



How to Manage Effectively Wind Farms in Real Time

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Operation and Maintenance Manager



Agenda

- About CEMEX Energia
- Business Challenge
- CEMEX Energia Connected Services RM&DC
- PI System® Products & Services applied
- PI ProcessBook®, PI DataLink® & Web Development
- RM&DC Architecture
- Results Obtained and Business Impact
- Demo
- Future plans & Next steps
- Conclusion

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About



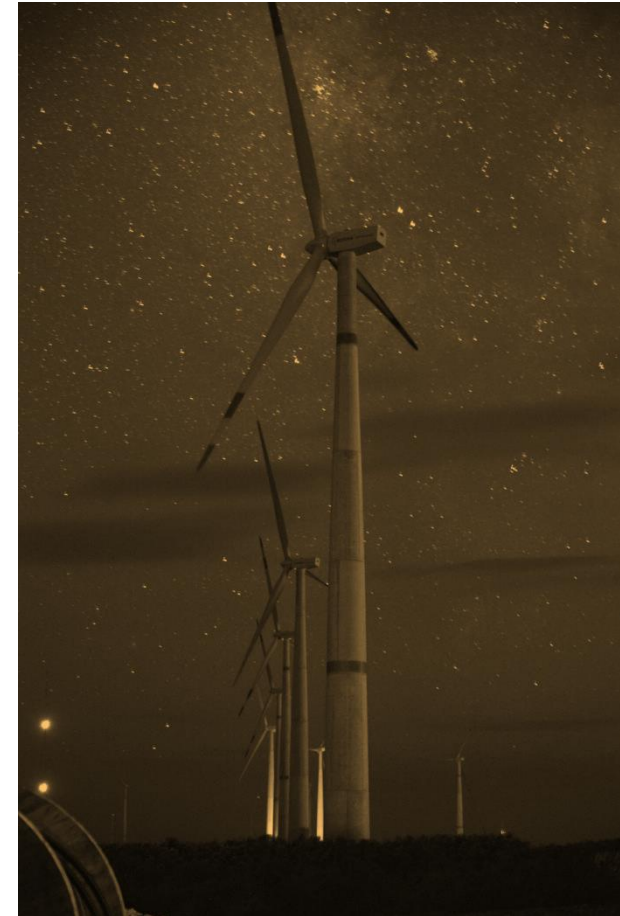
CEMEX has over 20 years participating in the Energy Industry. In 2014 creates its subsidiary - CEMEX Energia.

Mexico: Since 1998, 3 Power Plants developed (~1GW). Two of the largest wind farms in Latina America (+250MW each).

Abroad: Several projects developed in USA, Germany, Philippines, Latin America and Caribbean.

Objectives:

- Reduce electricity costs for cement production.
- Take advantage of opportunities that worldwide Energy Market offers.
- Since '90 reduction of CO₂ emissions and usage of alternative fuels in cement operations.
- Currently working in +20 projects around the world.



About:



Construction:	2001	2007	2014
Commercial Operation:	2004	2009	2016
Location:	Central Zone	South West	North East
CEMEX Role:	Owner of: 100% of Energy and Power output + Petcoke & Limestone supplier	Owner of: 100% of Energy and Power output	Partial Owner of Energy and A portion of Power output + Wind Farm Administrator
Technology:	1 x 230MW Coal-Fired Boiler with Pet Coke	250.5 MW 167 WTGs x 1.5MW	252MW 84 WTGs x 3MW

Business Challenge

Acquire right data infrastructure that allows Real-time monitoring and process data analysis.

Establish a reliable process from data acquisition until storage.

Data management to support Energy Operational Platform.

Enabling a reliable Asset Management strategy to comply with contractual obligations.

24x7 monitoring of Performance and Guarantees compliances of each asset.



CEMEX Energia & OSIsoft: Connected Services RM&DC

Connected Services RM&DC

- CEMEX Energia and OSIsoft entered into an agreement late 2015 in modality of “Connected Services”, which covers Power Plants (Renewable and Conventional) where CEMEX Energia provides Asset Management services – Ventika (wind).

Traditional License

- In late 2016 CEMEX Energia acquired a perpetual license with the aim to include into its “Operational Platform” mainly Electrical variables of TEG (Thermal), Eurus (Wind) and Cement Plants.

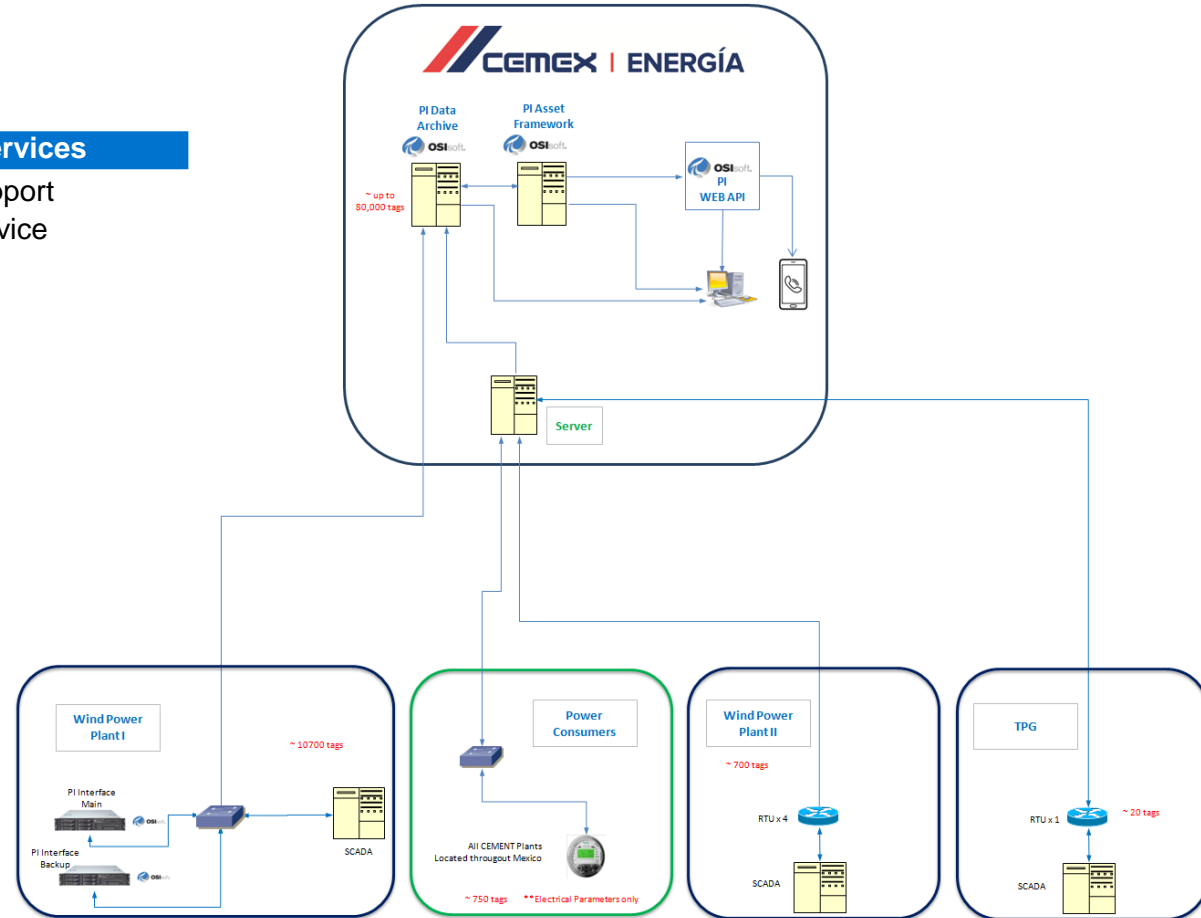
RM&DC Architecture

Products

High Availability (HA) Data Archive
 Asset Framework (AF)
 Notifications
 Event Frames
 PI ProcessBook
 PI DataLink
 PI System Access:
 (PI SDK, AF SDK, **PI WebAPI**)

Services

Tech Support
 Field Service
 Training



PI System® Products & Services applied

Elements

- (NEW) CEMEX Energy Division
 - Renewable Energy
 - Solar Power
 - Wind Power
 - Capacitor Bank
 - BC_55010
 - Feeders
 - F1_51015
 - F2_51025
 - F3_51035
 - F4_51045
 - F5_51055
 - F6_51065
 - Main Feeder
 - TR1_52010
 - TRAFOS
 - TR1_92010
 - TransLine
 - LT_93260
 - Turbines
 - A1.1
 - A1.2
 - A1.3
 - A1.4
 - A2.1
 - A2.2
 - A2.3
 - A2.4
 - A2.5
 - A3.1
 - A3.2
 - A3.3
 - A3.4
 - A3.5
 - A3.6
 - A4.1
 - A4.2
 - A4.3
 - A4.4
 - A4.5
 - A4.6
 - A4.7
 - A5.1

142 Attributes

- Event Frames
- Library
- Unit of Measure
- MyPI
- Notifications
- Contacts
- Management

A5.4

General Child Elements Attributes Ports Analyses Notification Rules Version

Filter

Name	Value
Category: <None>	
GPC	-572 kW
GPC_Dev	0
Guaranteed Power Curve Deviation	0
Plant Wind Speed	11.6346017916997 m/s
PowerOutputSim_PC	0 kW
WindSpeedCorrected	15.15093 m/s
WindSpeedNTF_5m	0 m/s
WTGFaultCounter	2
WTGFaultEventCount	45
WTGWakeCounter	Calc Failed
WTGWakeEventCount	0
Category: 34.5KV TRAF0	
Transformer n°1 temperature	54.82559 °C
Transformer n°2 temperature	58.47406 °C
Transformer n°3 temperature	55.46552 °C
Category: Alarms Groups	
Alarms Set 01	0
Alarms Set 02	0
Alarms Set 03	0
Alarms Set 04	0
Alarms Set 05	0
Alarms Set 06	1024
Alarms Set 07	0
Alarms Set 08	0
Alarms Set 09	32768
Alarms Set 10	0
Alarms Set 11	0
Alarms Set 12	0
Alarms Set 13	513
Alarms Set 14	128
Alarms Set 15	0

A5.4

General Child Elements Attributes Ports Analyses Notification Rules Version

Name	Backfilling	
f	Production Power	✓
f	Total PowerLoss	✓
H	Turbine Communication Fail	✓
H	Turbine Curtailment	✓
H	Turbine Fault	✓
H	Turbine Out of Operation	✓
f	Wind Direction Corrected	✓
H	WSM_Outside_Eval	✓
H	WSM_Outside_Notifications	✓
f	WTG.Availability_Daily	✓
f	WTG.Availability_MTD	✓
f	WTG.PowerProduction_Daily	✓
f	WTG.PowerProduction_MTD	✓
H	WTG_General Trip	✓

Event Frame Template: WTG_Amb_Conds

Name	Expression	True for	Severity	Value at Evaluation time	Value at Last Trigger time
WSMRange2_1	Variable2 > 'WSM_Range2_Val1'				
WSMRange2_2	Variable2 < 'WSM_Range2_Val1'			False	False
WSMRange1Eval	if WSM_Range1_1 = "True" and WSM_Range1_2 = "True" Then 1 else 0			0	0
WSMRange2Eval	if WSM_Range2_1 = "True" and WSM_Range2_2 = "True" then 1 else 0			0	0
WindSpeedEval	if '1 Min Average Wind Speed' > 'WindSpeed_RangeLow' and '1 Min Aver...			0	0
ConditionSectorManagementEval	if (WSMRange1_Eval = 0 or WSMRange2_Eval = 0) and WindSpeed_Eval =			0	0
ConditionEval	if OperState_Conditional = 1 and WALM6_Eval = 1 and WindSectorMana			0	0
StartTrigger2	ConditionEval = 1	30 minutes	None	False	False
EndTrigger1	ConditionEval <> 1			True	True

Add a new variable Add a new start trigger

Evaluation Time: 06-Mar-17 10:30:04 AM Last Trigger Time: 06-Mar-17 10:29:18 AM

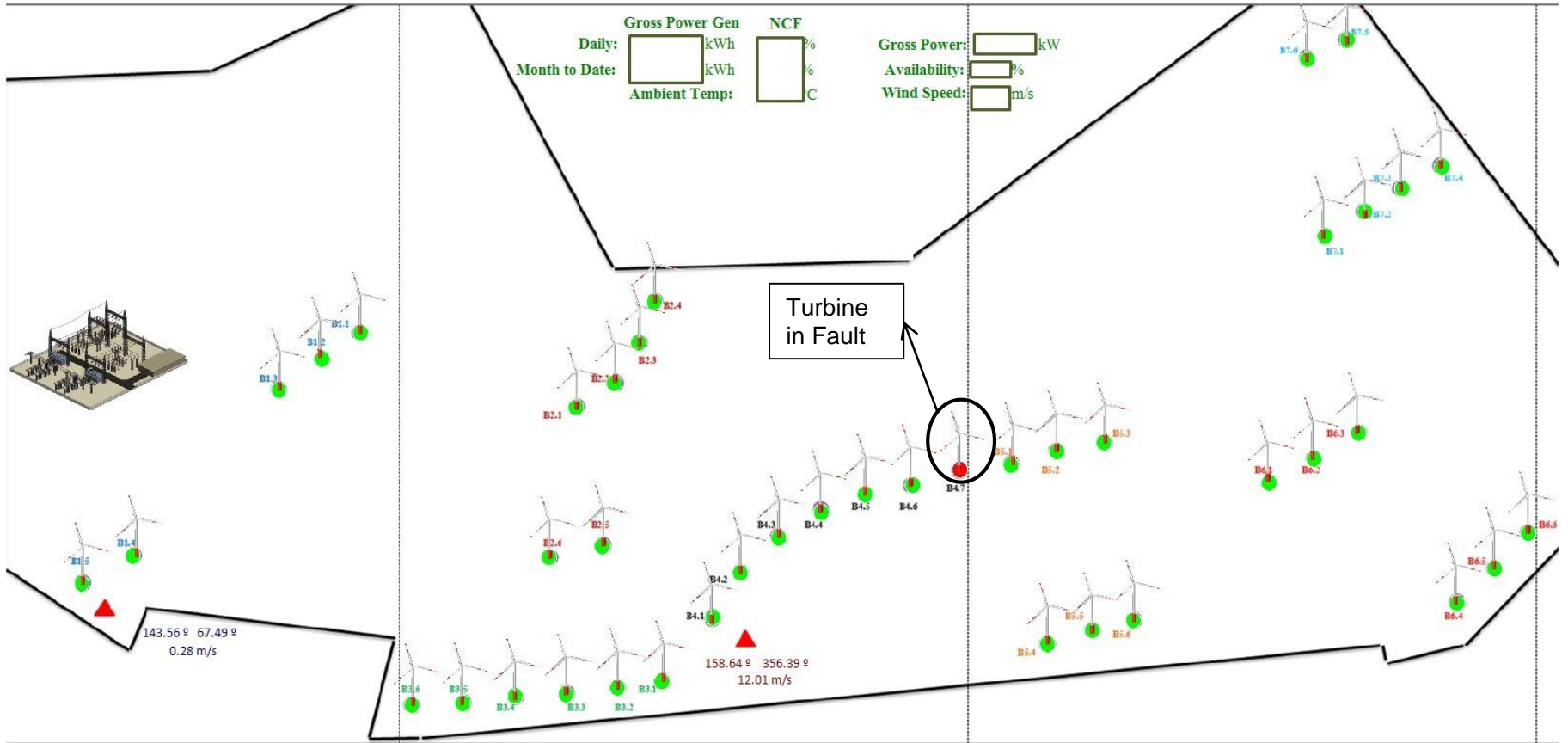
Scheduling: Event-Triggered Periodic

Trigger on Any Input

Advanced Event Frame Settings...

: 01-Jan-70 12:00:00 AM, Revision 16

PI ProcessBook®



A5.4 Emergency

Power Output: 0 kW

Daily Production: ██████ kWh

Monthly Production: ██████ kWh

Availability_Daily: ██████ %
Availability_Monthly: ██████ %

Electrical Parameters	Gearbox Parameters	34.5KV Trafo
Reactive Power: 0.0 kVAr	Oil Pressure: -1.5 bar	Phase R Temp: 56.6 °C
Voltage: 12,104.0 V	Oil Temperature: 57.6 °C	Phase S Temp: 60.0 °C
Current: Calc Failed	Bearing temp: 60.9 °C	Phase T Temp: 57.2 °C
Frequency: 60.00 Hz	High Speed temp: NO DATA	Power Converter
Power Factor: Calc Failed	HighSpeed shift Press: 1.3	
Generator Parameters		Coolant Temp: 33.0 °
Cooler Temp: 32.6 °C		DC Bus Voltage: 0.0 V
Main Shaft		Pitch System
GBX-GEN Brg Temp: 68.00 °C	Front bearing temp: 32.0 °	
GEN Free Brg Temp: 60.2 °C	Rear bearing temp: 34.7 °	Blade 1 Pressure: 219.48 bar
Generator Speed: -0.3 rpm	Rotor Speed: 0.2 rpm	Blade 2 Pressure: 218.99 bar
Gen Winding U Temp: 106.2 °	Yaw System	
Gen Winding V Temp: 106.9 °	Blade 1 Position: 91.07 °	
Gen Winding W Temp: 107.1 °	Hyd Pressure Yaw: 157.9 bar	Blade 2 Position: 91.27 °
Generator Rings Temp: 30.4 °C	Yaw turns number: 1.39	Blade 3 Position: 91.28 °

Hydr. Group Oil Temperature
44.34 °C

Nacelle Temperature
31.55 °C

Ambient Temperature
25.01 °C

Wind Speed
13.29 m/s

Wind Direction
11.96 °

Turbulence Index
24.24 %

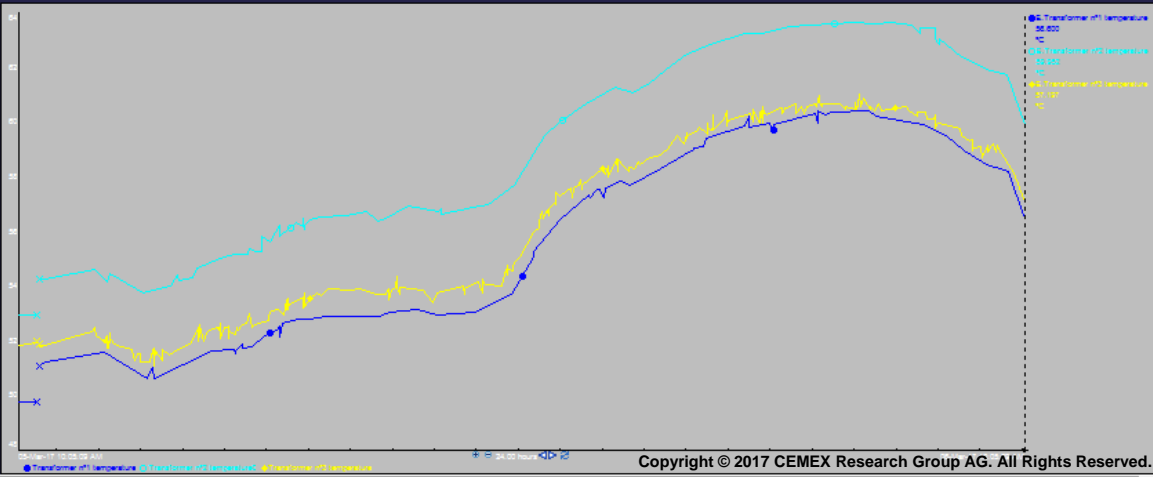
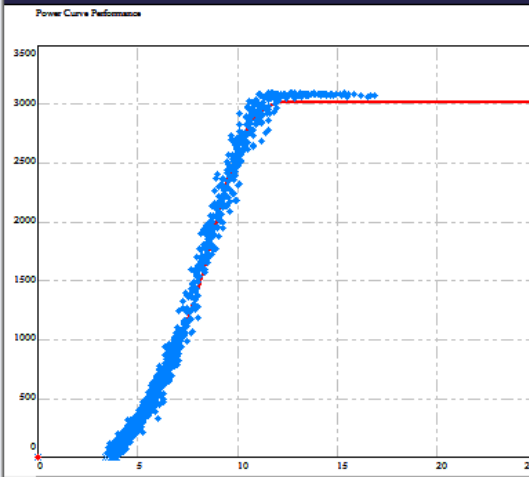
Vibration Level
1.99 %

Place for Turbine Manufacturer

Hydr group Pressure
152.6 bar

Back to main

Alarm Panel



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For every Turbine, SCADA system provides 33 alarms that consists of 16 bit word each one.

!Big functionality!: placing above each red square it will show a tooltip with the description of activated alarm, as shown in picture.

Examples:

(*) Alarm 6 has **“on”** slot 10 equivalent to 1024.

(*) Alarm 9 has **“on”** the slot 15 equivalent to 32768

(*) Alarm 13 has **“on”** the slots 0 (1) and 9 (512), equivalent to number 513.

A5.4 Emergency

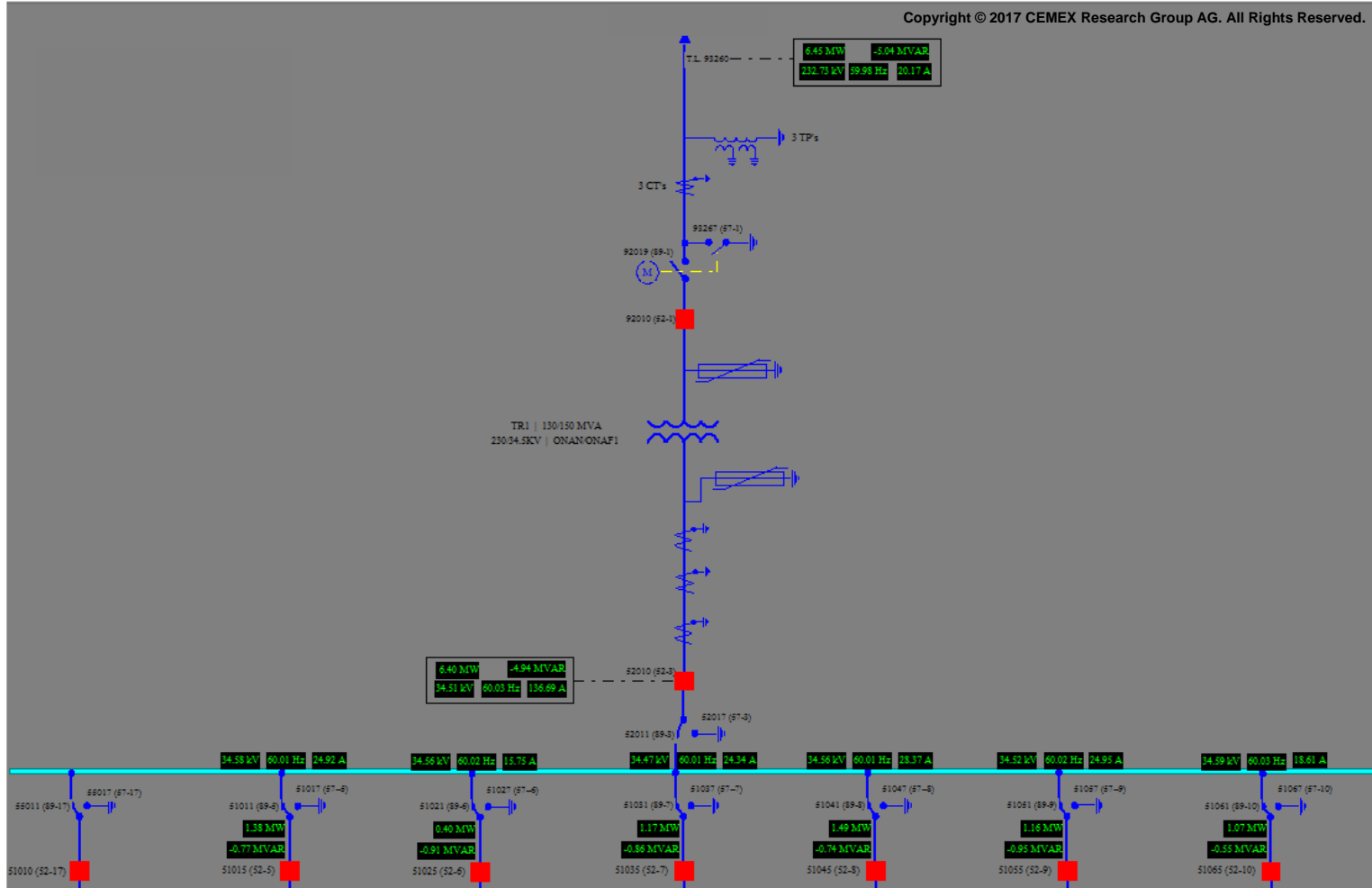
Alarm Panel

Back to Turbine
Back to Main

The screenshot shows a grid of 33 alarm rows. Each row consists of 16 bit slots. The following table summarizes the active slots for each alarm:

Alarm ID	Active Slots
Alarm 2	None
Alarm 4	None
Alarm 6	Slot 10
Alarm 8	None
Alarm 10	Slot 15
Alarm 12	None
Alarm 14	Slots 0 and 9
Alarm 16	None
Alarm 18	None
Alarm 20	None
Alarm 22	None
Alarm 24	None
Alarm 26	None
Alarm 28	Slot 15
Alarm 30	None
Alarm 32	None

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Event Reports:

- Based in PI Event Frames ®. Allowing us to focus in assets with high frequency of failure to stablish action plans.
- Allow us to track KPIs such as: MTBF and MTTR.
- Detect the cause of failures (Alarms) through the conversion from each 16bits to alarm descriptions.
- Allow us to calculate Lost Production and its related wind speed per event with aim to monetize.

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Monday, March 6, 2017

WTG Highest Failure Rate: **A7.1**

Total Unavailable Time: _____ Avg. Failure Rate: _____

Start Time: 01-C 0:00:00

End Time: 01-C 0:00:00

Manual

Turbine	Start Time	End Time	Duration	Operational/Fault	Wind Speed	Production Los	Alarm 1 to 5
A6.7	09:57	18:59	1:02:29	Emergency	13.38		YAW Starter contactor no feedback Vibrations sensor trip Safety system no OK (PLC) Hardware modules error
A5.1	10:54	23:42	1:48:10	Stop	7.61		
A3.2	07:32	09:23	:51:20	Emergency	5.97		Safety system no OK (PLC)
A6.1	10:10	10:15	:04:50	Stop	5.78		
A5.6	10:16	11:53	:37:00	Stop	6.88		
A6.2	10:21	11:50	:29:28	Stop	6.43		
A5.4	10:25	12:14	:49:00	Maintenance	6.48		Local EMERGENCY command

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Manual

Yesterday WTD

Today MTD

Start Time

End Time

Manual Start

Manual End

Total Power Generation _____ KWh

Lost Production _____ KWh

Expected Yield _____ KWh

Contractual Availability (Time base) _____ %

Turbina	Wind.Speed m/s	Real.Production KWh	Emergency		Fault		Stop		Pause		Contr.Stop		Ambient Cond		Maintenance		Manual		Grid Error		Curta
			mins	KWh	mins	KWh	mins	KWh	mins	KWh	mins	KWh	mins	KWh	mins	KWh	mins	KWh	mins	KWh	mins
.1			1,144	45,254.7	7	32,241.9	352	10,796.4	264	4,155.6	90		5,392	5,701	120,053.1	2	44.3	1	50.5	0	
.2			203	4,773.9	102	9,963.7	385	12,263.7	482	10,552.5	101		6,232	769	12,342.0	7	284.3	1	0.0	0	
.3			21	453.3	313	3,182.9	15	268.8	161	584.0	84		6,315	877	7,460.3	0	0.0	0	0.0	0	
.4			78	3,519.4	1	4.3	178	1,770.1	174	801.1	81		6,316	738	15,132.3	1	0.0	1	0.0	0	
.1			193	5,152.2	232	15,468.0	88	1,288.5	142	578.2	93		5,769	440	10,991.7	1	0.0	32	1,520.4	0	
.2			94	3,329.2	109	86.6	92	691.3	152	803.6	102		5,767	371	7,484.1	0	0.0	0	0.0	0	
.3			16	339.0	162	49.7	427	11,347.1	601	16,037.7	106		6,040	347	5,286.1	2	24.3	57	2,819.6	0	
.4			486	10,595.4	94	11,313.6	393	11,870.1	207	2,250.6	115		6,048	579	8,477.1	1	0.0	1	0.0	0	
.5			40	124.8	1	0.0	55	2,247.9	153	1,593.8	73		6,295	268	2,931.8	1	0.0	0	0.0	0	

Operational Report:

- Count the time that turbines have in each operational state (run, fault, emergency, maintenance, ambient conditions, etc.).
- According to relative time, calculates contractual availability per turbine and entire Wind Power Plant.

Notifications

- (i) Turbine trips
- (ii) Circuit Breakers Operations (MV/HV)
- (iii) Communication issues.
- (iv) Wind Sector Management (Turbines in Wake Effect).
- (v) Ambient temperature above safe operation.
- (vi) Reactive Power as Power consumer.
- (vii) Data freeze.
- (viii) Power Curve performance



B3.2 | Turbine in Wake Effect_Outside of WSM Limits | System: Turbines | Plant: Plant name | Ambient Cond |
PINotifications to: robertocarlos.medrano

[TURBINE B3.2 | Turbine in Wake Effect_Outside of WSM | Ambient Cond](#)

Plant Name: Plant name

Turbine: B3.2

Stoppage Reason: [64 - *Turbine in Wake Situation*] (The value 64 coming directly from SCADA and its processed in our system).

Start Time: 8:47:54 PM Central Standard Time (Mexico) (GMT-06:00:00)

Notification Time: '9:18:01 PM Central Standard Time (Mexico) (GMT-06:00:00)

End Time: 12/31/9999 11:59:59 PM Central Standard Time (Mexico) (GMT-06:00:00)

This e-mail has been generated automatically due to Turbine **B3.2** changes its operational state from "Running/Ready" to "Ambient Conditions", because the alarm "Turbine in Wake Situation" it has been active over 30 minutes.

The Wind Sector Management set under the unavailability when Turbine **B3.2** stops in next intervals:

Range 1: 72 ° - 95 °

Range 2: 252 ° - 275 °

Wind Speed Range: 4 m/s - 11 m/s

Wind Direction measured: {Error retrieving result} ° | **Wind Speed measured:** 9.1002 m/s

Wind Speed: 9.1002 m/s.

Ambient Temperature: 17.51142 °C.

Power Output if Running: 911.6437 KW

WTG Stops [Wake Situation]:

¡TIME TO EVOLVE!



DEMO

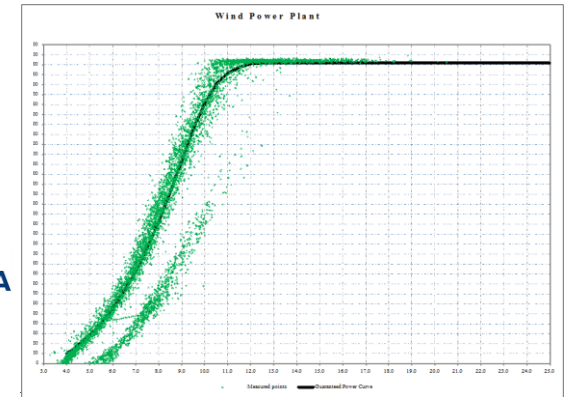


ENERGY OPERATIONAL PLATFORM

Timely detection of Turbines with underperformance – Power Curve

COMPANY and GOAL

CEMEX Energia is aware about underperformance in WTGs, due to this impacts directly in its KPIs (technical, contractual and economics).



CHALLENGE

Maximization of Wind Resource available in Wind Farm.

- Meet the Power Generation and incomes budget.
- Compliance of Contractual guarantees

SOLUTION

Creation of a specialized and reliable Analysis Tool which measures deviations of Real vs Guaranteed behavior in real time.

- Through PI System we gathered key information of every turbine to build algorithms.
- Realtime visualization of every turbine. Each deviation is detected quickly

RESULTS

Avoidance of Lost Production due to inefficiencies in turbine performance.

- Timely detection of turbines with bad performance.
- Diligent reparations and turbines with high performance in long term.
- Contractual guarantees under compliance.

Future Plans & Next Steps

Monitoring

- Include TEG (Thermal – CFB) and Eurus(Wind Farm) to Operational Platform.

Grid Code

- Attach Electrical Parameters of Cement Plants to manage the compliance of grid code.

Metering

- CEMEX Energia manages power meters (~3000). Under evaluation to use OSIssoft in upcoming projects.

Conclusions

- The high reliability of OSIssoft products, specially PI System and all its functionalities enabling us to provide: (i) effective asset Management, (ii) High Quality Services, (iii) Trust and credibility, (iv) Value added, and (v) Anticipation and Timely reaction in favor to our final Customers.

“No PI then NO Gain”

Contact Information

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Questions


Please wait for the **microphone** before asking your questions



State your **name & company**

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감사합니다

谢谢

Danke

Merci

Gracias

Thank You

ありがとう

Спасибо

Obrigado