Integrating Operations Technology (OT) and Information Technology (IT) with the PI System Infrastructure

Presented by **Vijayendra Shenoy**

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April 29th

GMR Overview

Creating Tomorrow, Today

GMR Group was established in June 1996

1996

Entry into Infrastructure

200 MW IPP in Chennai

2014

Gaining momentum

3 Airports
9 Highways*
8 Power Plants / 6 Projects
2 Coal Blocks
2 Power Transmission Projects

2018

Large & diversified infrastructure player

3 Airports
9 Highways*
2 Special Investment Regions
11 Power Plants / 3 Projects
2 Coal Blocks
2 Power Transmission assets

*include Minority stake in 2

Power Generation Capacity

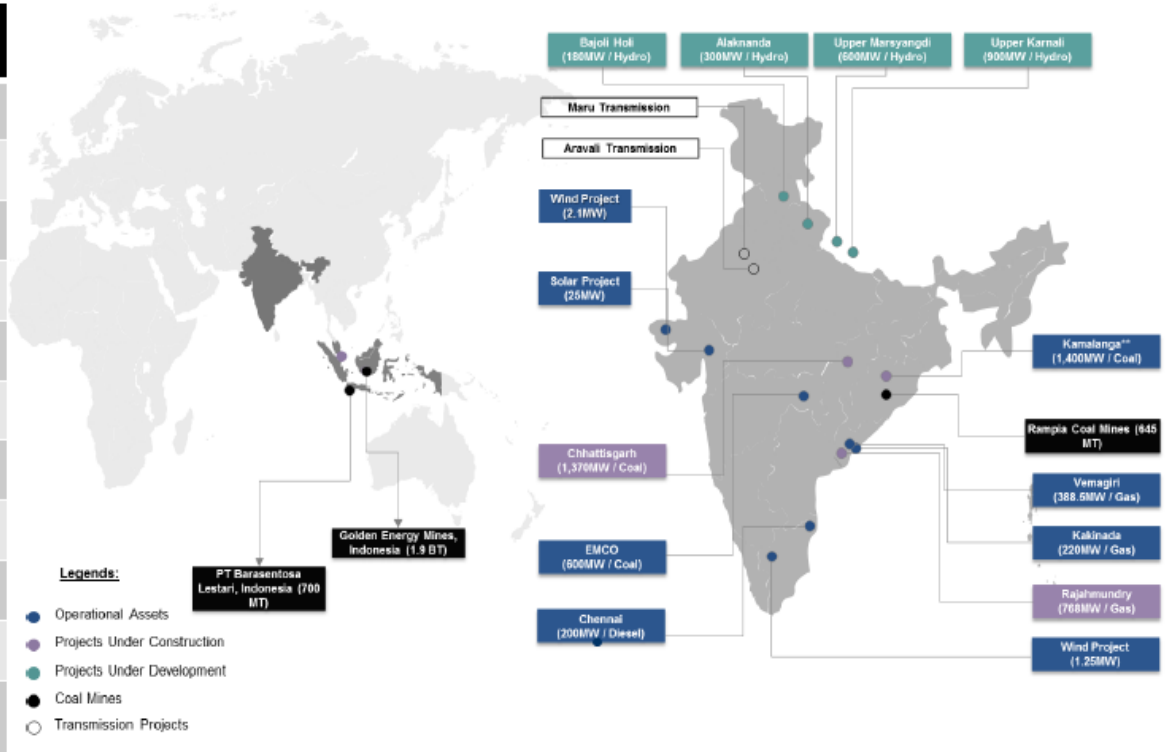
Balanced Fuel Mix
Portfolio of gas, coal & hydro projects

Optimal Revenue Mix
Mix of merchant & PPA based Revenues

Ensuring Fuel Security
Coal Mines in Indonesia & India

Diversification in related areas
Transmission & Power trading

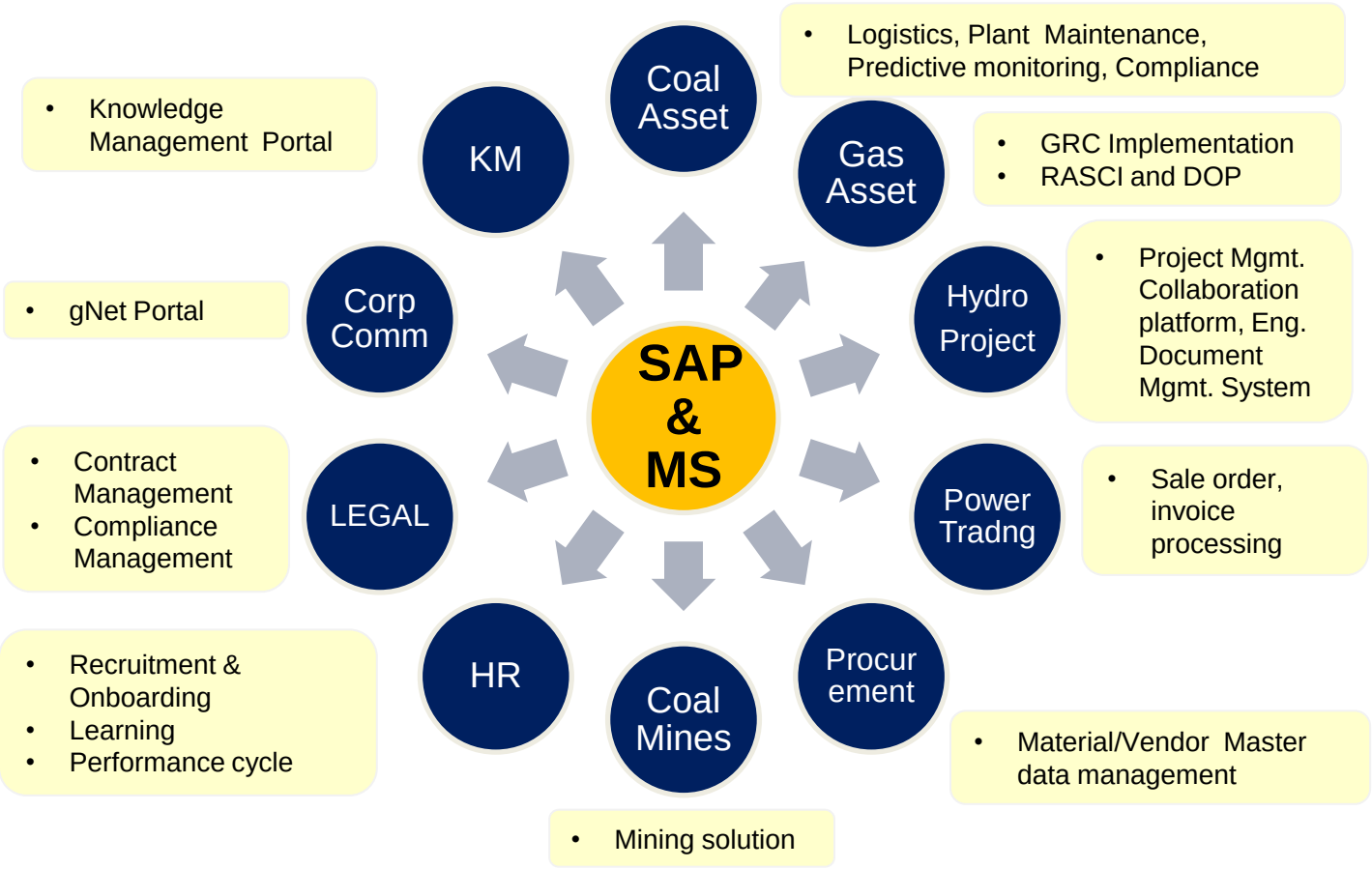
Value Chain element	Group's presence
Generation	√
Coal	√
Gas	√
Solar	√
Wind	√
Hydro	√
LSHS	√
Transmission	√
Distribution	X
Trading	√
Coal Resources	√



About GMR Fleet

Plant	Location	Capacity	Unit Size	OSIsoft PI System Automation
EMCO Energy Limited	Warora	600 MW	2* 300	Implemented
GMR Kamalanga Energy Limited	Kamalanga	1050 MW	3* 350	In Progress
GMR Chhattisgarh Energy Limited	Chhattisgarh	1370 MW	2* 685	In Progress
GMR Power Corporation Limited	Chennai	200 MW	4* 50	Implemented
GMR Energy Limited	Kakinada	240 MW	46.5*4+53.5	Implemented
GMR Vemagiri Power Generation Limited	Vemagiri	388 MW	155 * 1 + 233	Implemented
GMR Rajahmundry Energy Limited	Rajahmundry	768 MW	239* 6 + 144.2	Implemented

Snapshot of IT landscape..



Business requirements

- Proposed Solution should leverage existing systems in use like SAP Material Management, Plant Maintenance, Business Planning and Microsoft SharePoint
- Solution should Integrate all KPIs and Metrics into a Single Report called Daily Plant Performance Report (DPPR) which is standardized across the Enterprise
- Report should have daily comparison of Plan vs Actual figures
- Plan Figures to be broken down from Annual Operating Plan (AOP) approved by Top Management at start of Financial Year
- Top-Most Management(CXO level) to have Real-time rolling displays of Top 4 KPIs (Generation, APC, Specific Coal Consumption and Heat Rate)

Key Requirements (Performance Monitoring)

- Proposed Solution should standardize all Major Equipment Calculations like
  - Boiler Efficiency
  - Turbine Efficiency
  - Air Preheater Performance
  - Condenser and Heater Performance
  - Cooling Tower Performance
- The solution must calculate Design value at current load condition based on curves provided by Boiler/Turbine OEM
- Solution must calculate deviation between Design and Actual and provide variance figures
- The calculations must be standardized into templates which can facilitate easy roll out to newer sites

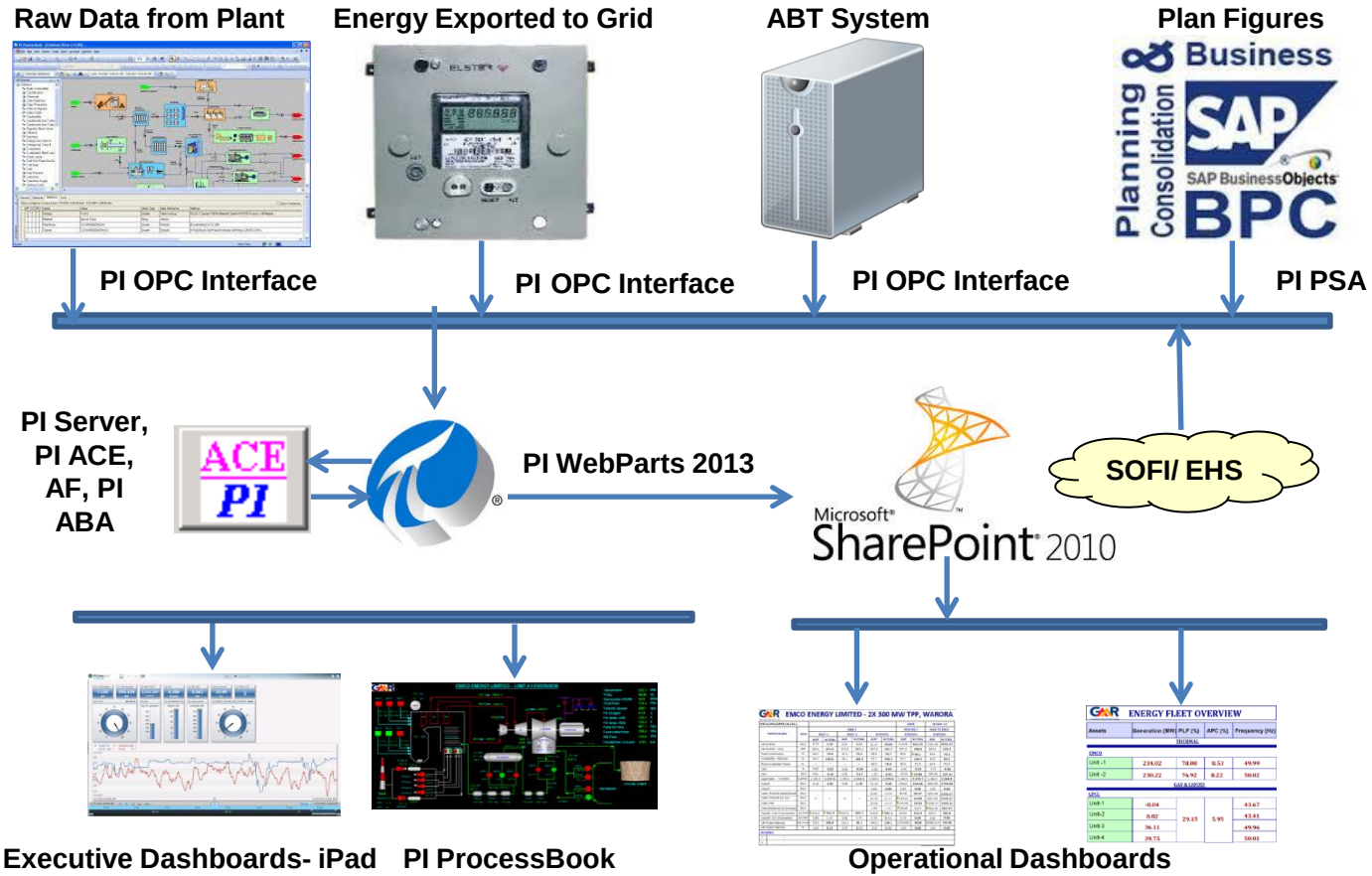
Technological Challenges

- Disparate data sources isolated from each other
  - Annual Operating Plan data from SAP BPC
  - Energy Export data from Energy Meters
  - Coal Consumption and Process Parameters from DCS

- To avoid Manual entry as much as possible, report should get generated Automatically

- To Ensure data reliability so that calculation results are accurate and trustworthy

Architecture Diagram



ENERGY FLEET OVERVIEW

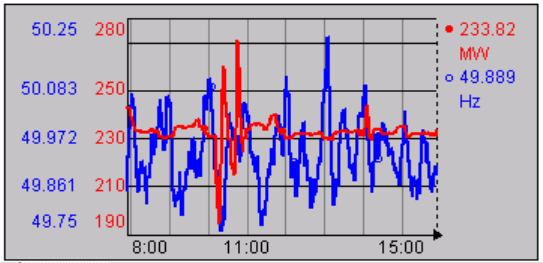
Creating tomorrow today

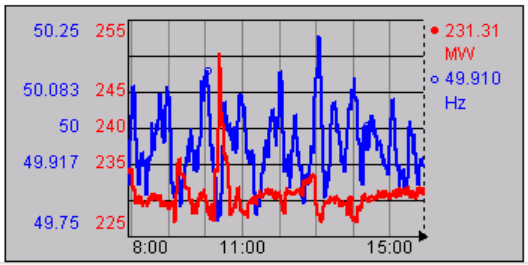
Assets	Generation (MW)	PLF (%)	APC (%)	Frequency (Hz)
THERMAL				
EMCO				
Unit -1	231.65	77.36	9.18	49.91
Unit -2	231.57	77.35	8.39	49.93
GAS & LIQUID				
GPCL				
Unit-1	-0.04	28.74	5.95	43.67
Unit-2	0.02			43.41
Unit-3	-0.07			43.43
Unit-4	40.16			49.91

Creating tomorrow today

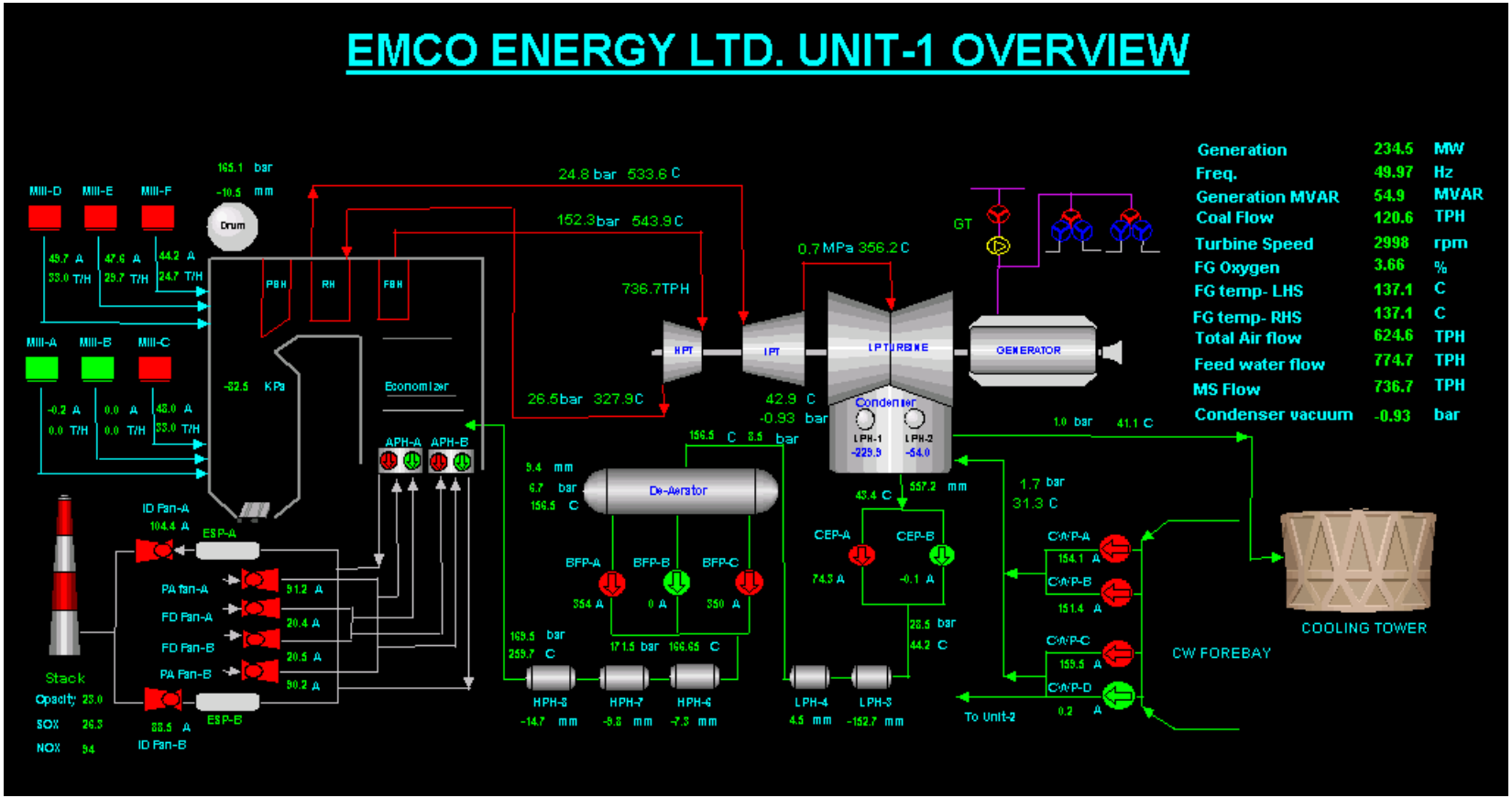
EMCO HIGHLIGHTS

GENERATION PARAMETERS	UNIT-I	UNIT-2
GENERATION(MU's)	5.61	5.56
GENERATION(MW)	233.89	231.57
HEAT RATE(Kcal/Kwh)	2337.64	2341.14
SP. COAL CONSUMPTION(gm/kwh)	504.69	538.53
APC (%)	8.90	8.18
ENVIRONMENT PARAMETERS		
TPM (< 50)mg/Nm3	22.99	43.20
SOX (< 46)mg/Nm3	18.25	23.74
NOX (< 150)mg/Nm3	69.76	50.80

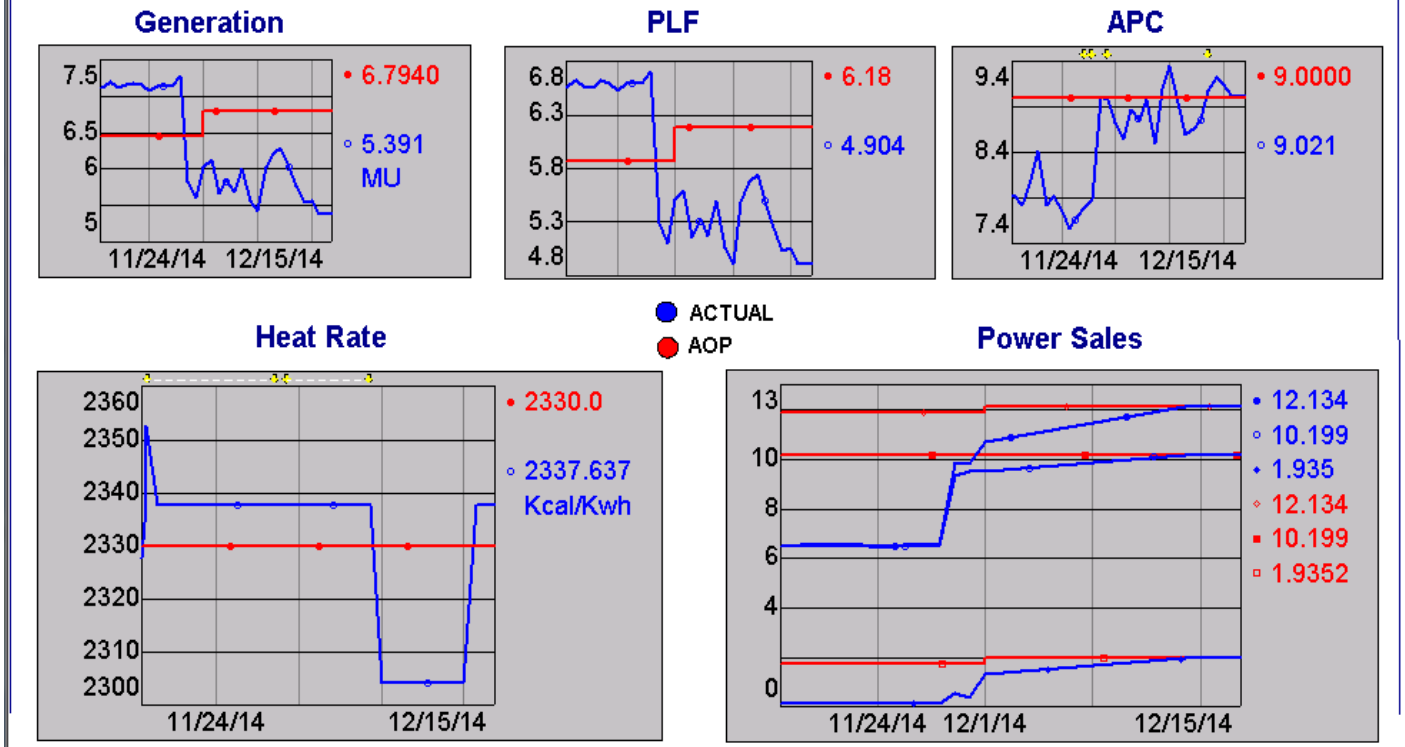




Unit Overview

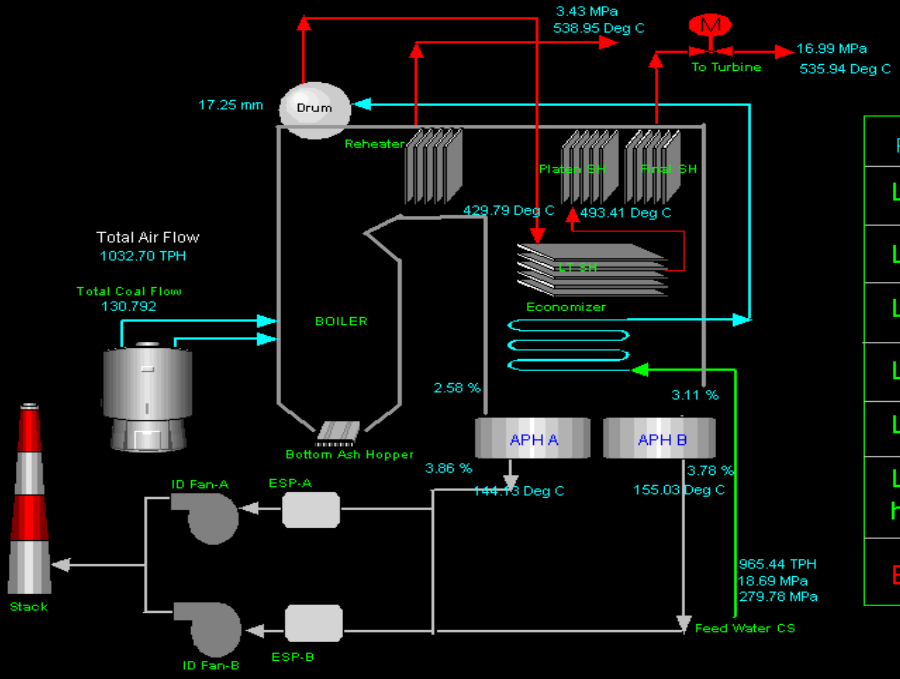


UNIT- 1 PERFORMANCE TREND



Boiler Overview

BOILER EFFICIENCY ANALYSIS
UNIT1



BOILER LOSSES

Parameter	UOM	Design Val.	Actual Val.	Varience
Loss Due to Dry Flue Gas	%	4.23	4.71	-0.48
Loss Due to Moisture in Air	%	0.16	0.15	0.01
Loss Due to Hydrogen In Fuel	%	4.21	4.90	-0.69
Loss Due to Moisture in Fuel	%	1.10	2.25	-1.15
Loss Due to Unburnt Carbon	%	0.50	0.38	0.12
Loss Due to Sensible heat of bottom Ash	%	0.06	0.10	-0.04
Boiler Efficiency	%	88.81	86.92	1.89

Input Parameters | All Units

Boiler | Turbine | HP Heater | LP Heater | Condenser | Air Preheater | HOME

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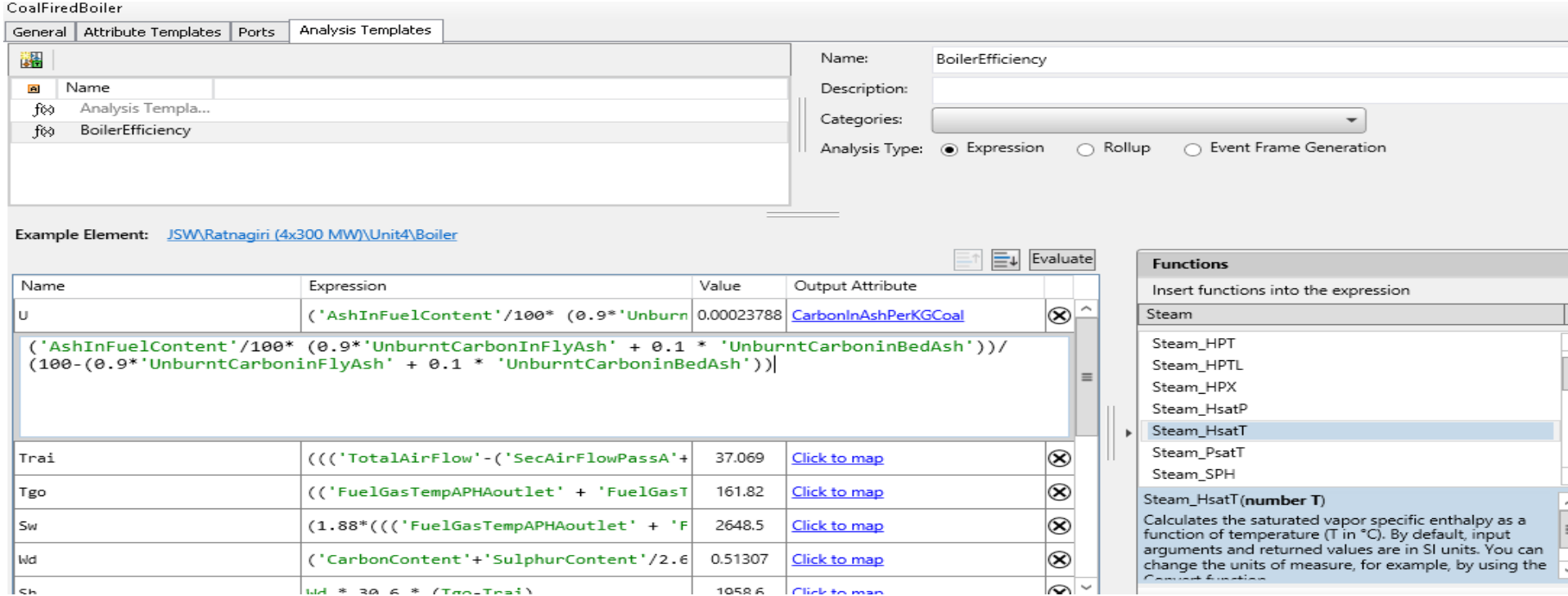
AF Template for Boiler Efficiency



Plant Performance Report

EMCO ENERGY LIMITED - 2X 300 MW TPP, WARORA

EMCO/IMS/DPPR/16/16.1								DATE		24-Apr-15	
PARTICULARS	UOM	DAILY						MONTHLY		YEAR TO DATE	
		UNIT-1		UNIT-2		STATION		STATION		STATION	
		AOP	ACTUAL	AOP	ACTUAL	AOP	ACTUAL	AOP	ACTUAL	AOP	ACTUAL
Generation	Mu's	6.41	**5.36**	6.41	**5.10**	12.82	**10.46**	307.71	**251.75**	307.71	**251.75**
Generation - Avg	MW	267.1	**223.3**	267.1	**212.6**	534.2	**435.9**	534.2	**437.1**	534.2	**437.1**
Plant Load Factor	%	89.0	**74.4**	89.0	**70.9**	89.0	**73.4**	89.0	**72.9**	89.0	**72.9**
Availability - Machine	%	99.3	**100.0**	99.3	**100.0**	99.3	**99.6**	99.3	**98.8**	99.3	**98.8**
Plant Availability Factor	%	-	-	-	-	89.0	⇩**73.2**	⇩89.1	**73.0**	⇩89.1	**73.0**
APC	%	8.50	**9.41**	8.50	**9.44**	8.50	**9.49**	8.50	**9.40**	8.50	**9.40**
APC	Mu's	0.54	**0.50**	0.54	**0.48**	1.09	**0.99**	26.16	**23.67**	26.16	**23.67**
Heat Rate - 19-Apr-2015	Kcal/KWh	2,330.0	**2,342.0**	2,330.0	**2,338.9**	2,330.0	**2,340.4**	2,330.0	**2,223.7**	2,330.0	**2,223.7**
Export	Mu's	5.87	**4.85**	5.87	**4.62**	11.73	**9.47**	281.56	**228.08**	281.56	**228.08**
Import	Mu's					0.00	**0.00**	0.00	**0.04**	0.00	**0.04**
Sales Plan(Schedule/Actual)	Mu's					9.54	9.47	⇩228.29	**228.08**	⇩228.29	**228.08**
Sales-Total @ Bus bar	Mu's	-	-	-	-	11.73	9.47	281.56	**228.08**	281.56	**228.08**
Sales-PPA	Mu's					10.30	9.47	247.10	**226.45**	247.10	**226.45**
Sales(Bilaterals+Exchange)	Mu's					1.41	0.00	33.75	**1.63**	33.75	**1.63**
Specific Coal Consumption	gm/KWh	585.4	**549.5**	585.4	**620.8**	585.4	⇩**584.2**	585.4	**632.0**	585.4	**632.0**
Specific Oil Consumption	mL/KWh	0.50	0.00	0.50	0.01	0.50	**0.03**	0.50	**0.29**	0.50	**0.29**
DM Water MakeUp	cub m/day	730.1	**55.3**	730.1	**96.3**	1460.2	**151.7**	33584	**5589**	33584	**5589**
DM Water MakeUp	%	3.00	**0.22**	3.00	**0.39**	3.00	**0.33**	0.00	⇩**0.47**	0.00	**0.47**

BI Dashboard

ASSET PERFORMANCE – EMCO

05.2014

Heat rate : 2395.87 Kcal/Kwh | APC : 9.95 % | Availability : 100 % | Customer Outstanding : 52 Cr | Vendor Outst

PLANT PERFORMANCE

KPI	AOP	ACTUALS
Availability %		100.00
PLF %		47.80
APC %		9.95
No of Trips	0.00	0.00
Gross Heat Rate (Kcal/Kwh		2,395.87
Power Generation (MU)	0.00	206.51

Click for the detailed level

COAL INVENTORY

Storage Location	Stock Available (Tonnes)
Coal Storage Yard	94,823
Emco Energy Ltd (PBH1)	0

Click for the detailed level

POWER SALES Vs TARIFF

Mode of Sale	Sales Vol (MU)	Sales Price (INR/KWH)
PPA	112	4
Bilateral	1	3
Exchange	13	3

Click for the detailed level

FINANCIALS

Type	Outstanding Amount (In Cr)
Customers	52
Vendors	-239

Click for the Finance P& L

Click for the AR/AP

COST OF GENERATION

Cost Types	Plan Val (In Cr)	Actuals (In Cr)
COG	2	6
FC	1	6
VC	0	0

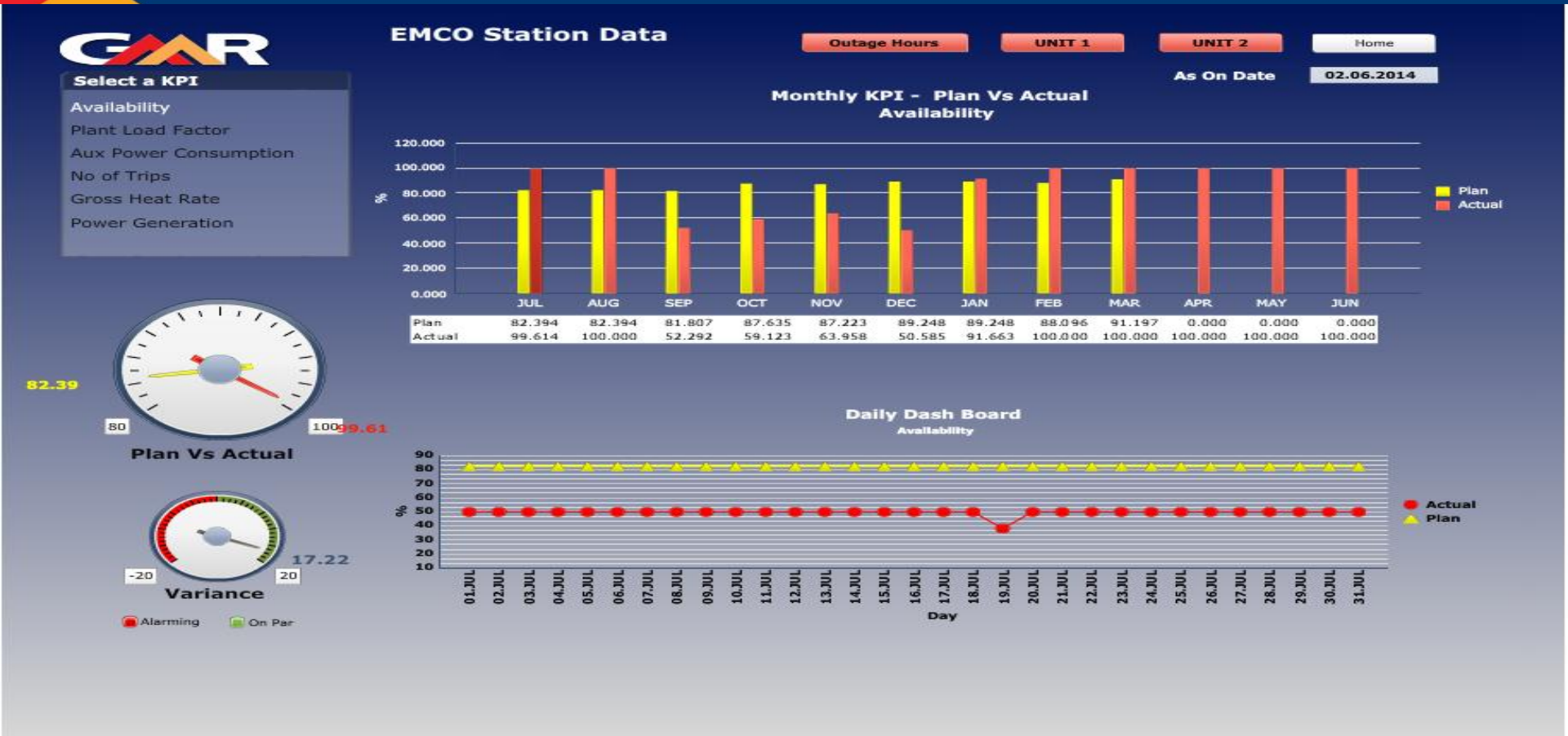
Click for the detailed level

MAINTENANCE STATUS

Dept	Notification Crtd	Carry Fwd	Pending Notifn
CIVI	51	95	137
ELEC	96	32	76
INST	121	75	99
MAHP	49	9	18
MBLR	48	51	62
MBOP	54	24	37
MCHP	70	125	181
MECH		0	0
MTUR	27	16	26

Click for the detailed level

BI Dashboard



Mobility - On-the-fly Reporting

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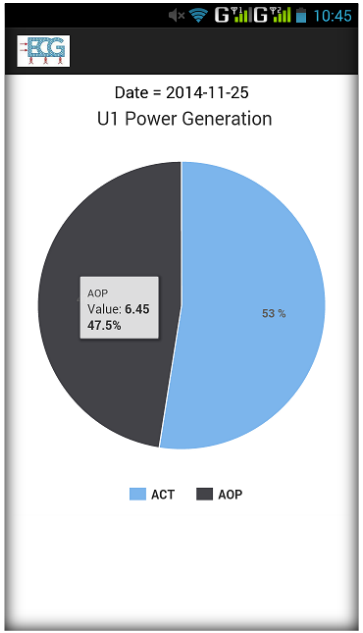
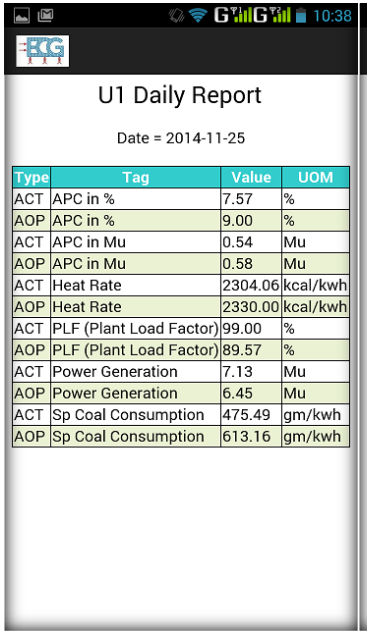
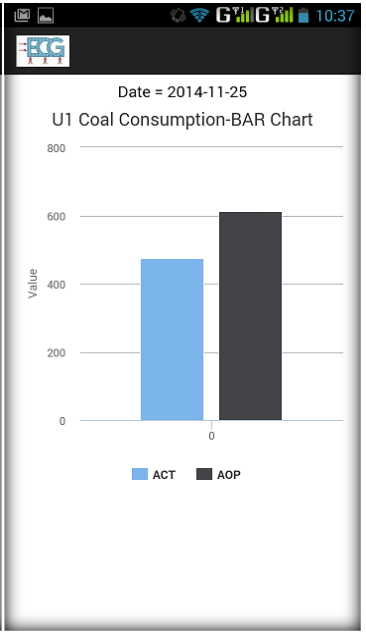




Type	Tag	Value	UOM
ACT	APC in %	7.57	%
AOP	APC in %	9.00	%
ACT	APC in Mu	0.54	Mu
AOP	APC in Mu	0.58	Mu
ACT	Heat Rate	2304.06	kcal/kwh
AOP	Heat Rate	2330.00	kcal/kwh
ACT	PLF (Plant Load Factor)	99.00	%
AOP	PLF (Plant Load Factor)	89.57	%
ACT	Power Generation	7.13	Mu
AOP	Power Generation	6.45	Mu
ACT	Sp Coal Consumption	475.49	gm/kwh
AOP	Sp Coal Consumption	613.16	gm/kwh

Tag	NValue	MUnit
APC Actual	0.00	Per
APC in Mu	0.00	Mu
GENERATION	0.00	Mu
Heat Rate	0.00	kcal/Kwh
PLF	0.00	Per
Specific Coal Consumption	0.00	gm/kwh



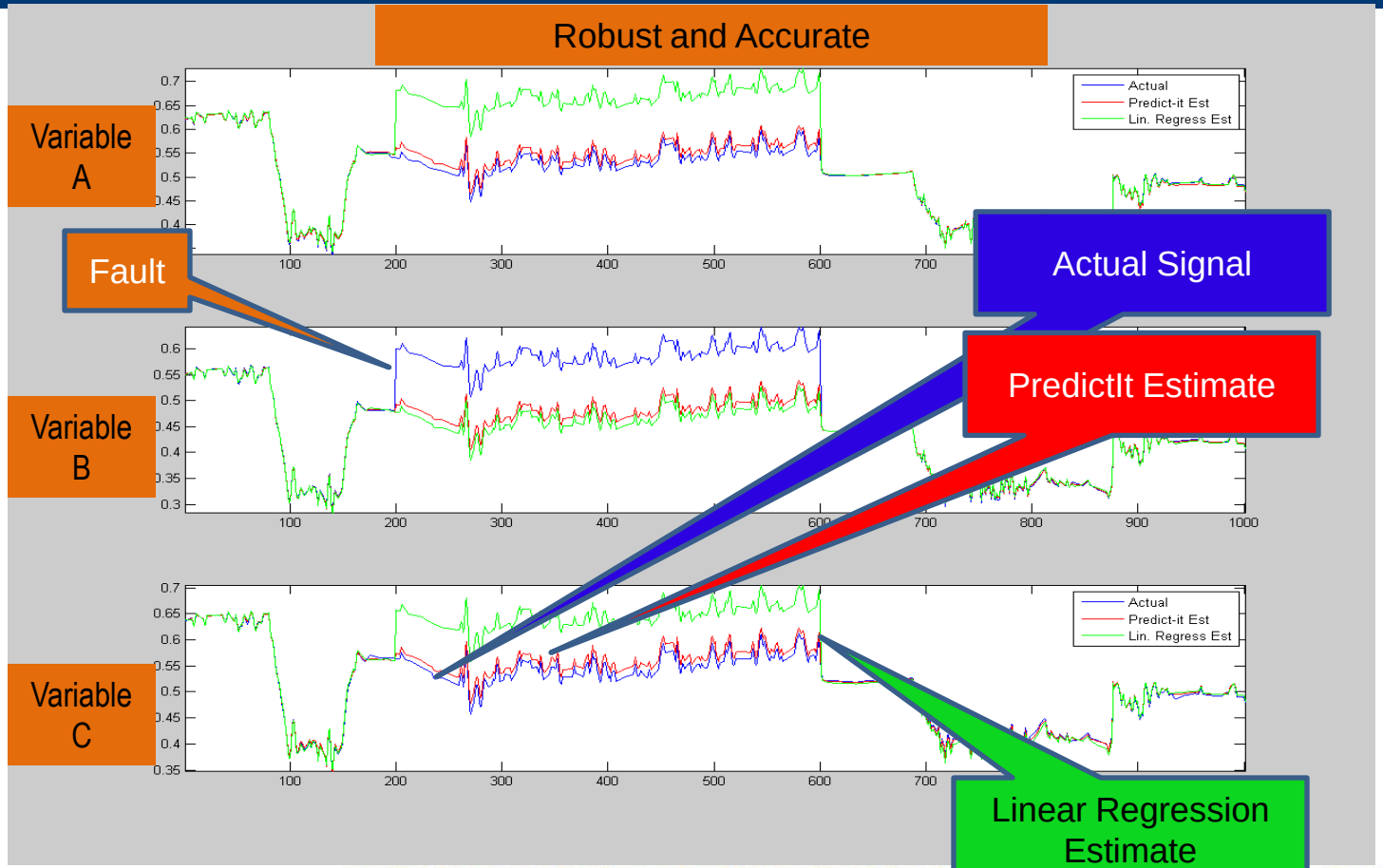
Next Step - Predictive Analytics using Predict-IT

- Monitoring - Recent advances in modelling algorithms have made it possible to track trends in process variables on a continuous basis and compare them to the “standard” for the operation.
- Detection - Its primary function is to receive measured readings from instruments and use an advanced pattern recognition engine to determine if the readings are valid.
- Analysis - It is highly intuitive, and it's easy to use model developer allows for quick deployment of process models.

It's advanced pattern recognition engine uses the well-known nearest neighbour algorithm and is specifically adapted to the task of fault identification.

- Prevention- Predict-It provides the following.
  - Early warning/Fault detection
  - Advanced pattern recognition
  - Proactive plant management
  - Reduce unexpected outages; increase availability
  - OSIsoft PI System compatibility

Next Step - Predictive Analytics using Predict-IT



Conclusion

- Business Benefits
  - Proactive information on generation to Power Trading team
  - Coal sourcing decision making about consumption & inventory
  - PI is the Single source of Truth

- Operational Benefits
  - SMS and Email Notifications for early resolution of issues
  - Operational Dashboards to identify and resolve issues
  - Automated Operational Reporting at different levels

- Decision making
  - Business Intelligence and operational dash boards

Questions

Please wait for the microphone before asking your questions

State your
name & company

THANK YOU