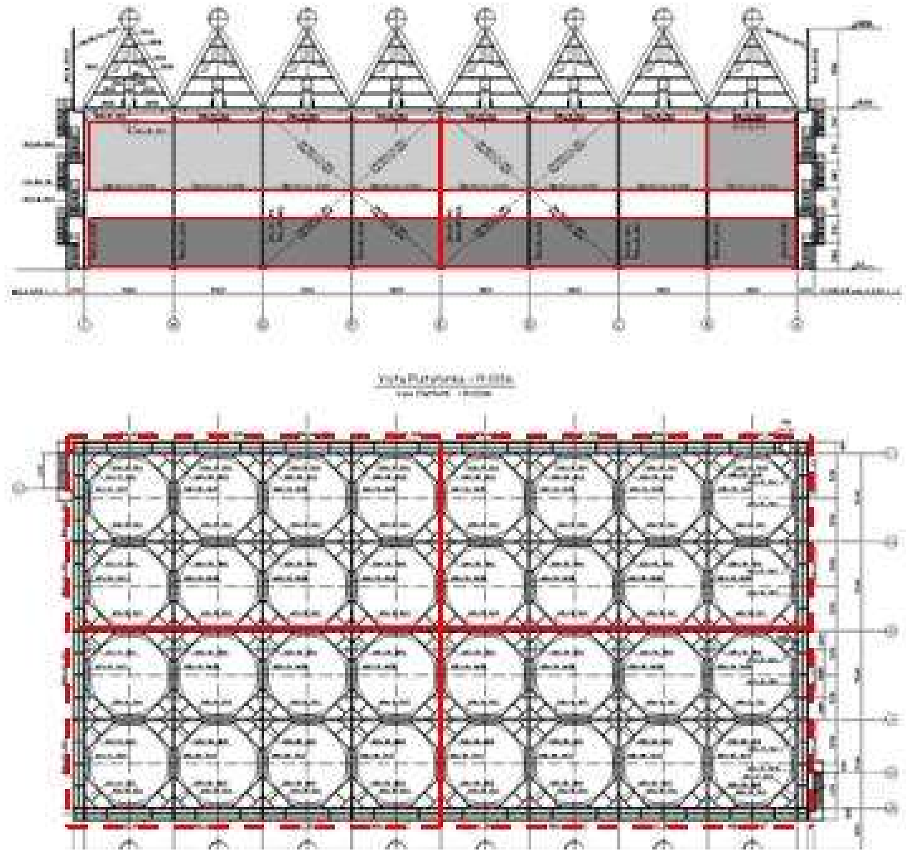
SELECTION OF WIND SCREENS LOCATION FOR SRB ACC´S

	Advantages and Disadvantages
Solid Wind Wall (Cruciform)	• Block crosswinds in the ACC low level and push air upwards into the fans. • Will have a negative pressure behind the solid wall. • More expensive than Wind Screen. • Wind loadings will be higher.
Wind Screen on the Outside	• Reduce the velocity of the horizontal jet stream under the fan level allowing the fan to collect more air. • Low wind load on the ACC structure. • Cheaper than Solid Wind Wall. • Does not reduce the air velocity in the ACC low level.
Wind Screen (Cruciform)	• Reduce the velocity of low level air passing under the ACC allowing the fan to collect more air. • Low wind load on the ACC structure. • Cheaper than Solid Wind Wall. • Does not reduce the air velocity under the fan level.
Wind Screen One Bay Back	• Low wind load on the ACC structure. • Cheaper than Solid Wind Wall. • Theoretically is a greater potential for mechanical damage to the fan blades due to cyclical loading.
Rolling System on the Outside	• Reduce the velocity of the horizontal jet stream under the fan level allowing the fan to collect more air. • Low wind load on the ACC structure. • Retraction during periods of low wind speed or very high speeds (hurricane). • More expensive than Wind Screen. • Does not reduce the air velocity in the ACC low level.
Wind Screen on the Outside combined with Wind Wall (Cruciform)	• Reduce the velocity of the horizontal jet stream under the fan level allowing the fan to collect more air. • Block crosswinds in the ACC low level and push air upwards into the fans. • Recently this combination has been installed in some ACC´s. • Wind loadings will be higher due to the solid Wind Wall.
Wind Screen on the Outside combined with Wind Screen (Cruciform)	• Reduce the velocity of the horizontal jet stream under the fan level allowing the fan to collect more air. • Reduce the velocity of low level air passing under the ACC allowing the fan to collect more air. • Low wind load on the ACC structure. • Recently this combination has been installed in some ACC´s and it is highly recommended by the supplier.

SELECTION OF WIND SCREENS LOCATION FOR SRB ACC´S

- Option selected was the combination of a cruciform Wind Screen underneath the ACC in addition to Wind Screens on the outside, this option was highly recommended by the supplier and it is according with experiences and studies in other Power Plants ACC´s.

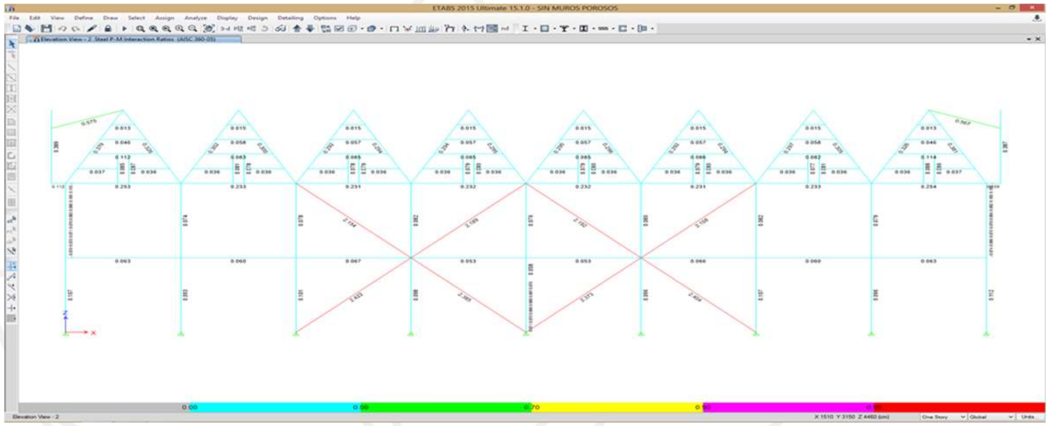


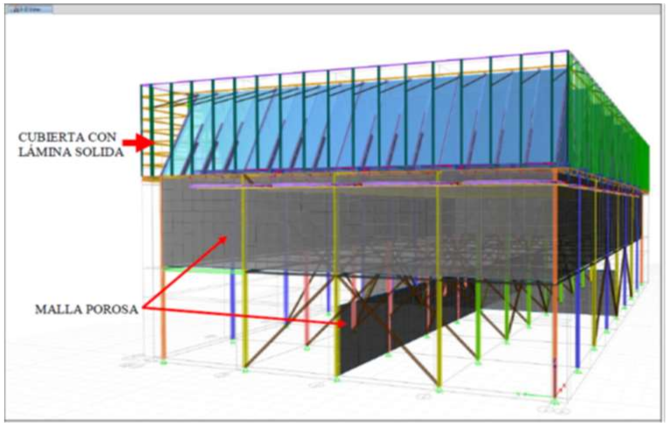
WIND SCREENS PROJECT INSTALLATION

- Before the installation of the wind screens, two structural analysis were conducted in order to confirm that structures will support the new loads after the installation of the screens.

- Results from both studies indicated that a structural reinforcement was needed in order to comply with the Mexican regulation.

- Diagonal braces were replaced by new ones with higher diameter and thickness as was recommended in the structural study results.





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WIND SCREENS PROJECT INSTALLATION

- After the replacement of the diagonal braces, the windscreens were installed in May 2018.

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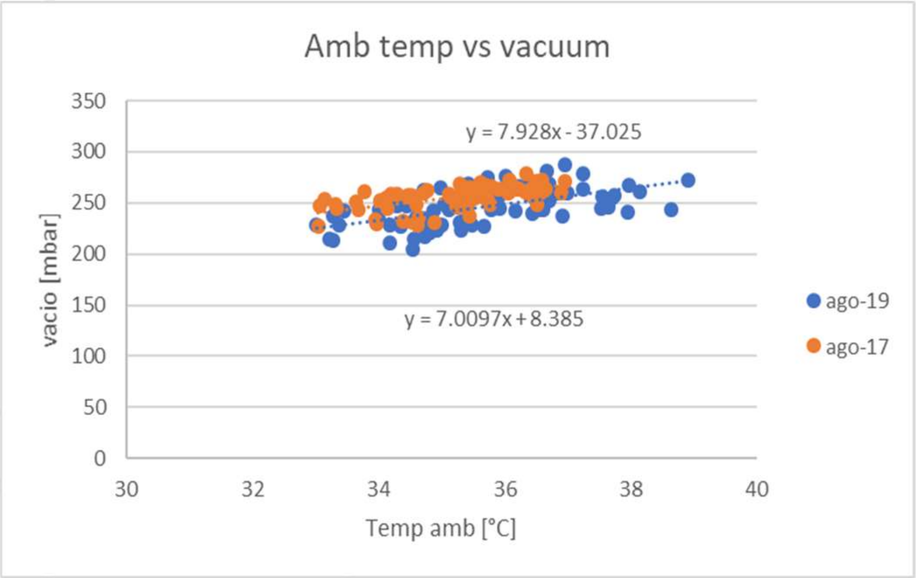
RBIV VACUUM IMPROVEMENT

CASE 1: WIND SPEED (15-20 km/h) & AMBIENT TEMPERATURE>33° C

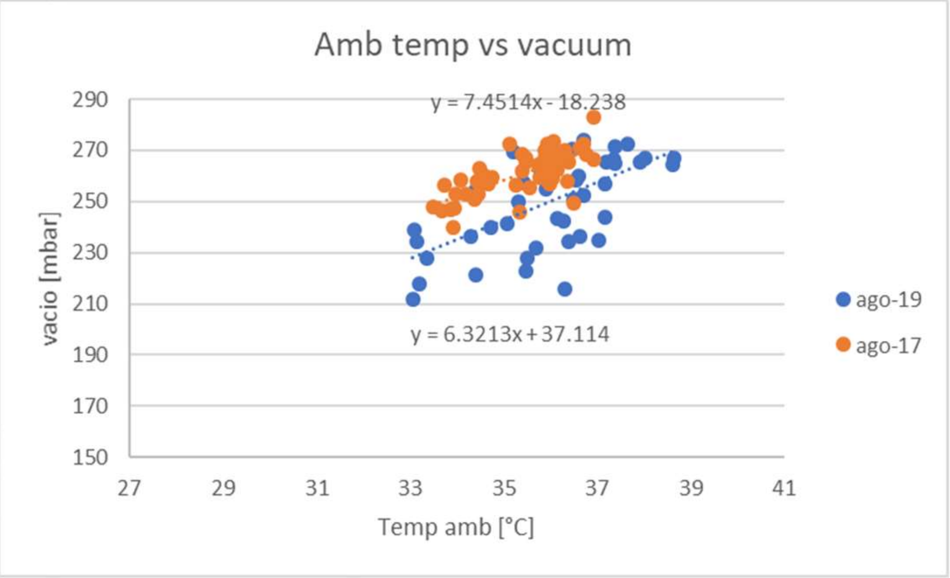
- Data was extracted before and after the Wind Screens installation (base load).
- It is noticed an improvement in the ACC performance when the ambient temperature is greater than **33° C** and the wind speed is greater than **15 km/h** and less than **20 km/h**
- For these conditions, the average improvement noticed is **9 mbarg.**



RBIV VACUUM IMPROVEMENT

CASE 2: WIND SPEED (20-25 km/h) & AMBIENT TEMPERATURE>33° C

- It is noticed an improvement in the ACC performance when the ambient temperature is greater than **33° C** and the wind speed is greater than **20 km/h** and less than **25 km/h**
- For these conditions, the average improvement noticed is **15 mbarg.**



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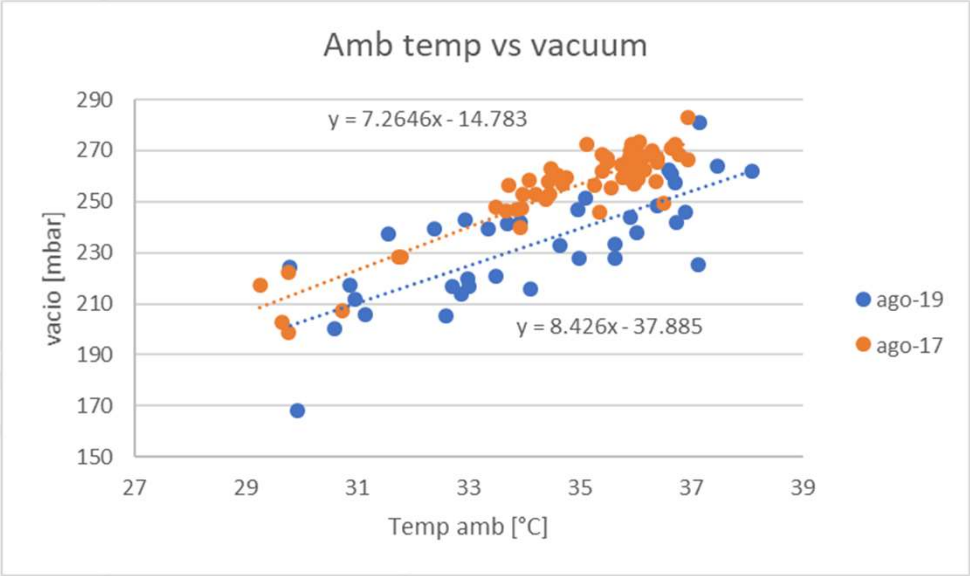
RBIV VACUUM IMPROVEMENT

CASE 3: WIND SPEED (25-30 km/h) & AMBIENT TEMPERATURE>30° C

- It is noticed an improvement in the ACC performance when the ambient temperature is greater than **30° C** and the wind speed is greater than **25 km/h** and less than **30 km/h**
- So the more ambient temperature and wind speed, the more performance recovery will be, thanks to the windscreens.
- For these conditions, the average improvement noticed is **18 mbarg.**



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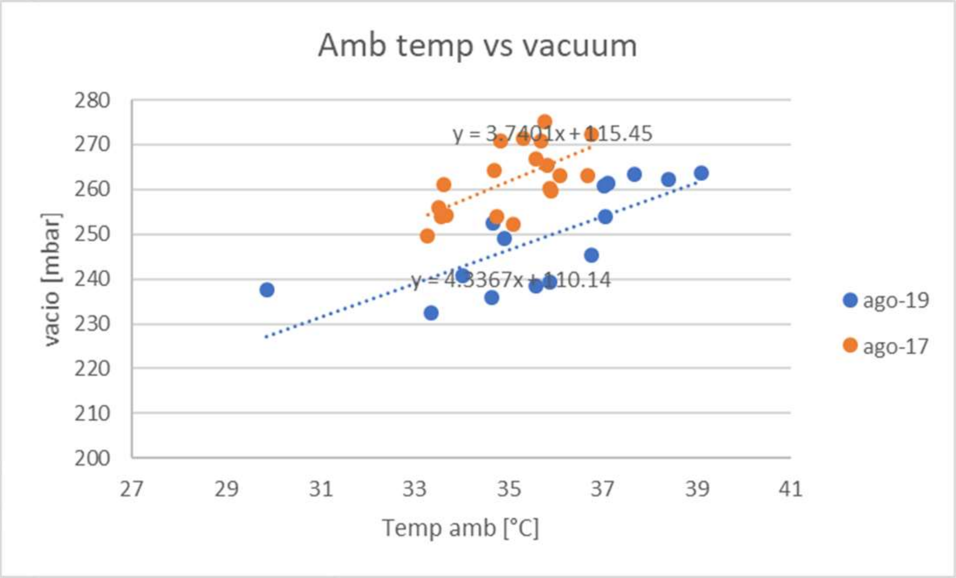
RBIV VACUUM IMPROVEMENT

CASE 4: WIND SPEED >30 km/h & AMBIENT TEMPERATURE>30° C

- It is noticed an improvement in the ACC performance when the ambient temperature is greater than **30° C** and the wind speed is greater than **30 km/h**
- For these conditions, the average improvement noticed is **20 mbarg**.



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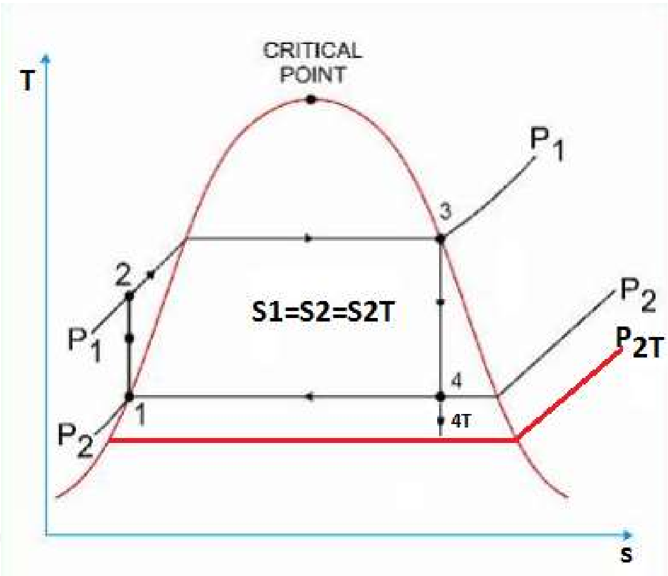
RBIV Power Improvement

EXAMPLE OF CALCULATION OF THEORETICAL ST POWER INCREASE FOR CASE 4



- For 20 mbar of improvement @30° C & Wind speed > 30km/h
- It is considered an isentropic expansion for the calculation.
- We calculate new enthalpy to the expansion of the LP ST to obtain power gain thanks to the improvement of the vacuum.

Wind speed@ 30 Km/h	2017	2019
h in [KJ/Kg/h]	3063	3063
h out [KJ/Kg/h]	2532	2520
steam flow [kg/s]	140	140
power [MW]	74.34	76.02

Power improvement=1.68MW

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Thank You

PI DATA analysis

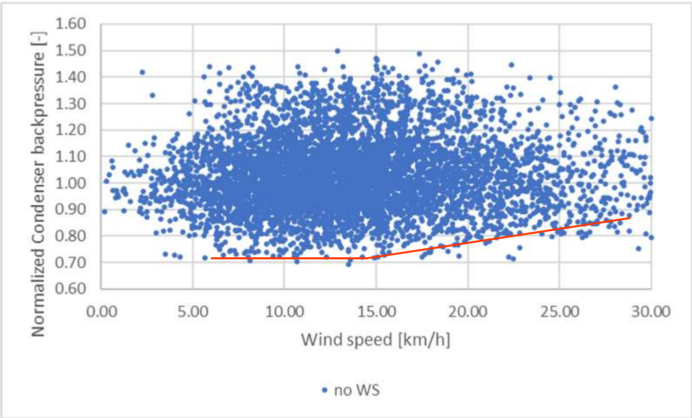
RioBravo plant

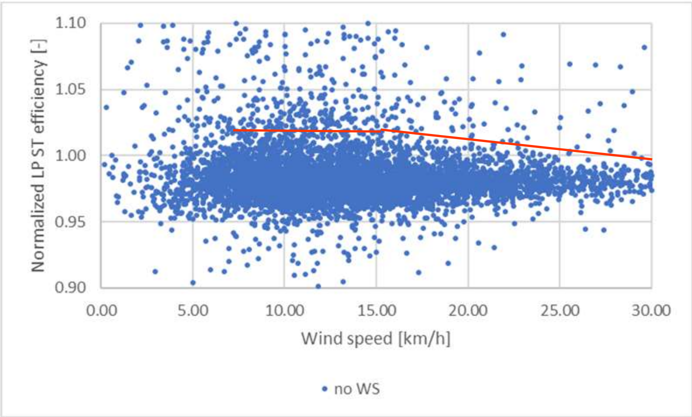
Energia e Meccanica
Ergon research
info@ergonresearch.it
www.ergonresearch.it

Ergon Research
Via Campani 50
Firenze

PI data analysis

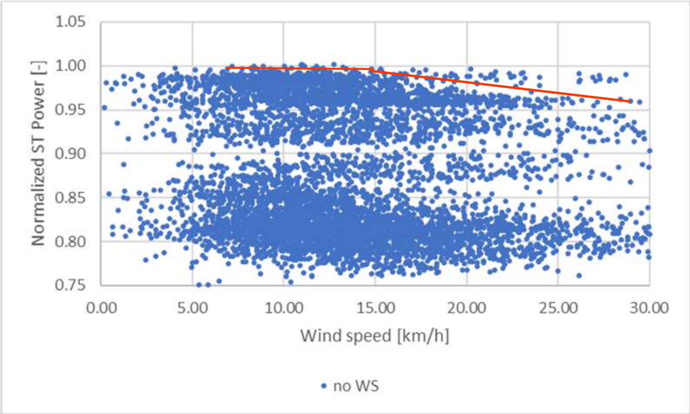
- Deficiencies caused by high wind
  - Analysis extends from January 2017 to March 2018
    - → Filter on hot days 28 °C < T ambient < 32 °C
  - Negative wind effects are registered starting from 15 km/h
    - → Effects highlighted looking at the best performance achieved at given ambient conditions
      - Many other parameters affect plant performance
        - » Instantaneous values are not representative of ACC malfunctioning
        - » Only best (achievable) performance actually depends on bottlenecks at ACC
  - Main deficiencies are related to the low pressure steam turbine
    - → Reduced LP Steam turbine efficiency due to increased condenser backpressure

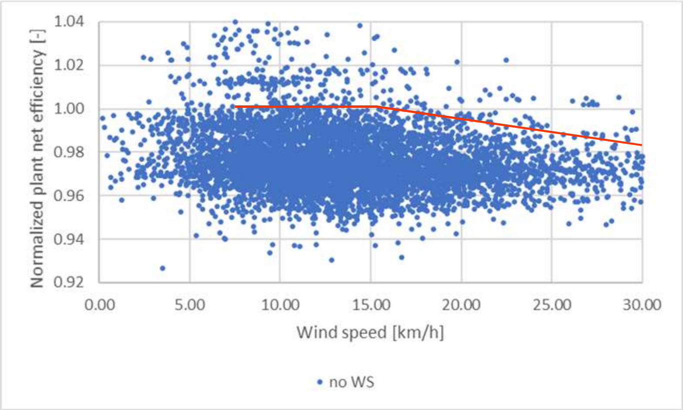




PI data analysis

- Deficiencies caused by high wind
  - Deficiencies related to the low pressure steam turbine has a significant impact on global plant net efficiency
    - → -5% gross steam turbine power at 30 km/h
    - → 1% plant efficiency lost at 30 km/h



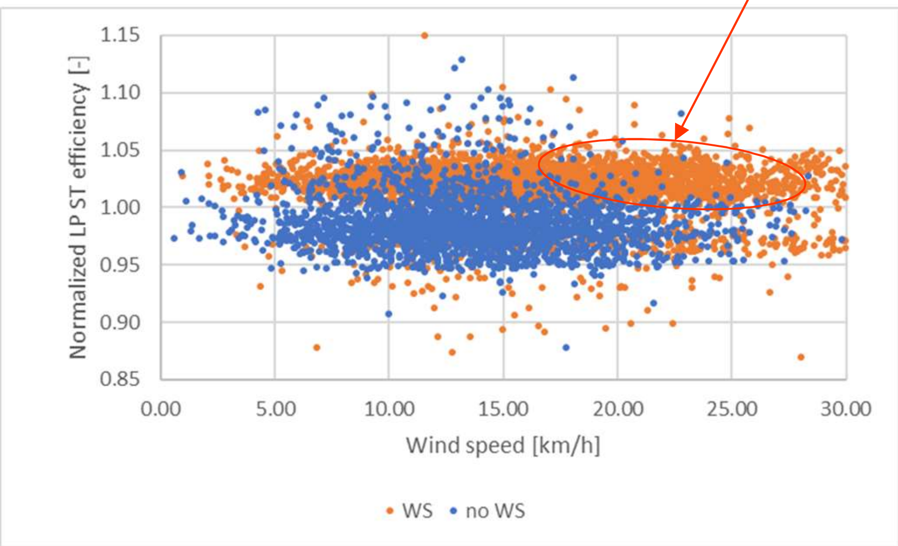


PI data analysis

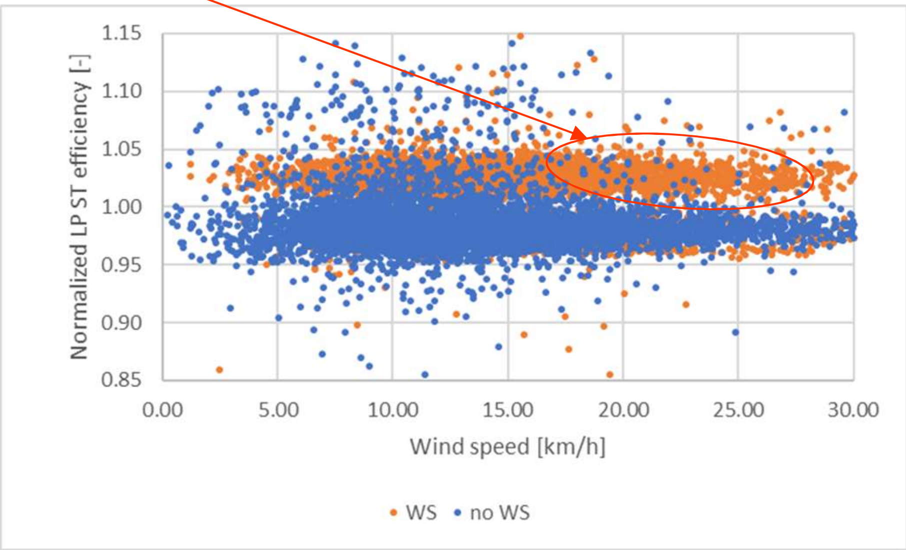
- Installation of wind screen during May 2018
  - Low pressure turbine efficiency is improved for hot and windy weather conditions
  - Some benefits seems gained also at low wind speed

Region of major benefits

T ambient > 32 °C



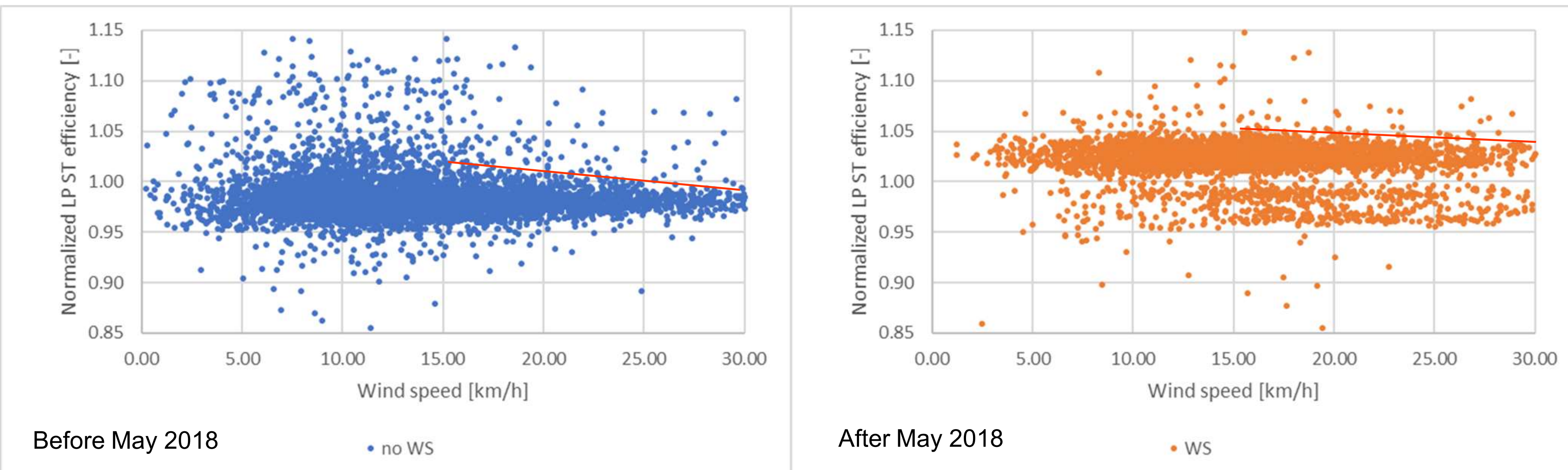
28 °C < T ambient < 32 °C



PI data analysis

- Installation of wind screen during May 2018
  - Deficiencies due to high wind are substantially mitigated by using wind screens
    - → Low pressure steam turbine efficiency drop
      - Without wind screens = -0.2% every +1km/h in wind speed
      - With wind screens = -0.08% every +1km/h in wind speed

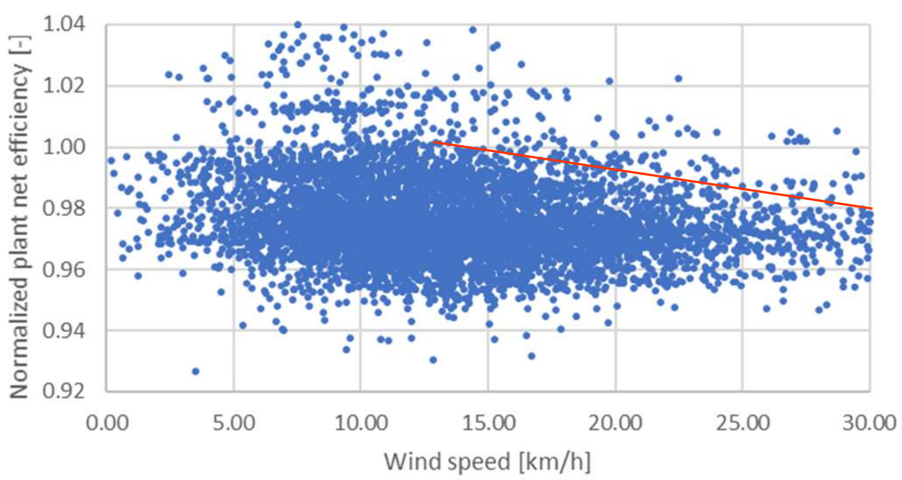
28 °C < T ambient < 32 °C



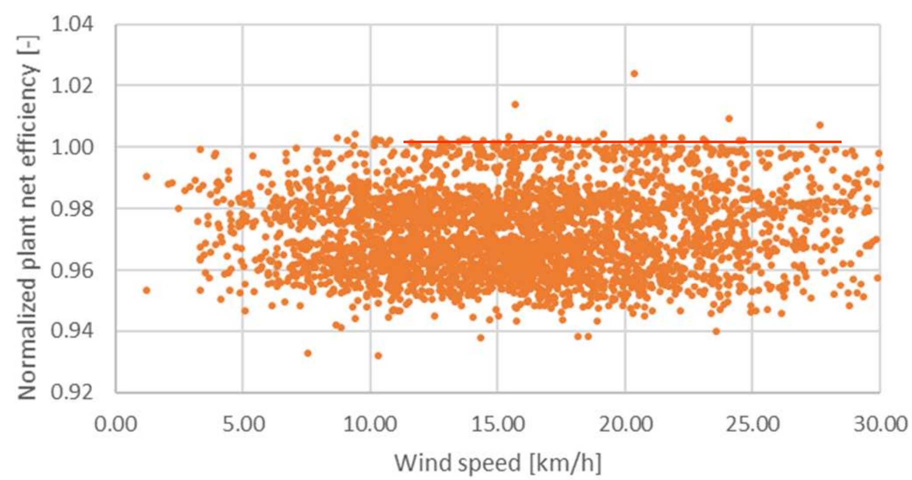
PI data analysis

- Installation of wind screen during May 2018
  - Plant net efficiency becomes with wind screens more independent to wind speed
    - → No efficiency drop is highlighted with wind screens
    - → Without wind screens maximum achievable plant net efficiency drop by 0.08% every km/h

28 °C < T ambient < 32 °C



Before May 2018



After May 2018