EDC's 5Cs Digitalization Strategy

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Chief Technology and Digital Transformation Officer

Energy Development Corporation (EDC)

- 40 years of Geothermal Operations in the Philippines
- 4 Sites nationwide with a total of 25 Operating Turbine Units
- EDC is part of the First Gen Corporation ("First Gen") Group, which has the largest portfolio of power plants using clean and renewable technology in the Philippines with capacity of 2,763 MW – about 10% of the total Philippine Capacity 13,272 MW.


GEO
ASC Ref. E009N083116E

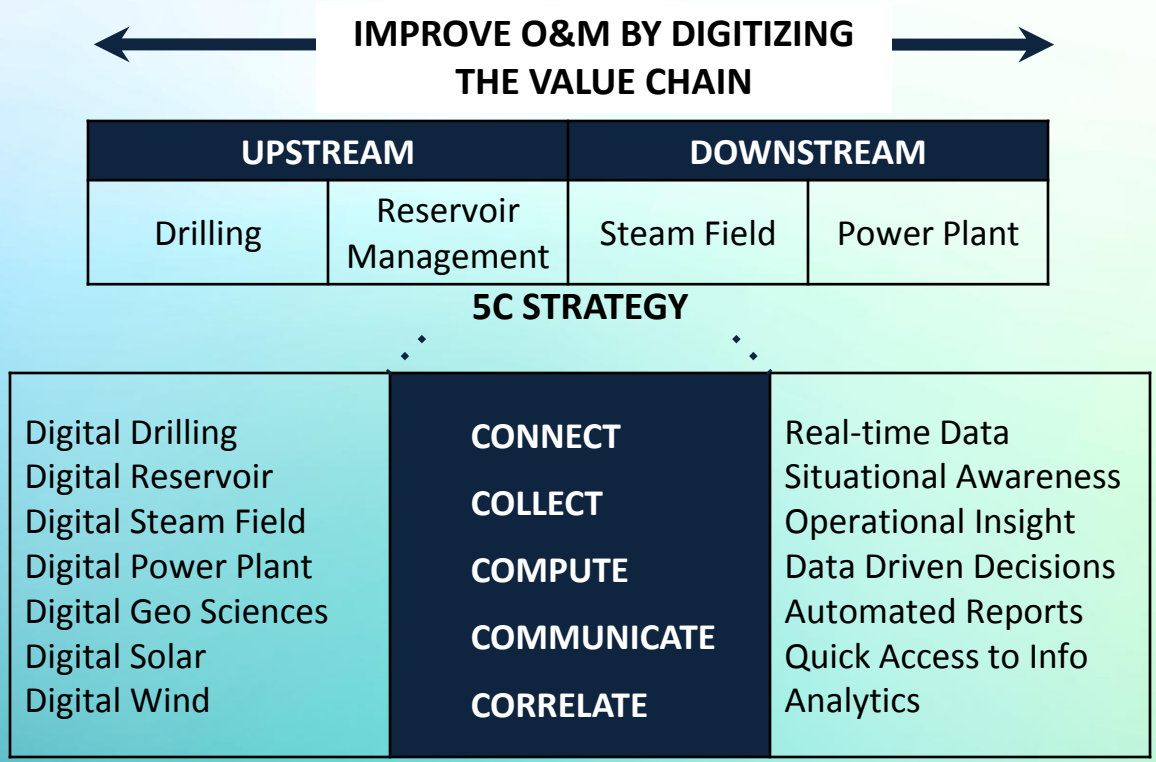
Some of EDC's Operational Challenges

- 2018 Unplanned Outage Factor at 13.72%
- 2018 Availability Factor at 84.81% (Target is 95%)
- 90% of Preventive Maintenance Schedule (PMS) has extended work
- Silo'ed data – Operations & Maintenance, Reliability Management, Power Plant Data, Steam Field Data.
- Incomplete fleetwide operational data standards
- Limited operational awareness of well performance
- Heat/steam losses along the Steam Filed Pipeline network
- Data management by Excel/Screenshot/CSV files

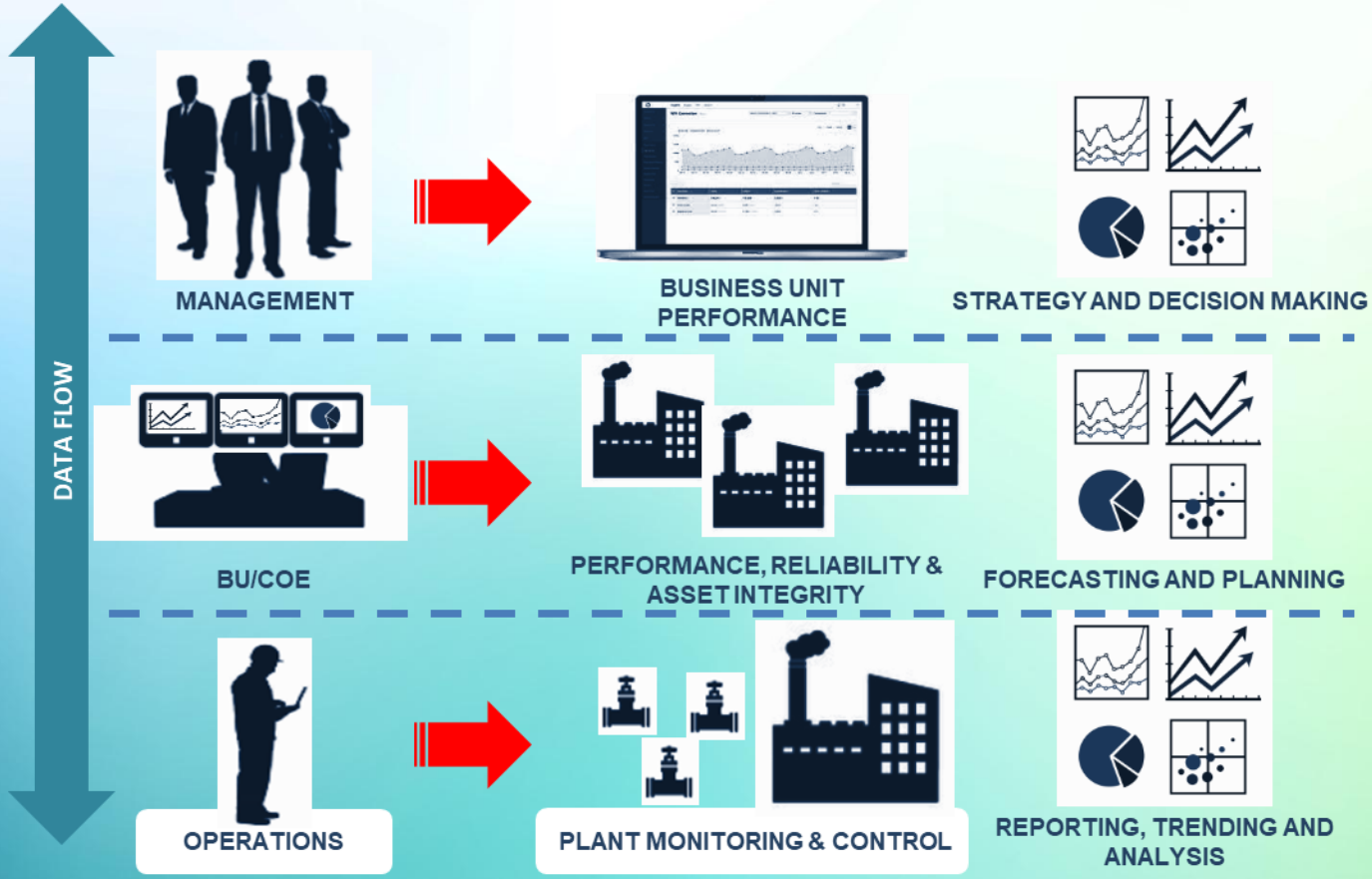
OBJECTIVE

Improve Operation & Maintenance by leveraging Operational Data - data generated by our assets

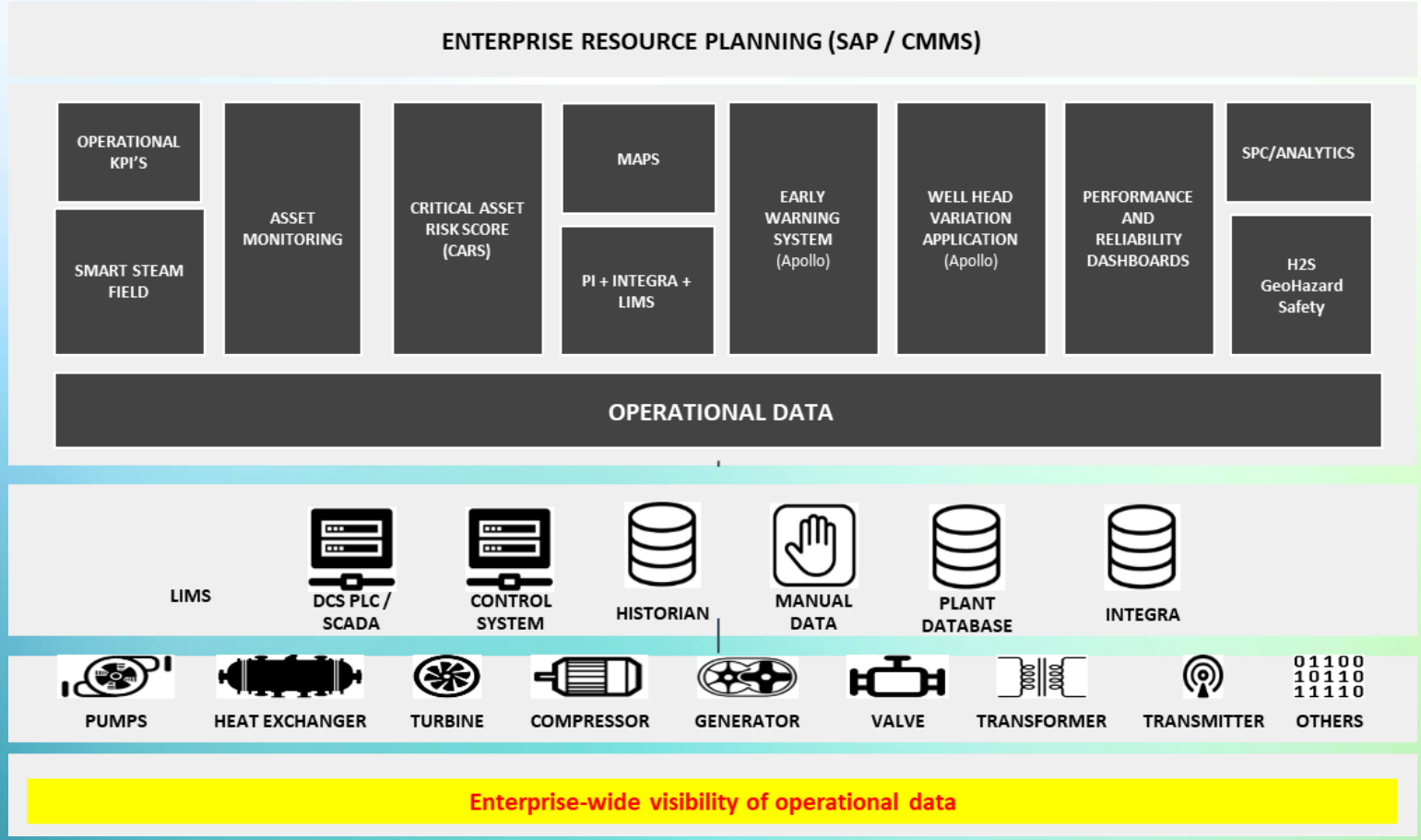
Digital Transformation Vision and Strategy



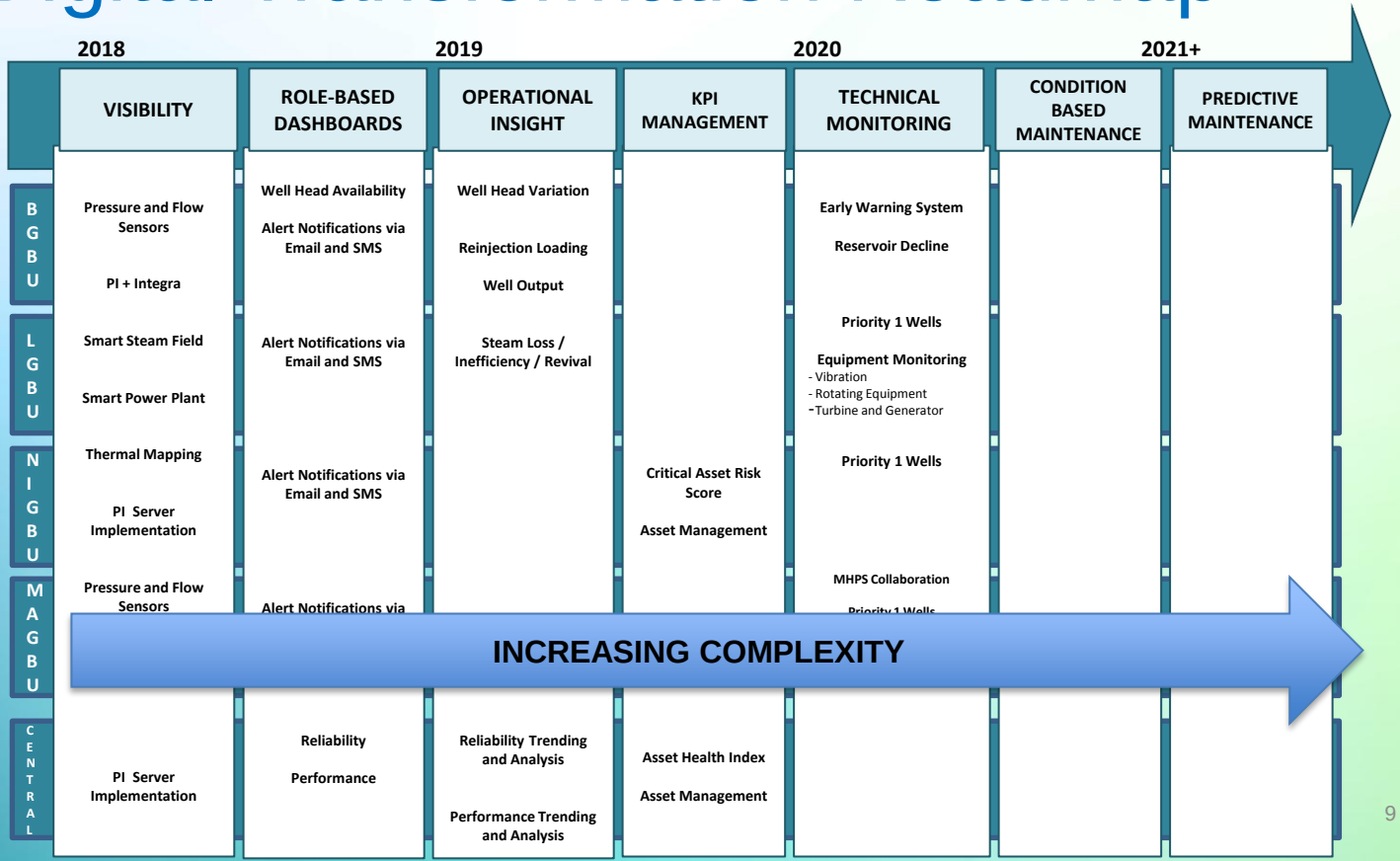
DELIVER OPERATIONAL INSIGHT WITH VISIBILITY AND REAL-TIME DATA



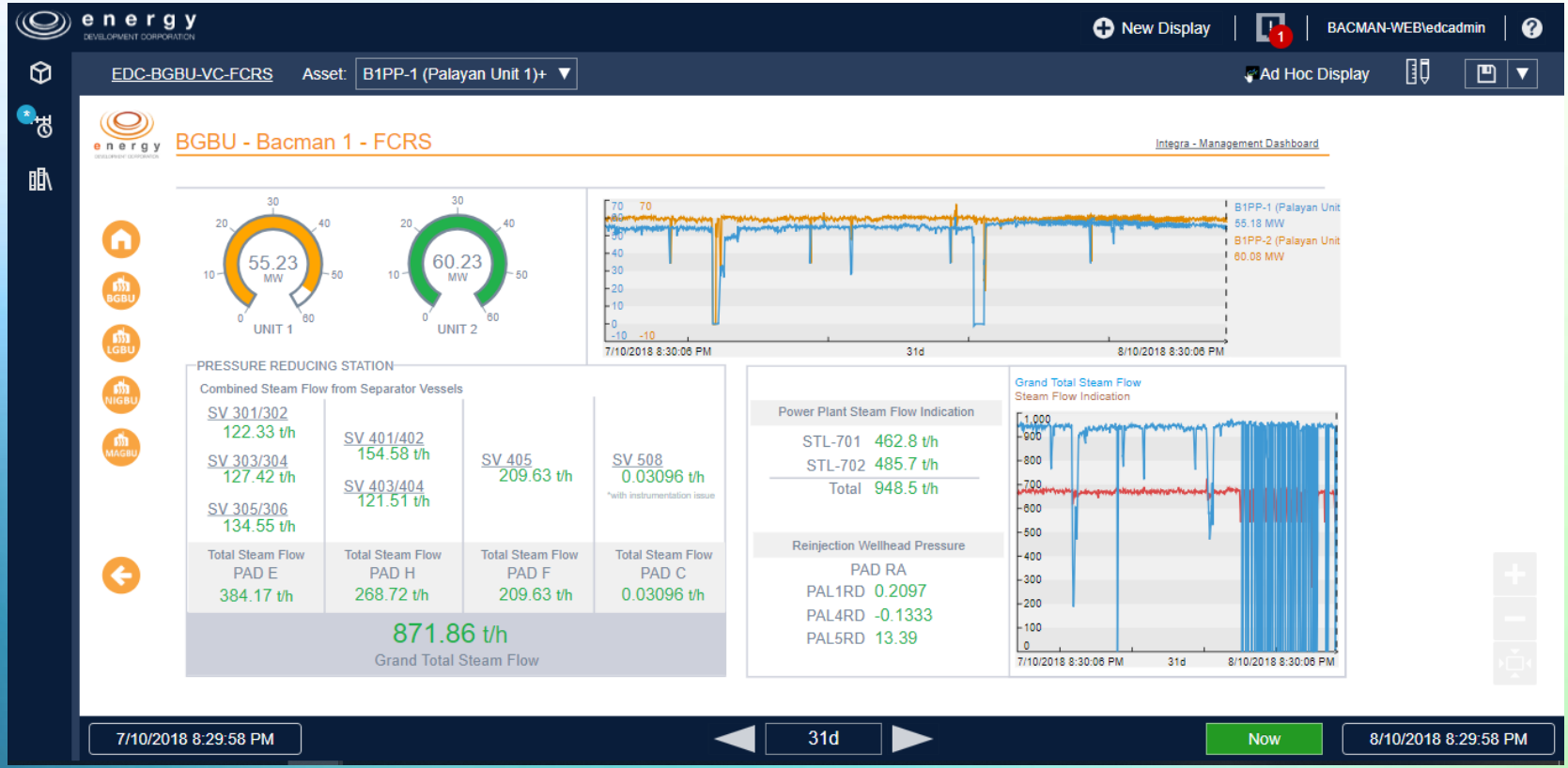
Operational Data Flow



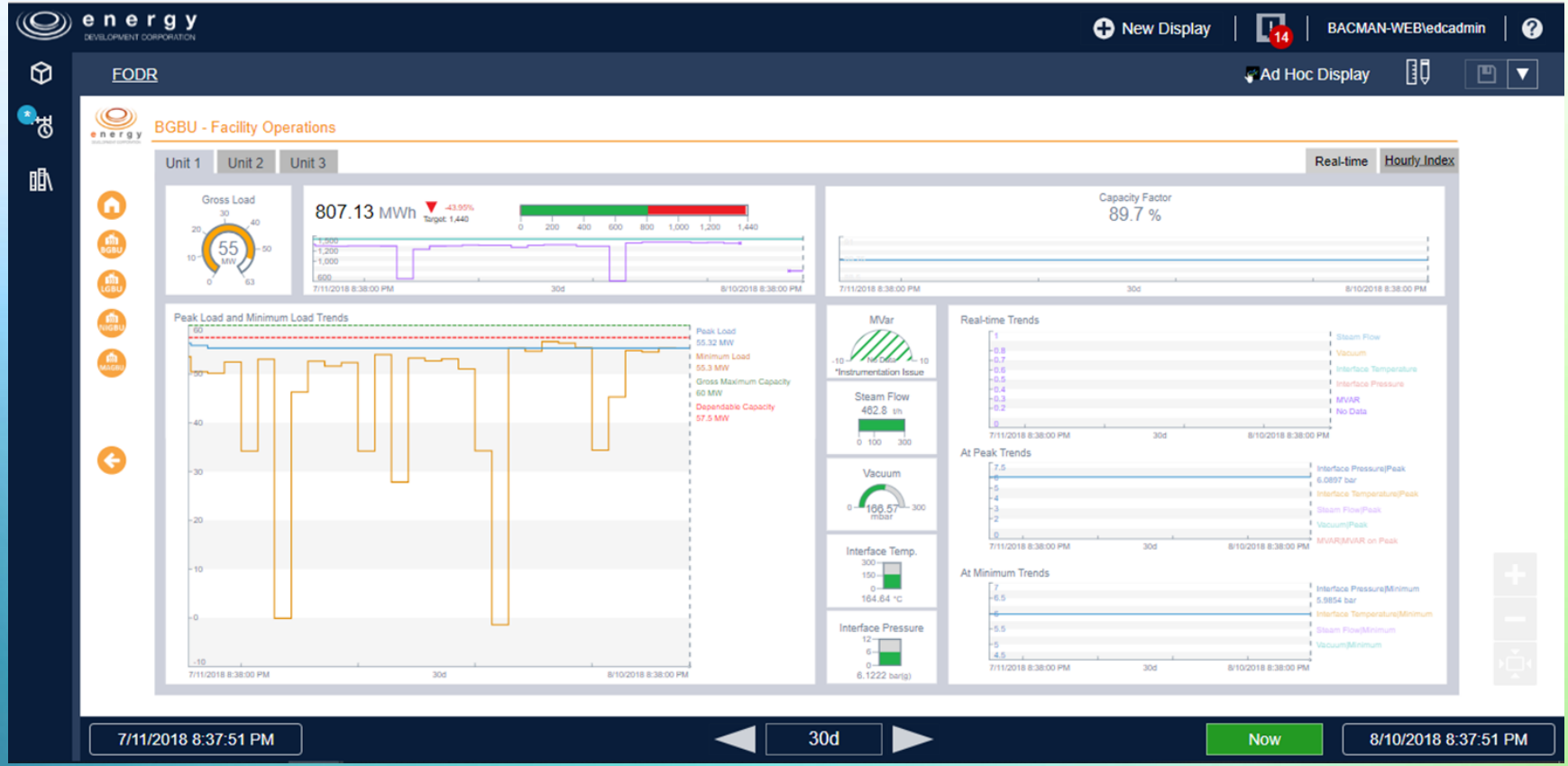
EDC Digital Transformation Roadmap



PI Vision Displays



Facility Daily Operation Report (FODR) – Real Time

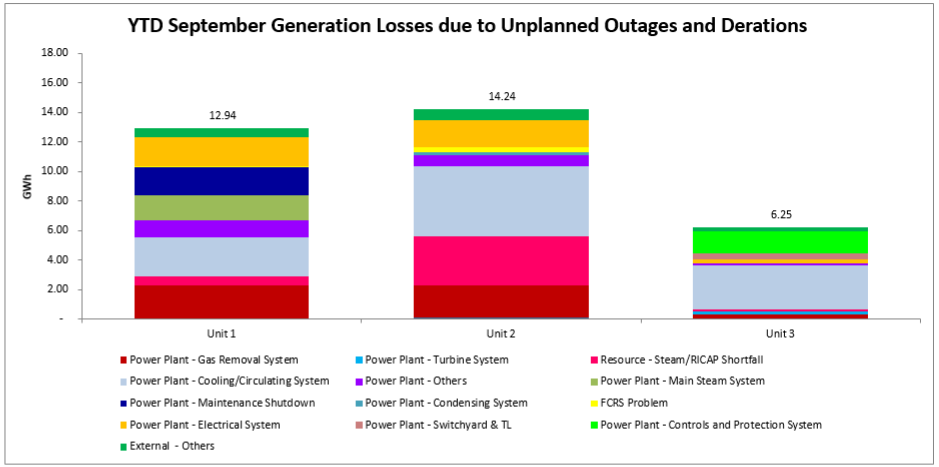


Sample Datalink Reports

YTD September Total Unplanned Outage and Deration

in GWh

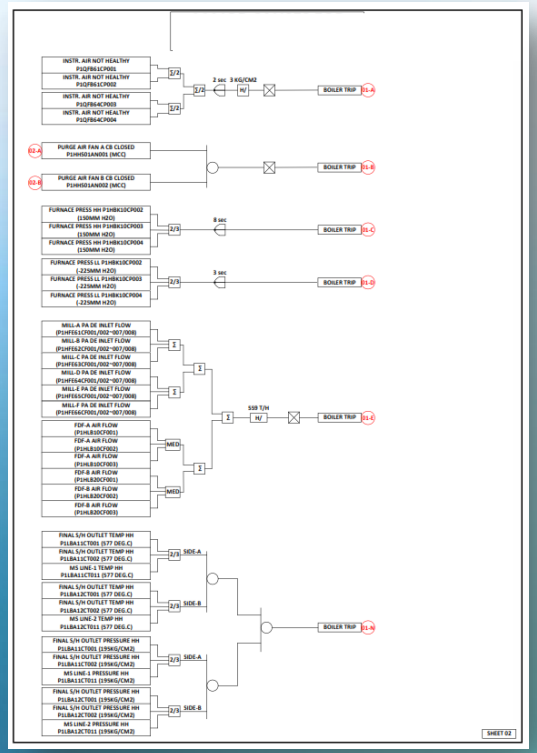
Unplanned	Unit 1	Unit 2	Unit 3	Total
External - Market Intervention	0.08	0.11	0.03	0.22
Power Plant - Gas Removal System	2.19	2.17	0.30	4.66
Power Plant - Turbine System	-	0.02	0.20	0.22
Resource - Steam/RICAP Shortfall	0.61	3.27	0.11	3.99
Power Plant - Cooling/Circulating System	2.69	4.79	3.02	10.49
Power Plant - Others	1.10	0.76	0.13	1.99
Power Plant - Main Steam System	1.70	-	-	1.70
Power Plant - Maintenance Shutdown	1.93	-	-	1.93
FCRS Testing	-	-	-	-
Power Plant - Generator System	-	-	-	-
Power Plant - Condensing System	-	0.16	-	0.16
FCRS Problem	0.04	0.39	-	0.43
Power Plant - Electrical System	1.99	1.79	0.25	4.02
Power Plant - Switchyard & TL	-	-	0.45	0.45
Power Plant - Controls and Protection Syst	-	-	1.44	1.44
External - Others	0.61	0.77	0.32	1.71
External - Force Majeure	-	-	-	-
Total	**12.94**	**14.24**	**6.25**	**33.42**

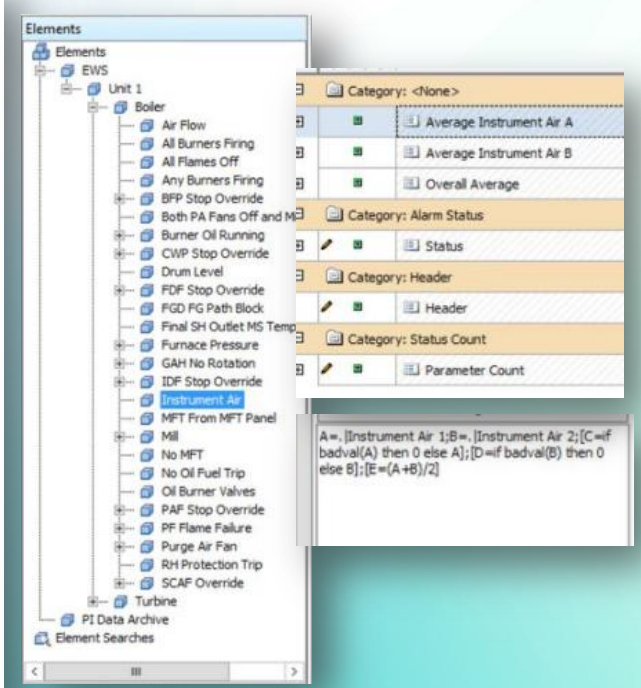


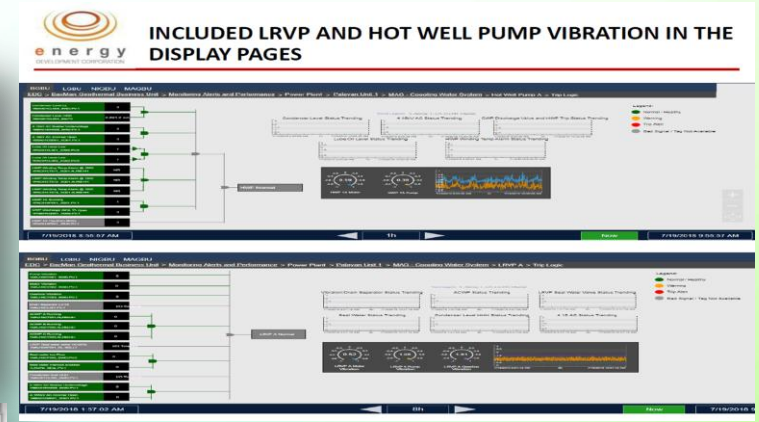
Top 80% Unplanned Outages/Derations

Unit	Outages/Deration	eneration Loss (MW	Cause Code Category	ion Cause of Outage/De	Actions Taken
Unit 1	Outage	2,671	Power Plant - Cooling/Circu	• Unstable water level at n	• Maintenance personnel replaced cooling water discharge valve shaft positioner connecting link• Replaced burnt solenoid coil
Unit 1	Outage	1,701	Power Plant - Main Steam S	• Actuation of Demister lev	• Reset alarm and re-start the unit • Conducted welding works on the detached bracing on the main steam line strainer #2
Unit 1	Outage	1,933	Power Plant - Maintenance	Extended PMS due to dela	Re-start the unit and put back to commercial operation
Unit 1	Outage	1,986	Power Plant - Electrical Sy	• Loss of 480V power supp	• Open vent of Buchholz relay to release trapped gas. • Reset actuated alarm and conducted loop check
Unit 1	Deration	1,769	Power Plant - Gas Remova	Low Condenser vacuum	Fine adjustment on Steam Gas Ejector (SGE) System
Unit 1	Deration	1,064	Power Plant - Others	RTD Schedule	Maintain limited load and increase load after clearance
Unit 2	Outage	1,785	Power Plant - Electrical Sy	Actuation of Generator Loc	Conduct testing on transformer
Unit 2	Deration	2,169	Power Plant - Gas Remova	Low Condenser vacuum	Fine adjustment on Steam Gas Ejector (SGE) System
Unit 2	Deration	3,274	Resource - Steam/RICAP S	Low steam pressure due to	Conducted valve manipulation/adjustment of steam balancing line at Pressure Reducing Station
Unit 2	Deration	4,406	Power Plant - Cooling/Circu	Low condenser vacuum pr	Manipulated valves in steam system to limit the gas content of steam supply and also reduced the condensate flow going to cooling tower
Unit 3	Outage	2,949	Power Plant - Cooling/Circu	Outage of hotwell pump	Repair of hotwel pump and replace Hot Well Pump discharge valve
Unit 3	Outage	1,441	Power Plant - Controls and	Defective Main Stop Valve	Repair of MSV #2 actuator
	Total	27,148			
	% of Total	81%			

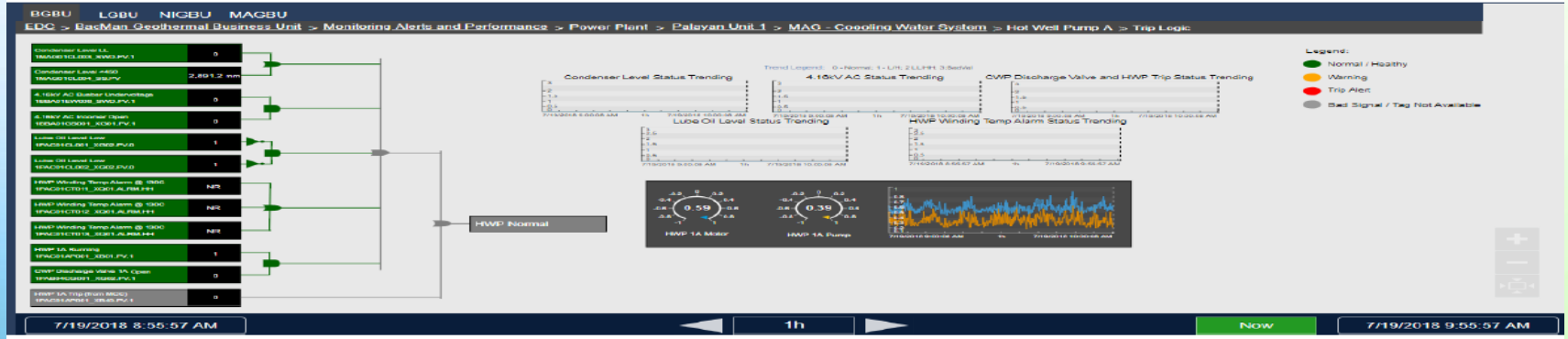
PI AF - Early Warning System

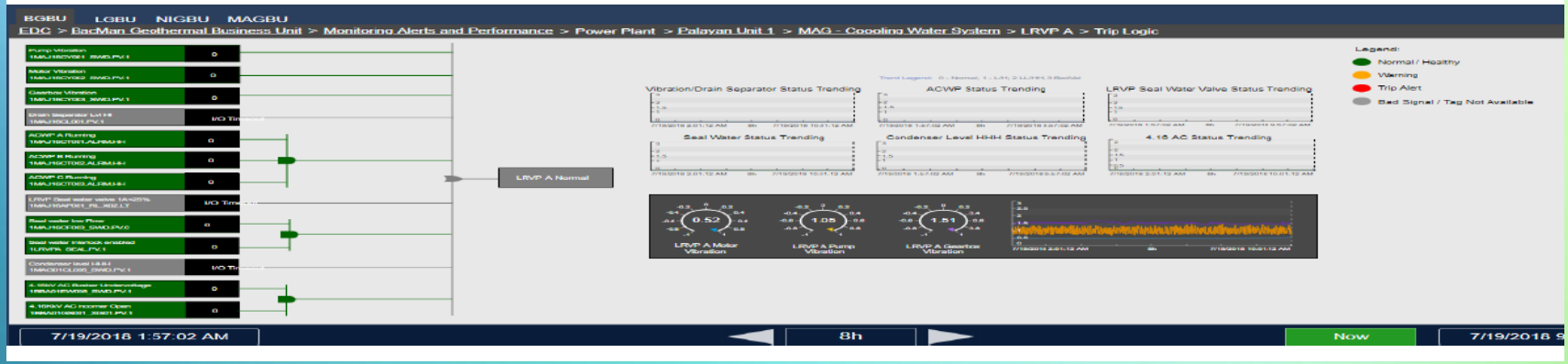






INCLUDED LRVP AND HOT WELL PUMP VIBRATION IN THE DISPLAY PAGES





PI Notifications

energy DEVELOPMENT CORPORATION

ADDITIONAL EMAIL NOTIFICATION FOR LEVEL DUMP VALVE

BGBU FCRS SV 405 Warning - Level Dump Valve Notification

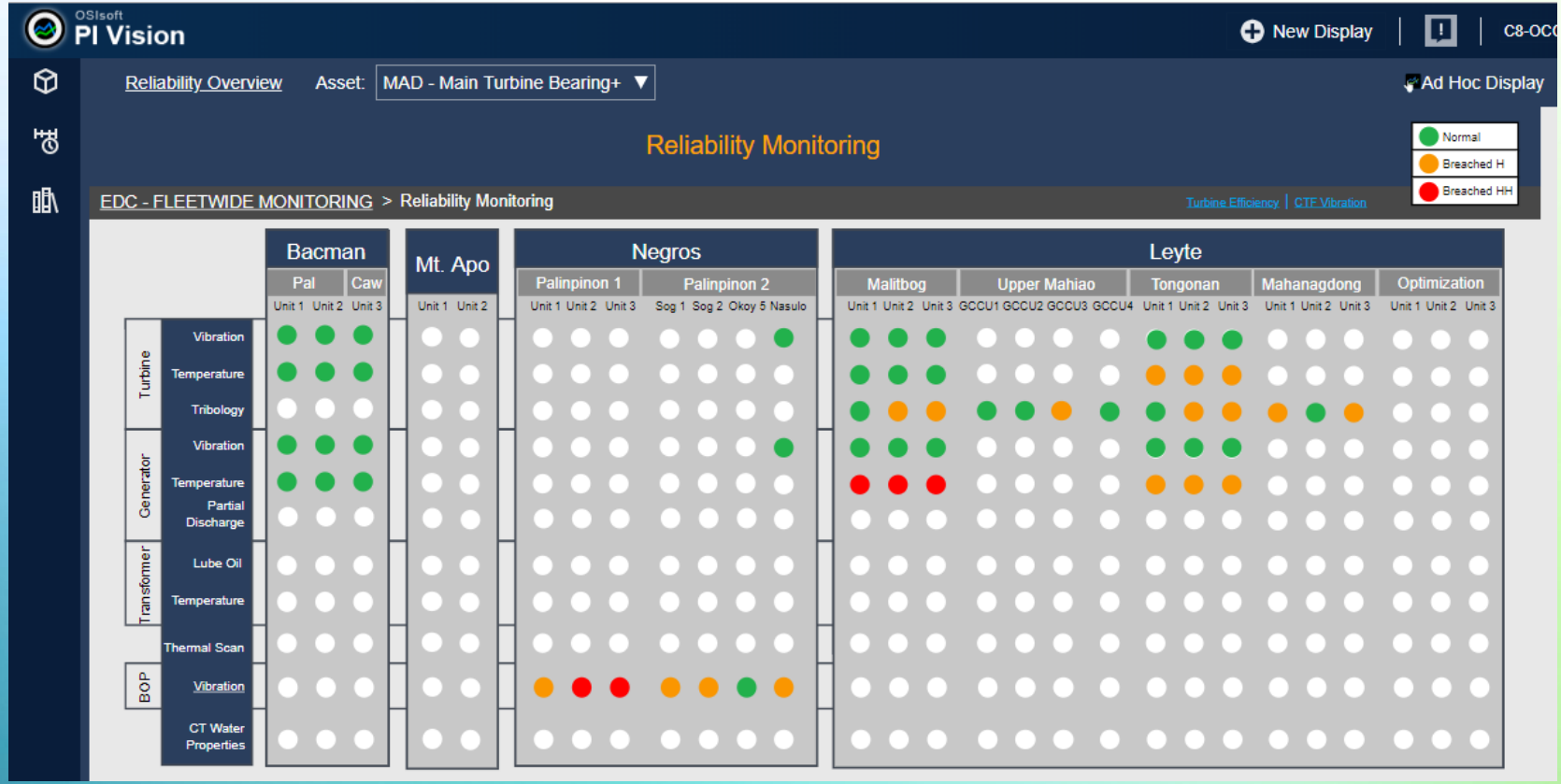
N notify@energy.com.ph
Yesterday, 4:03 PM
Alexa Tolentino

Reply all

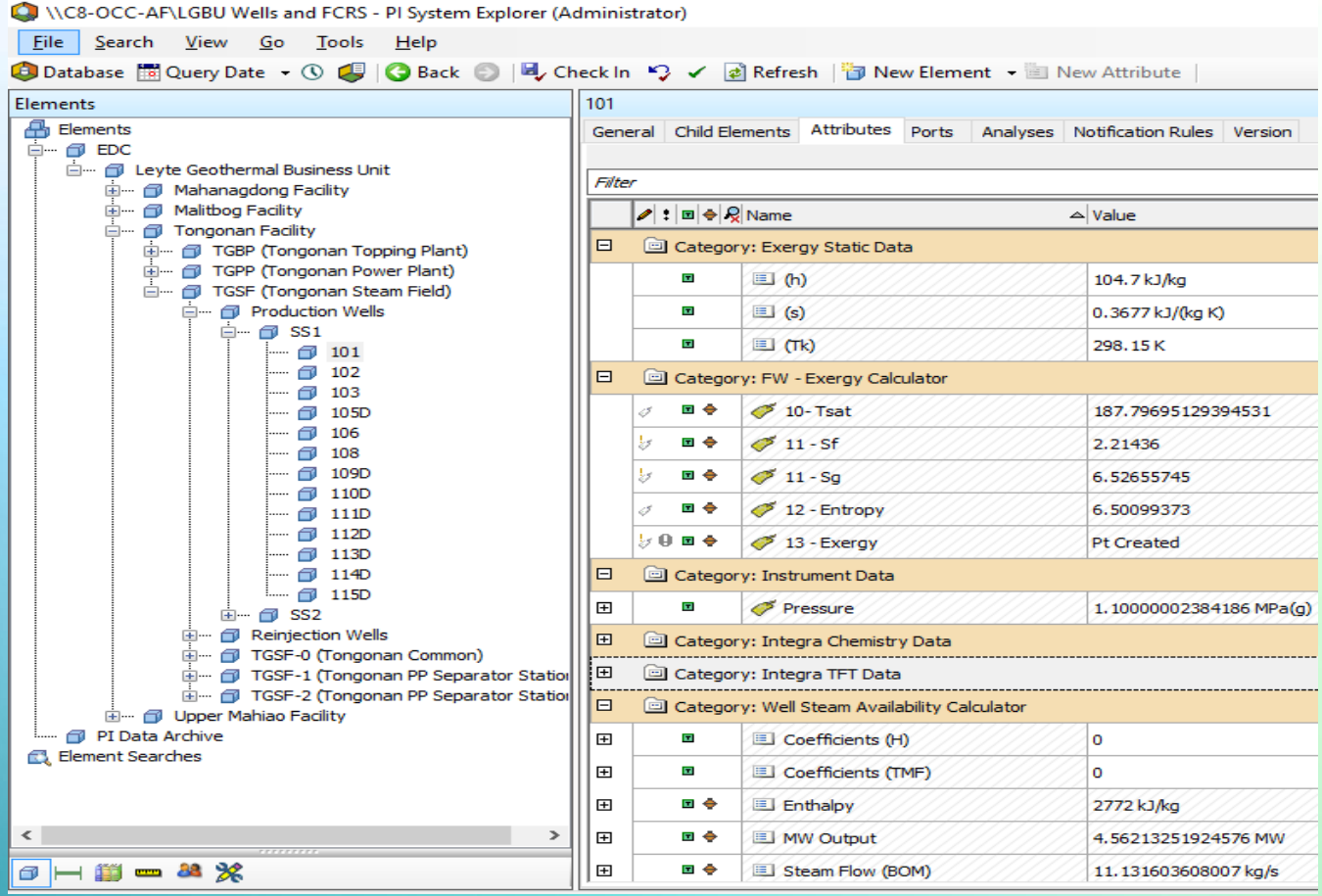
BGBU **FCRS SV 405** Level Dump Valve Logic is triggered at Jul-18-2018 03:51:29
Level High is triggered and Level Transmitter reached its limit (2 out of 3) parameters are triggered. **LDV potentially will Open.**

See link:
EWS Display

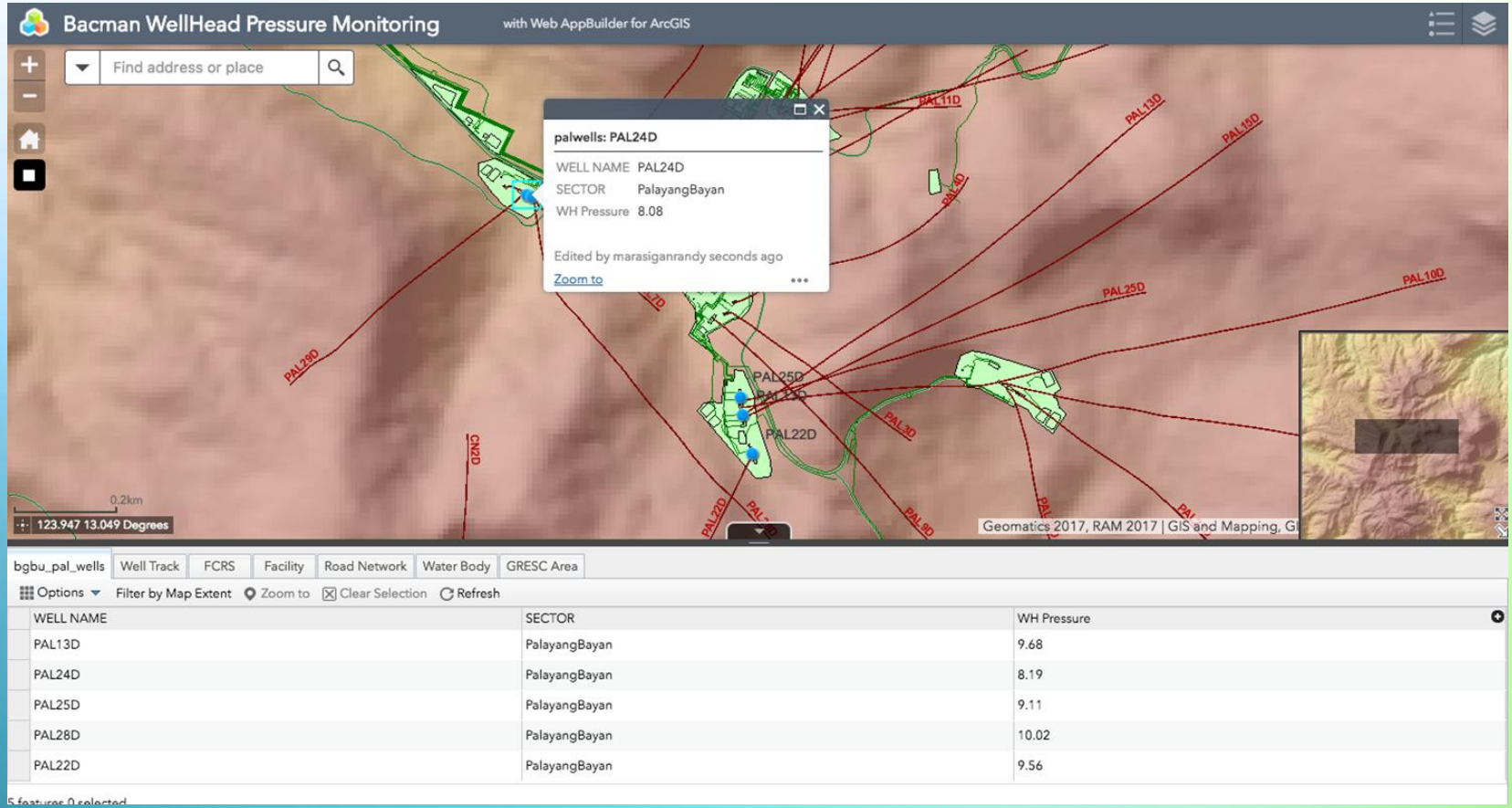
Exergy Analysis Model using the real time data and historical data



Exergy Analysis Model Algorithms in Asset Framework



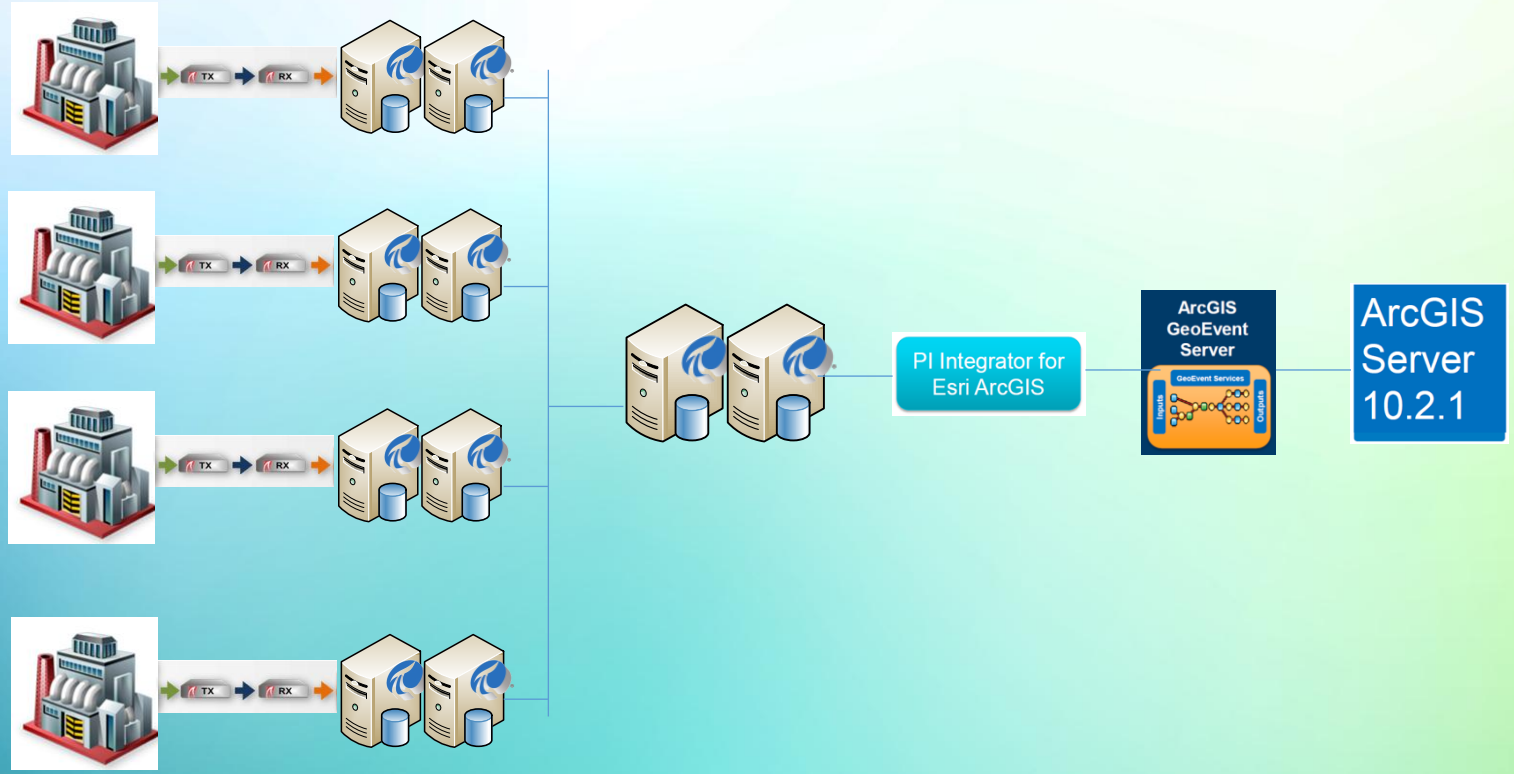
PI Integrator for ESRI



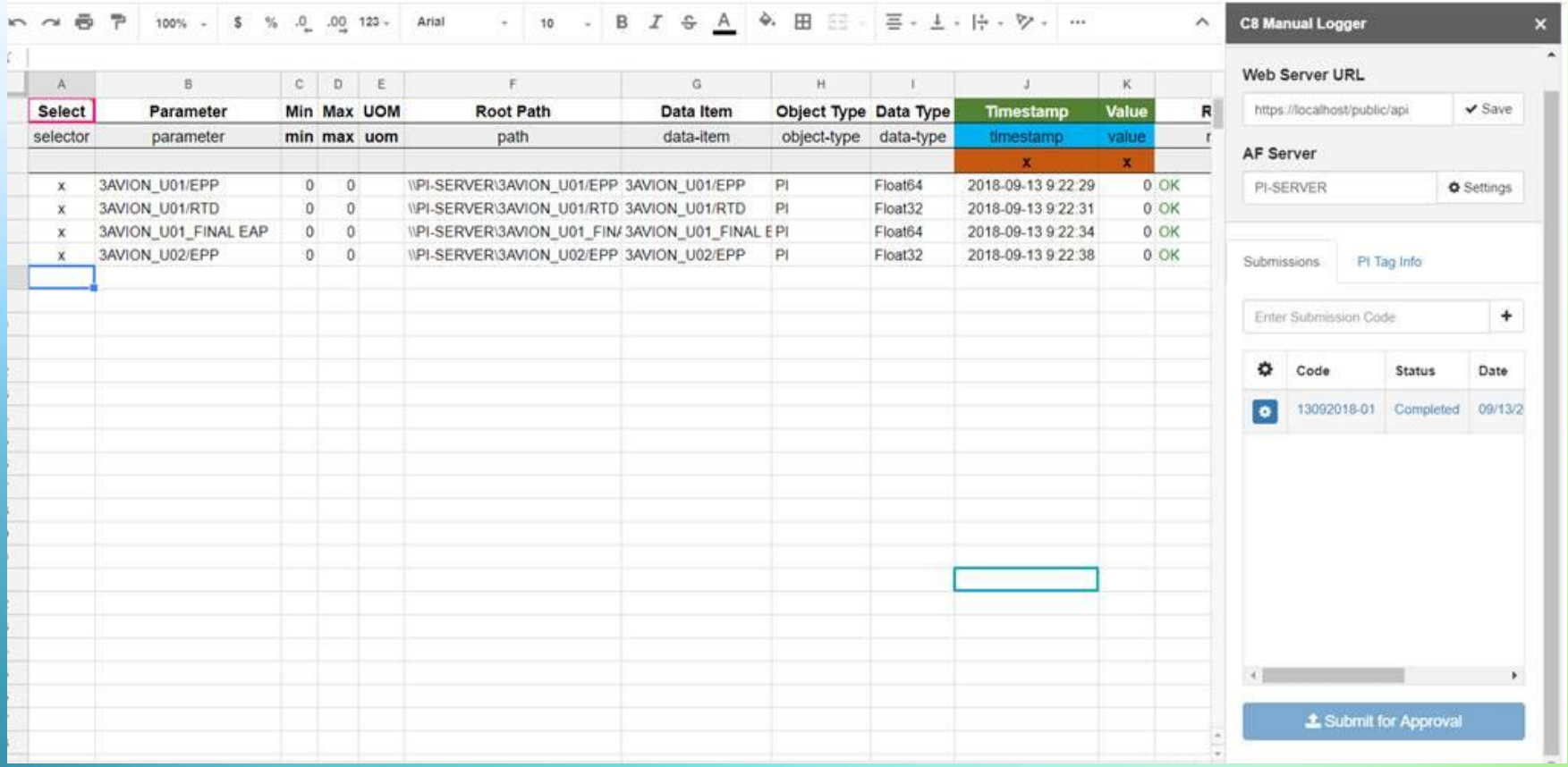
WELL NAME	SECTOR	WH Pressure
PAL13D	PalayangBayan	9.68
PAL24D	PalayangBayan	8.19
PAL25D	PalayangBayan	9.11
PAL28D	PalayangBayan	10.02
PAL22D	PalayangBayan	9.56

5 features 0 selected

Secured PI System Architecture with Waterfall



Google Sheets – Manual Logs



Select	Parameter	Min	Max	UOM	Root Path	Data Item	Object Type	Data Type	Timestamp	Value	R
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x	3AVION_U01/EPP	0	0		\\PI-SERVER\3AVION_U01/EPP	3AVION_U01/EPP	PI	Float64	2018-09-13 9:22:29	0	OK
x	3AVION_U01/RTD	0	0		\\PI-SERVER\3AVION_U01/RTD	3AVION_U01/RTD	PI	Float32	2018-09-13 9:22:31	0	OK
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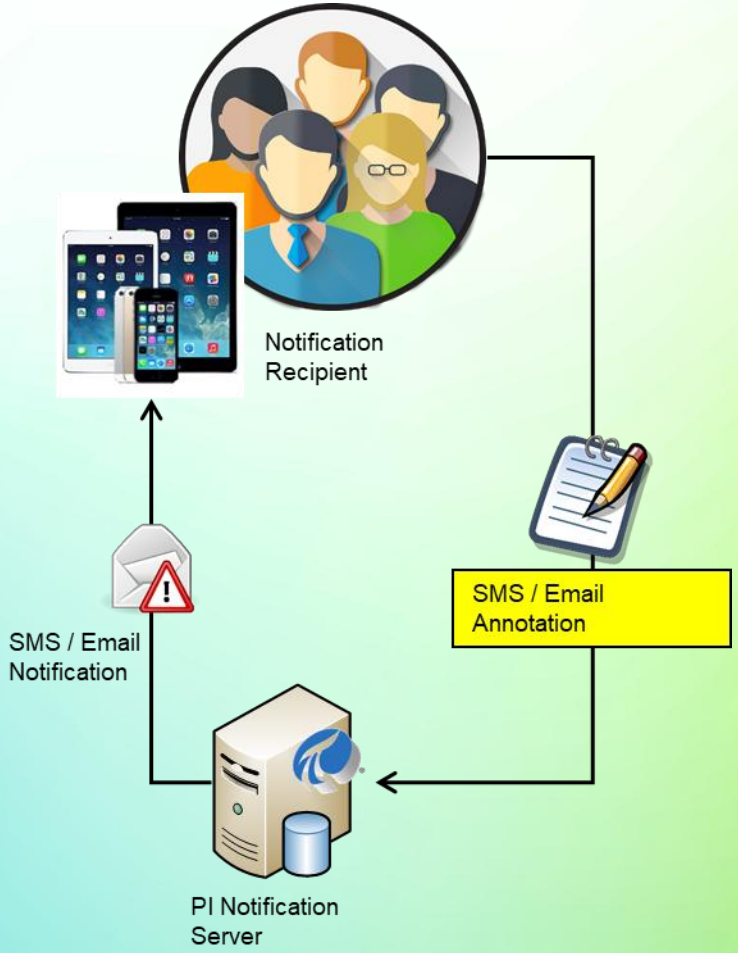
x	3AVION_U02/EPP	0	0		\\PI-SERVER\3AVION_U02/EPP	3AVION_U02/EPP	PI	Float32	2018-09-13 9:22:38	0	OK

SMS or Email Event Annotation

Given constraints with the PI Vision access, this allows the user to annotate an event received. Annotation and attachment could be sent out via SMS or Data.

1. PI Notification Server sends out Notification
2. Recipient receives notification
3. User sends out response or annotation back to the PI Server



Some Early Wins

Before	After
72 hours needed to revive PAL25D well	Reduced to **15 hours** with online well head pressure visibility
Silo'ed data - Steam Field data not readily available to Power Plant and vice versa	**End-to-end visibility** helps consistent power plant generation
1-4 hours needed by Operator to inform concerned stakeholders when forced outage occurs	System-generated alert notifications sent **within minutes** when thresholds are breached and outage occurs (April 18 and May 1)
Operator-dependent and reactive issue resolution	**Faster issue identification and resolution** with critical asset visibility (controlled shutdown last May 1)
Hourly manual logging of operational data.	**Reduced manual logging**

Next Steps…

- Integration to CMMS
- PI Integrator for Business Analytics
- More Data
  - HART IP for Steam Field Devices
  - Geo Sciences
    - Weather Stations
    - Landslide / Soil Monitoring
  - Safety Notifications

Energy Development Corporation

5Cs Digitalization Strategy

CHALLENGE

Data was in Silos and not delivered Real Time to Users for accurate decision making.

- Power Plant and Steam field Data are not correlated
- Root Cause Analysis takes some time

SOLUTION

Real Time Data Visibility has immediate impact as different groups now work together more seamlessly.

- PI System as Single Source of Data
- **Connect** and **Collect** all – Manual, Digital, LIMS, Historical, Sciences Data
- **Communicate** – Visualize and Notify
- **Compute and Correlate** – automate calculations, continuous improvement

RESULTS

Ability to have a more accurate forecast on Well Head Pressure that translate into faster resolution and availability of Steam to the Turbine

- Est. 75% increase in time to revive a Well for immediate operation
- Faster Root Cause analysis
- With Real time notifications and Early Warning System, they can detect and prepare for the Well reviving operation as a team.

Contact Persons:

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Questions?

Please wait for the **microphone**

State your **name & company**

Please remember