PI System paves the way:
ISO 50001- Energy Management &
ISO 55001- Asset Management

Presented by **Anas Diab**

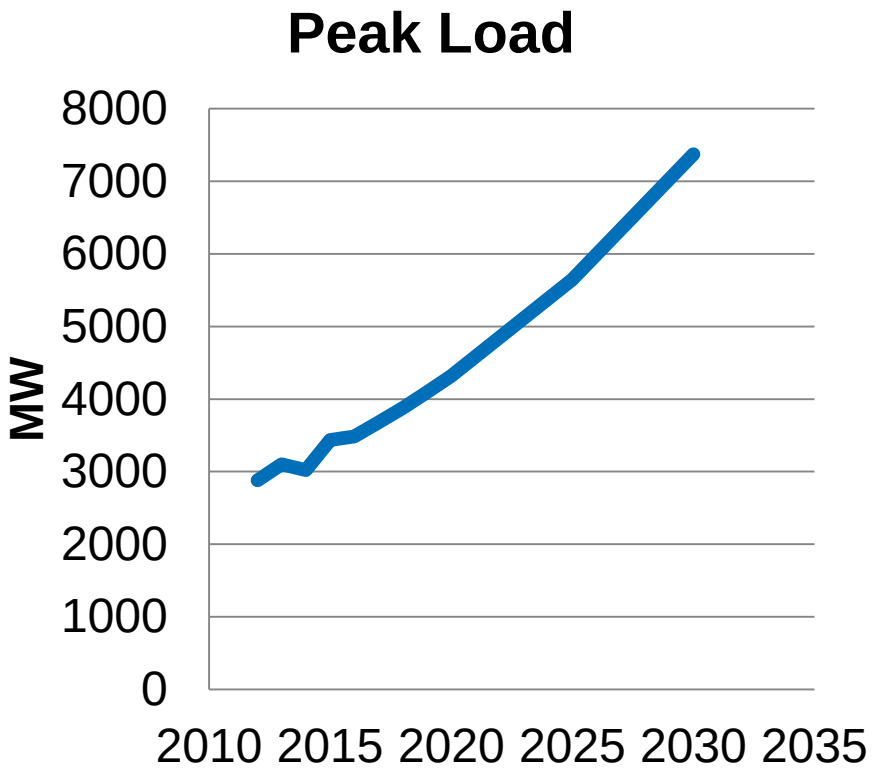
Performance Manager

AES
we are the energy

Hashemite Kingdome of Jordan (HKJ)

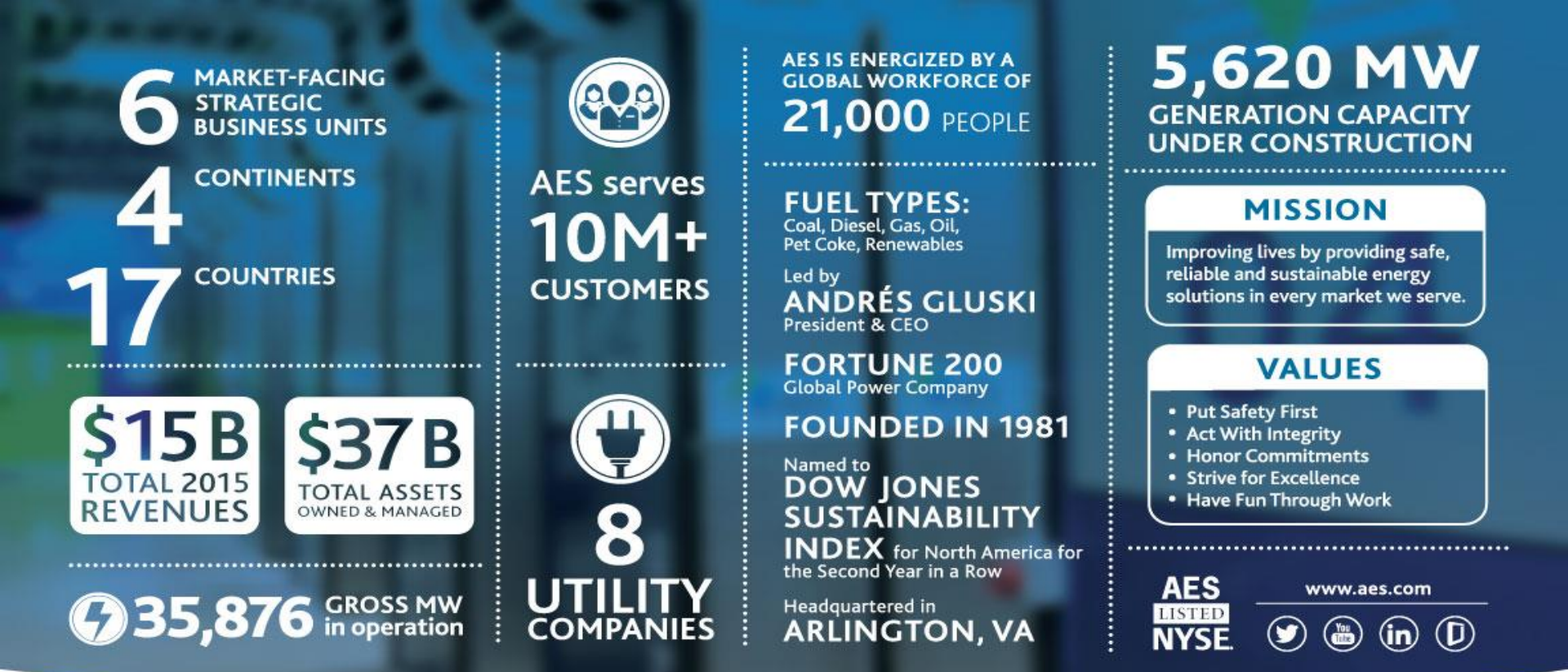
Hashemite Kingdome of Jordan (HKJ)

- Limited natural resources
- Political situation in the region
- 20 % of population are refugees
- Increasing demand for energy



Agenda

- About AES Jordan & AES Corporation
- Business Challenge
- Why we implemented the PI System
- How the PI System helps us
- Technical Problems Solved by the PI System
- Results Obtained and Business Impact
- Future Plan and Next Steps
- Conclusion



THE AES CORPORATION

AES we are the energy

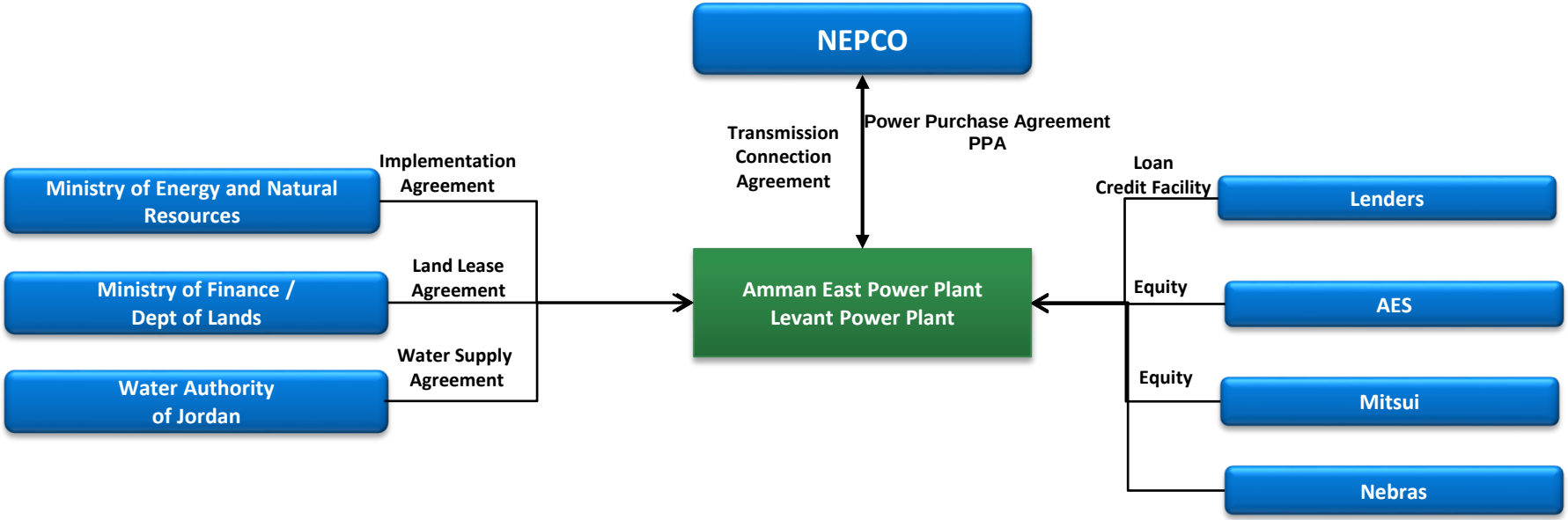
AES in Jordan

Amman East Power Plant
First independent Power Producer (IPP1)
370 MW Plant Capacity + 30 MW Fogging system

Levant Power Plan
Fourth independent Power Producer (IPP4)
241MW Plant Capacity

AES in Jordan

Contractual framework



AES in Jordan

- Long term PPA with NEPCO (Transmission and System Operator)
- IPP1 and IPP4 Project companies responsible for facilities O&M for 25 years under BOO agreement
- It is consortium of AES corporation , Mitsui LTD and Nebras
- IPP1 Commissioned in 2009 with 370 MW combined cycle power plant and IPP4 Commissioned in 2014 with 241 MW tri-fuel engines
- State-of-the-art technology in power production
- PI System implemented in 2015

IPP1- Plant Configuration

Commercial Operation Date
August 2009

Plant Design	• 2 GT 300 MW- Dual fuel • 2 HRSG – Dual pressure • 1 ST 145 MW
Plant Technology	• GT: AE94.2 Ansaldo • ST : Fuji • HRSG : Doosan

IPP4 - Plant Configuration

Commercial Operation Date
July 2014

Plant Design

- 16 tri fuel engines 15.06x16 =241 MW
- 4 SCR

Plant Technology

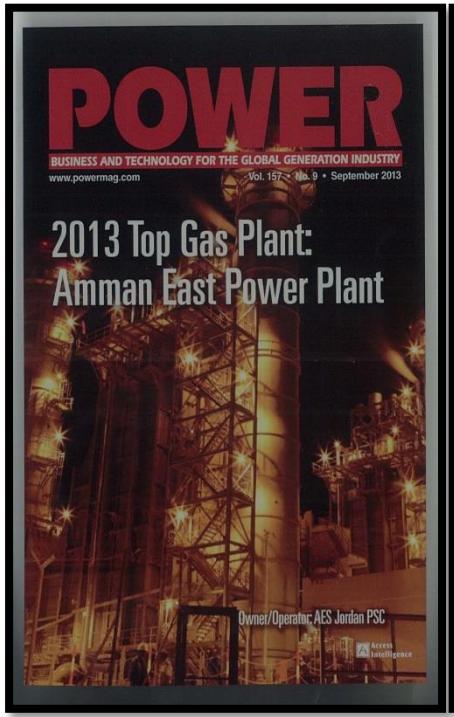
- Engine : W18V50DF-Wartsilla

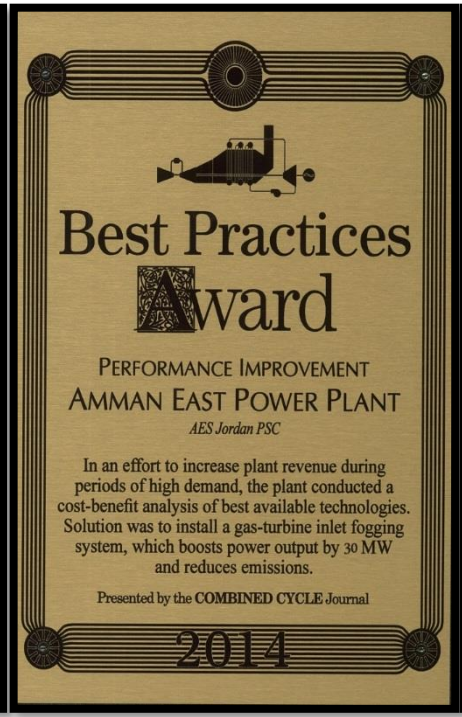
Awards and Recognition

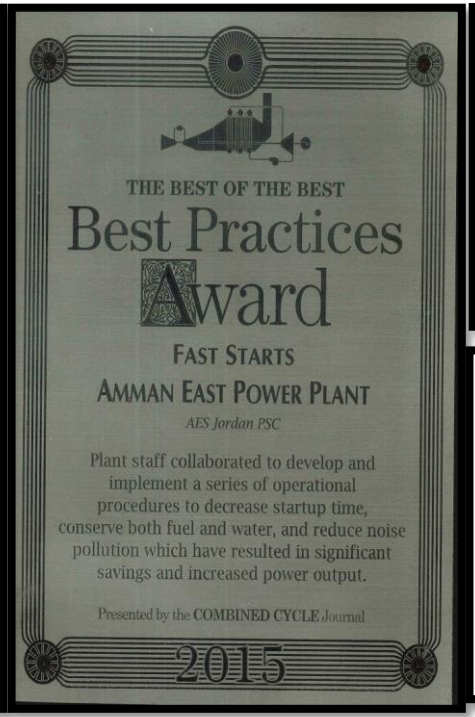
Health , Safety and Environment

Awards and Recognition

Best Practices , Top Plant , Partnership Awards

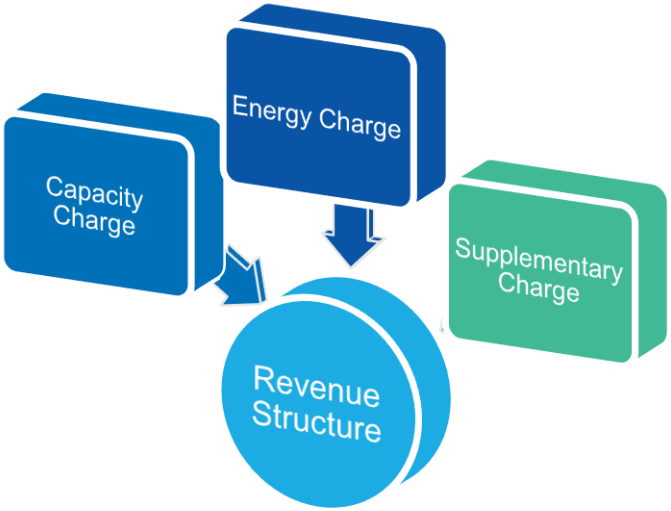






Business Environment

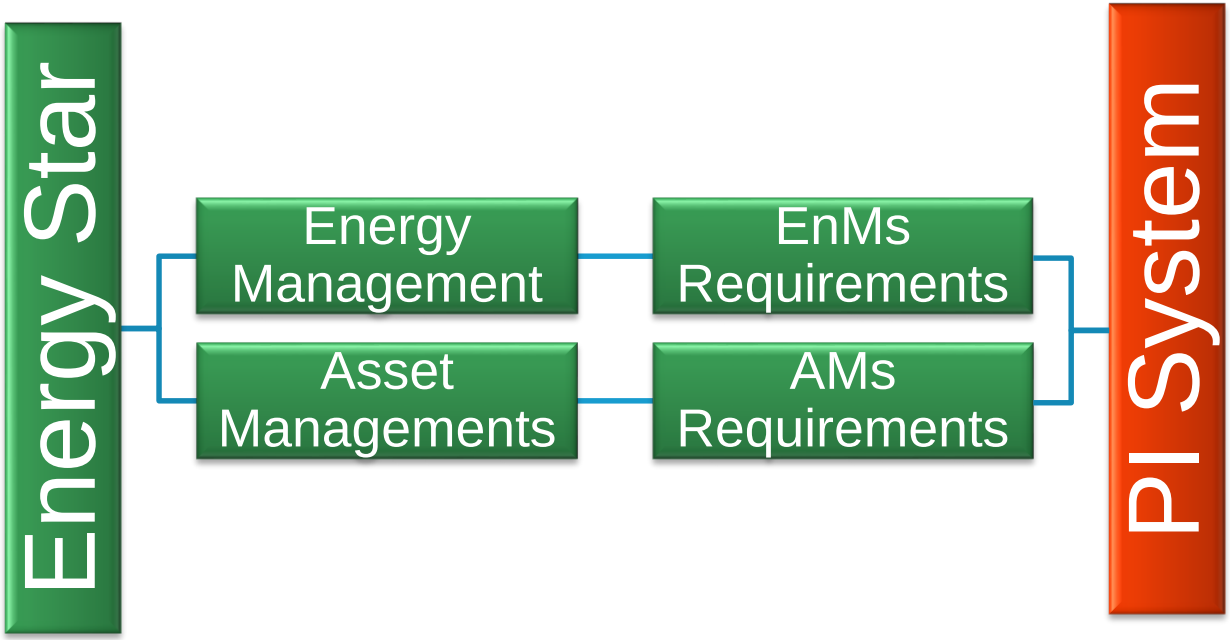
- Company income through PPA
- Fuel types (Gas , HFO, LFO) is pass-through under PPA and it is customer responsibility
- Plant performance is the main driver for business profits and to avoid penalties



Why we implemented the PI system

- AES initialed Energy Star Program which is basically to reach cheapest and most efficient power company by managing our assets and optimize our operation.
- Optimize best performance of current Assets by implementing Asset Management System
- Operate the plant on highest level of efficacy by Energy Management Implementation

Why we implemented the PI System



Road to ISO 50001 Energy Management

Challenges :

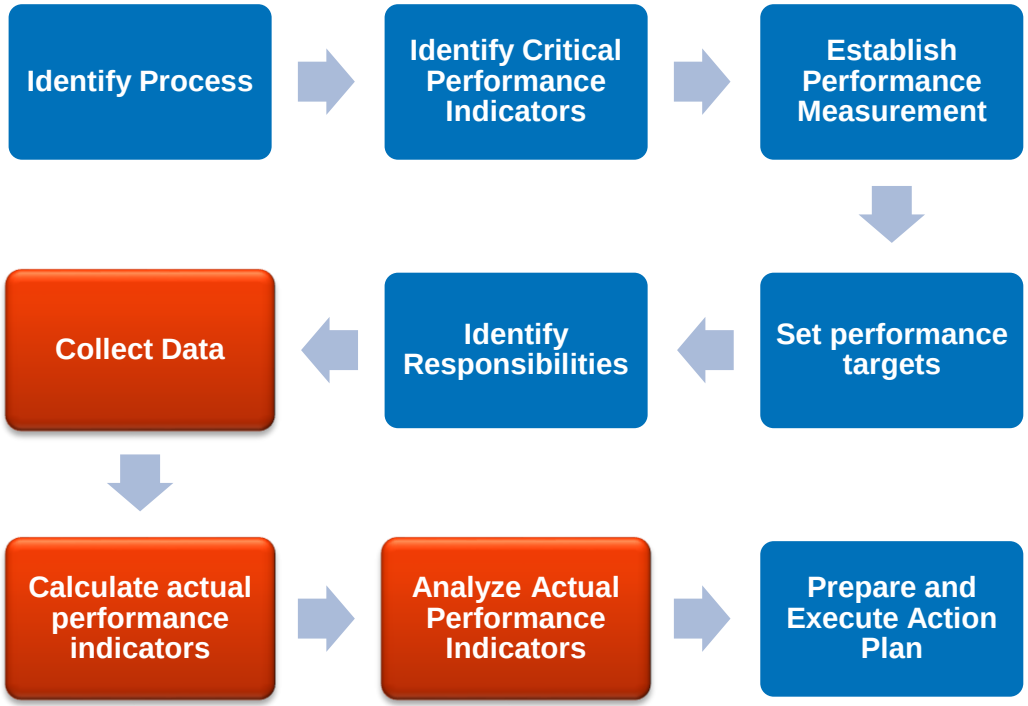
ISO 50001 Requirements:

- Monitoring plant House load in details
- Efficiency and Heat Rate
- Actus HR Vs PPA HR
- Efficiency of individual equipment

Road to ISO 55001 Asset Management

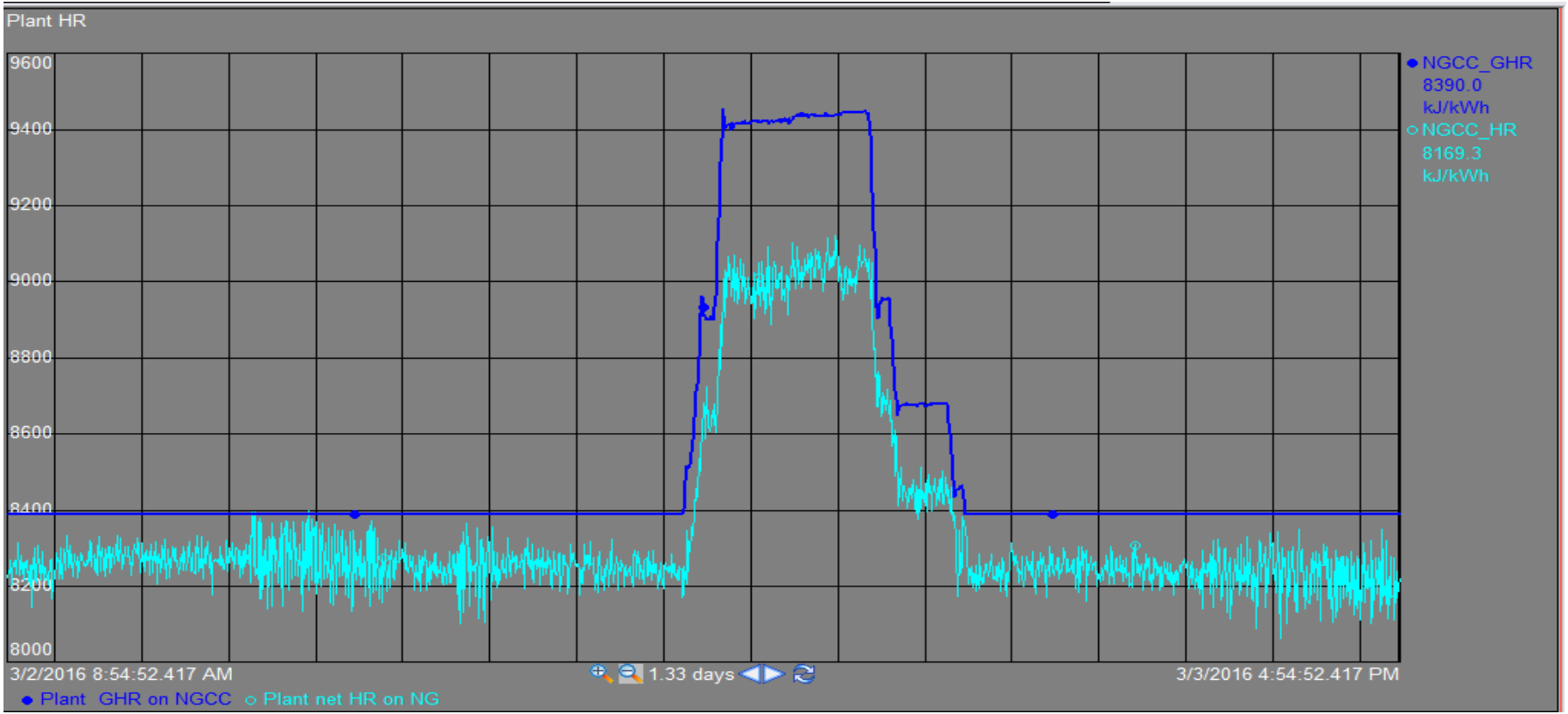
Overview

- AES developed 15 standards to implement Asset Management
- One of these standards is “Performance Monitoring”
- Performance Monitor requirements ==========➔



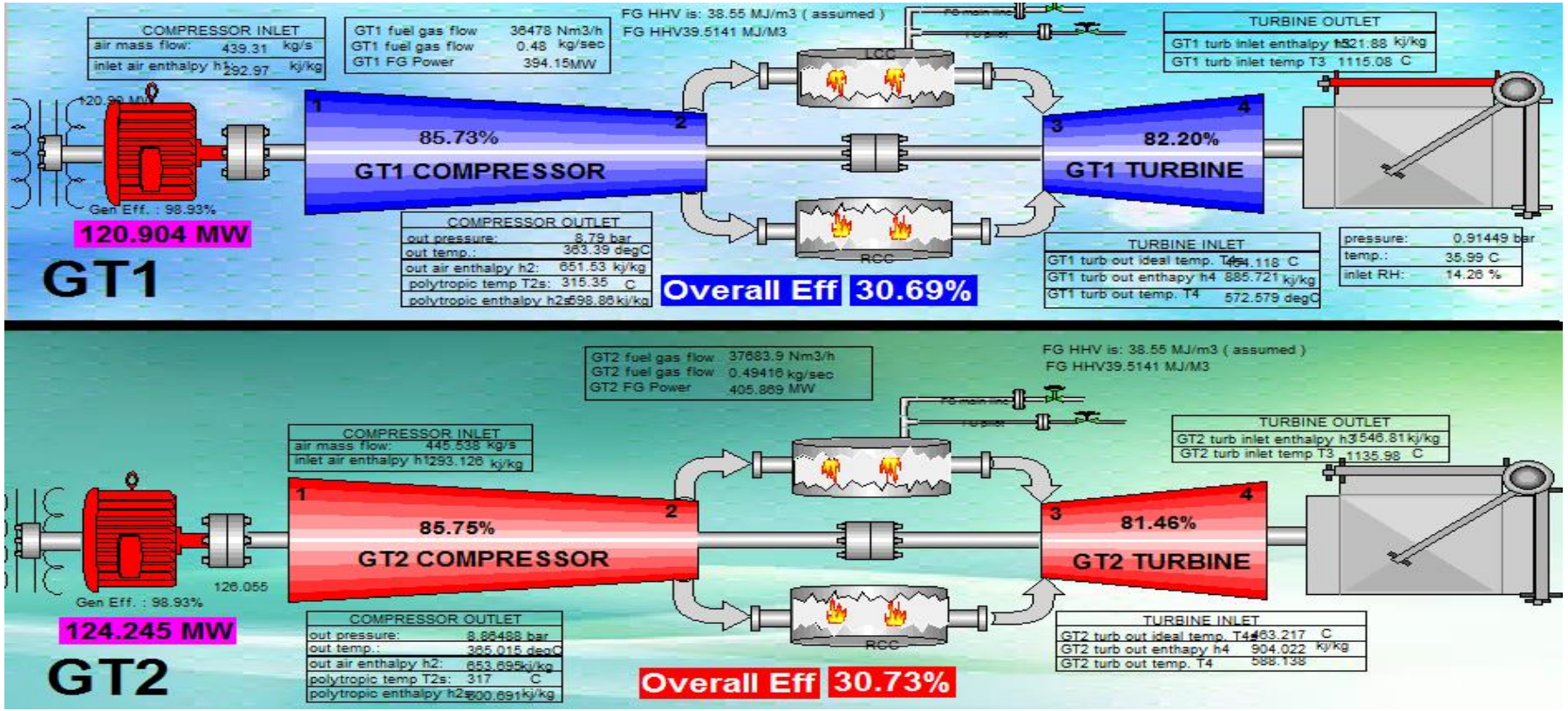
How we benefit from the PI System

Plant HR Vs PPA HR



How we benefit from the PI System

GT Model

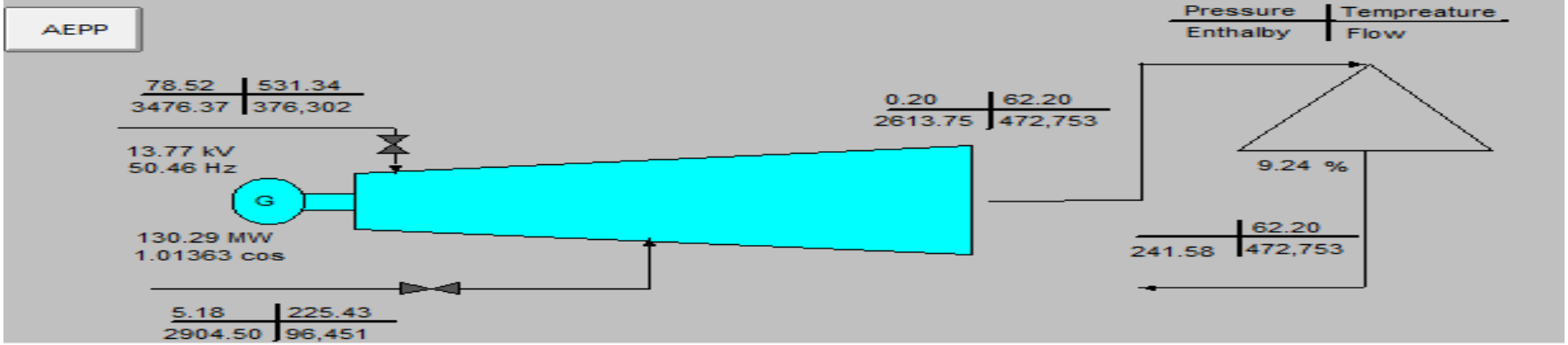


How we benefit from the PI System

Steam Turbine Model

Steam Turbine Performance Model

Inputs	Perf	Actual	Calculated	Perf	Actual
Condensate Flow (t/h)	504.56	492.80	Ejet Mot Stm flow bfr desphtr (kg/h)	697	700.81
HP1 feedwater flow (t/h)	205.04	194.71	Spray Flow for Eject mot stm (kg/h)	173	169.19
HP2 feedwater flow (t/h)	205.45	202.82	Spray Flow for turb Glnd SS (kg/h)	39	40.58
Ejector Motive Steam flow (kg/h)	870	870	HP steam flow at turbine inlet (kg/h)	409,794	376,302
Turbine Gland Sealing Stm (kg/h)	230	230	LP steam flow at turbine inlet (kg/h)	93,892	96,451
HP Steam Enthalby (kJ/kg)	3468.8	3476.37	Condensate flow at outlet (kg/h)	503,656	472,753
Ejet Mot Stm Enthalby(kJ/kg)	2920.6	2938.52	Field current (A)	610.89	623.05
HP Steam Press (bar a)	80.1	78.52	Field voltage (V)	223.26	229.93
HP Steam Temp (C)	528.9	531.34	Generator terminal output (MW)	140.79	130.85
Turb.Glnd Stm Enthalby (kJ/kg)	3001.9	2988.33	Excitation Power (kW)	147	153.22
Spray Enthalby (kJ/kg)	710.7	710.56	Gross output (MW)	140.64	130.69
HP1 Superheater spray flow (kg/h)	0.00	8.06	Gross Heat Rate (kJ/kWh)	11,305.2	11,279.25
HP2 Superheater spray flow (kg/h)	0.00	18.13			
Makeup water flow (kg/h)	0.00	20327.35			



How we benefit from PI System

House load “Aux Consumption “ Monitoring

Major Power Consumers		
CEP's consumption	525 kW	7.32 %
BFP's consumption	2174 kW	30.31 %
CPH's consumption	134 kW	1.87 %
CCWP's consump	207 kW	2.89 %
ACC consumption	2875 kW	40.08 %
Normal Lighting	58 kW	0.80 %
Essential Load	46 kW	0.65 %
HVAC Power	398 kW	5.55 %
GT1 AUX Power	398 kW	5.55 %
GT2 AUX Power	372 kW	5.19 %
Air compressors	30 kW	0.42 %
DMWTP power	44 kW	0.61 %
WWTP power	17 kW	0.23 %
400kV SS supply	24 kW	0.34 %
HRSG 1&2 MCC	34 kW	0.47 %
ST MCC	39 kW	0.54 %
CCCW Fans	254 kW	3.54 %

Plant Aux Power Consumption : 7.173 MW

50.50 kWh saving Equal 1 point HR improvement

	MW	MVAR
GT1	120	7
GT2	125	9
STG	132	26

PCC-1 Power :	775 kW
PCC-2 Power :	568 kW
PCC-3 Power :	602 kW
PCC-4 Power :	1332 kW
PCC-5 Power :	1041 kW

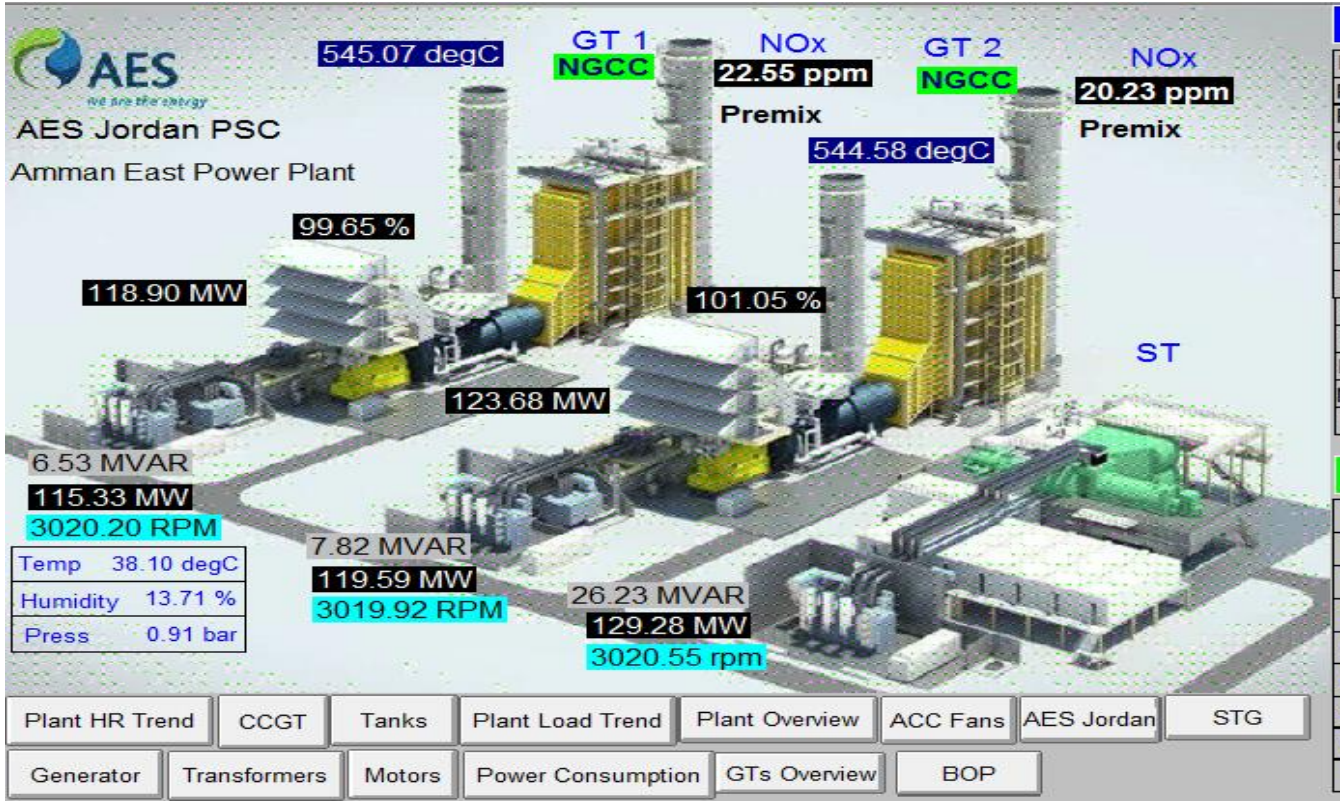
Minimize Your Heat Rate

A 1% improvement in heat rate can save up to $500,000 in fuel costs!'

' based on NG operation at 75% Capacity Factor annually

How we benefit from PI System

IPP1- Plant Technical and Financial Performance

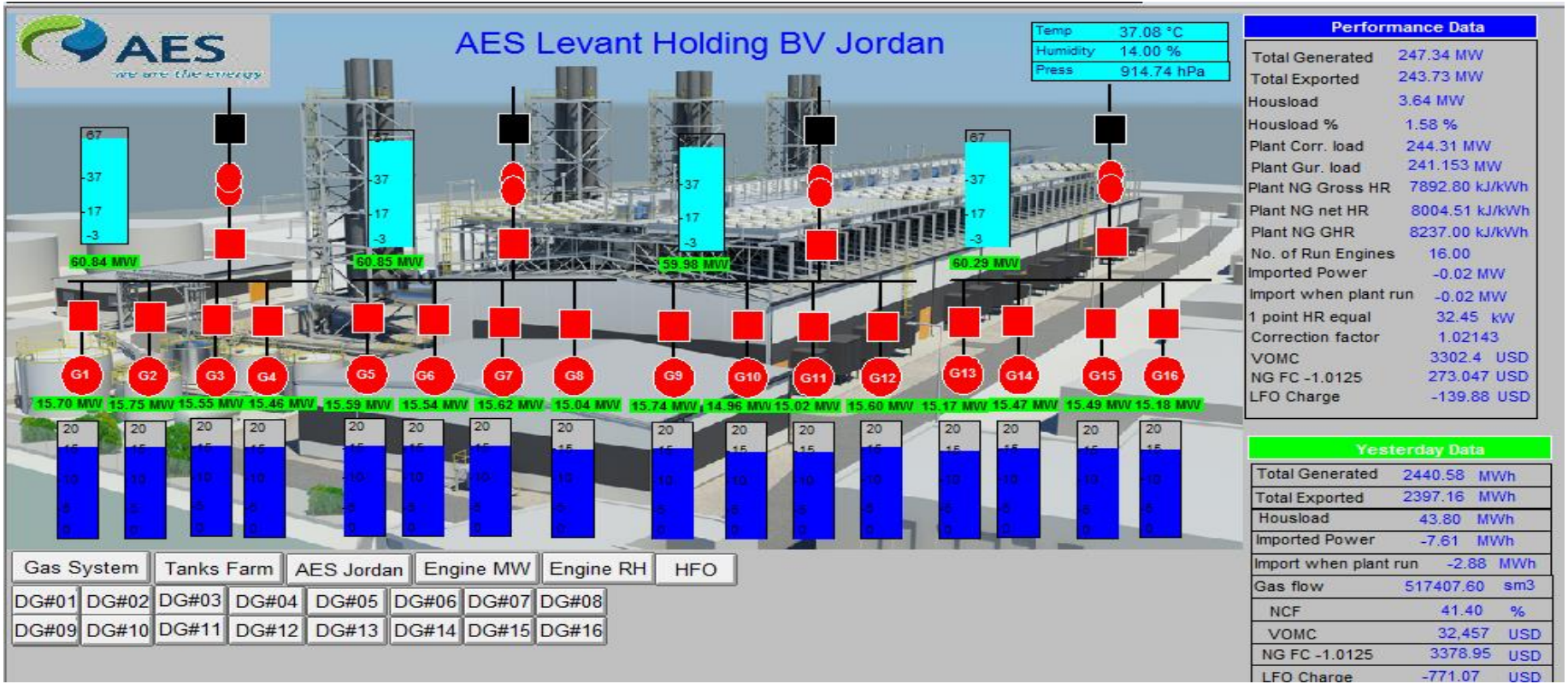


Performance Data	
Plant gross NG HR	8112.29 kJ/kWh
Plant net NG HR	8290.05 kJ/kWh
Plant NG GHR	8390.00 kJ/kWh
Corrected Load	376.55 MW
Exported Energy	365.00 MW
Generated Energy	372.00 MWh
Houseload	7.26 MWh
Houseload	1.82 %
Effciency Exp.	43.58 %
NG _NCF_ PPA	102.07 %
NG _NCF_ISO	78.65 %
NG Extra Energy	7.63 MWh
NG Fuel Charge	101.42 USD
1 point HR equal	40.87 kW

Yesterday Data		
Total Gen. Energy	9392.97	MWh
Total Exp. Energy	9209.01	MWh
Total Houseload	183.96	MWh
Total Fuel Gas	3165.86	GJ
NCF ISO	82.52	%
Average Plant HR	8266.23	kJ/kWh
BAHR	8103.38	kJ/kWh
NG Fuel Charge	3211.92	USD
Effciency Exp.	43.56	%

How we benefit from the PI System

IPP4- Plant Technical and Financial Performance

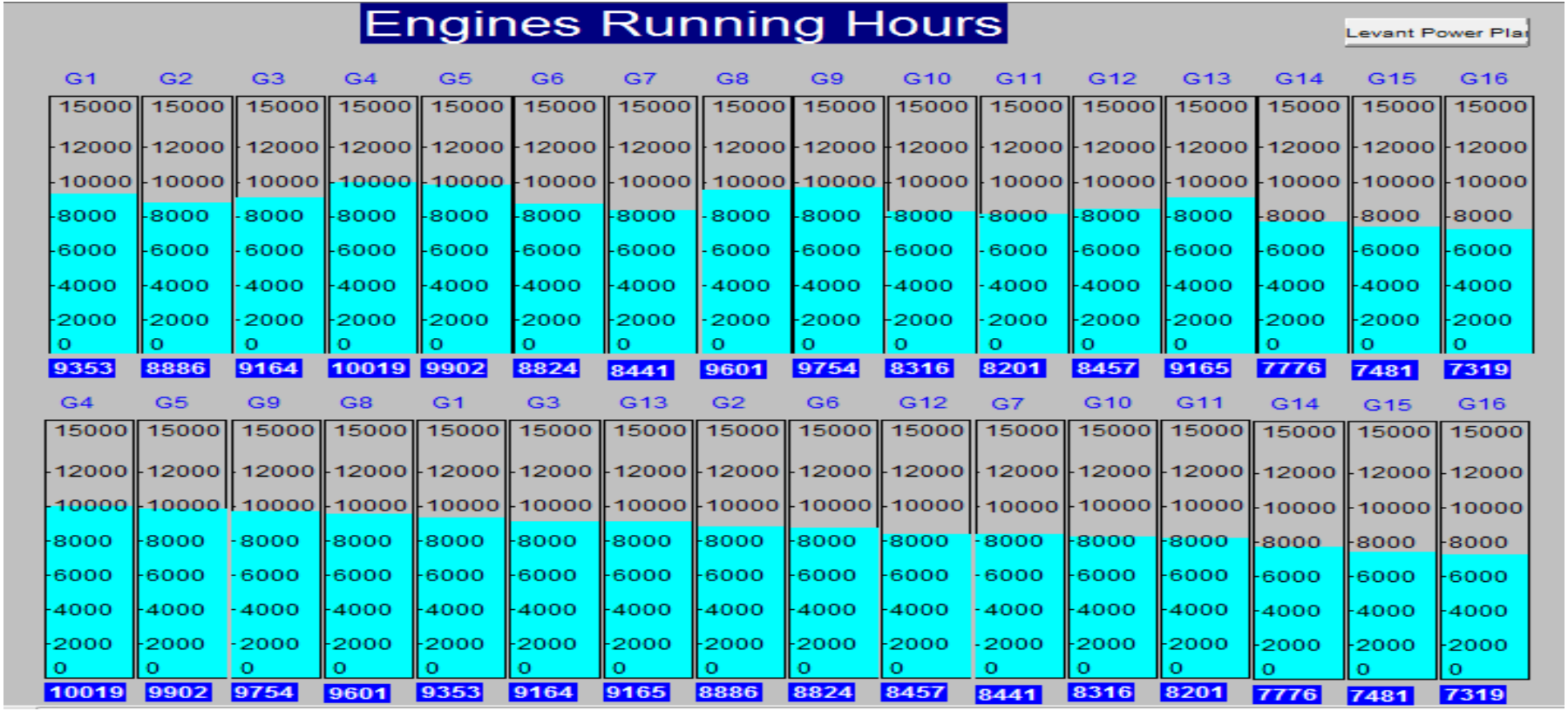


Performance Data	
Total Generated	247.34 MW
Total Exported	243.73 MW
Housload	3.64 MW
Housload %	1.58 %
Plant Corr. load	244.31 MW
Plant Gur. load	241.153 MW
Plant NG Gross HR	7892.80 kJ/kWh
Plant NG net HR	8004.51 kJ/kWh
Plant NG GHR	8237.00 kJ/kWh
No. of Run Engines	16.00
Imported Power	-0.02 MW
Import when plant run	-0.02 MW
1 point HR equal	32.45 kW
Correction factor	1.02143
VOMC	3302.4 USD
NG FC -1.0125	273.047 USD
LFO Charge	-139.88 USD

Yesterday Data		
Total Generated	2440.58	MWh
Total Exported	2397.16	MWh
Housload	43.80	MWh
Imported Power	-7.61	MWh
Import when plant run	-2.88	MWh
Gas flow	517407.60	sm3
NCF	41.40	%
VOMC	32,457	USD
NG FC -1.0125	3378.95	USD
LFO Charge	-771.07	USD

How we benefit from PI System

Engines hours



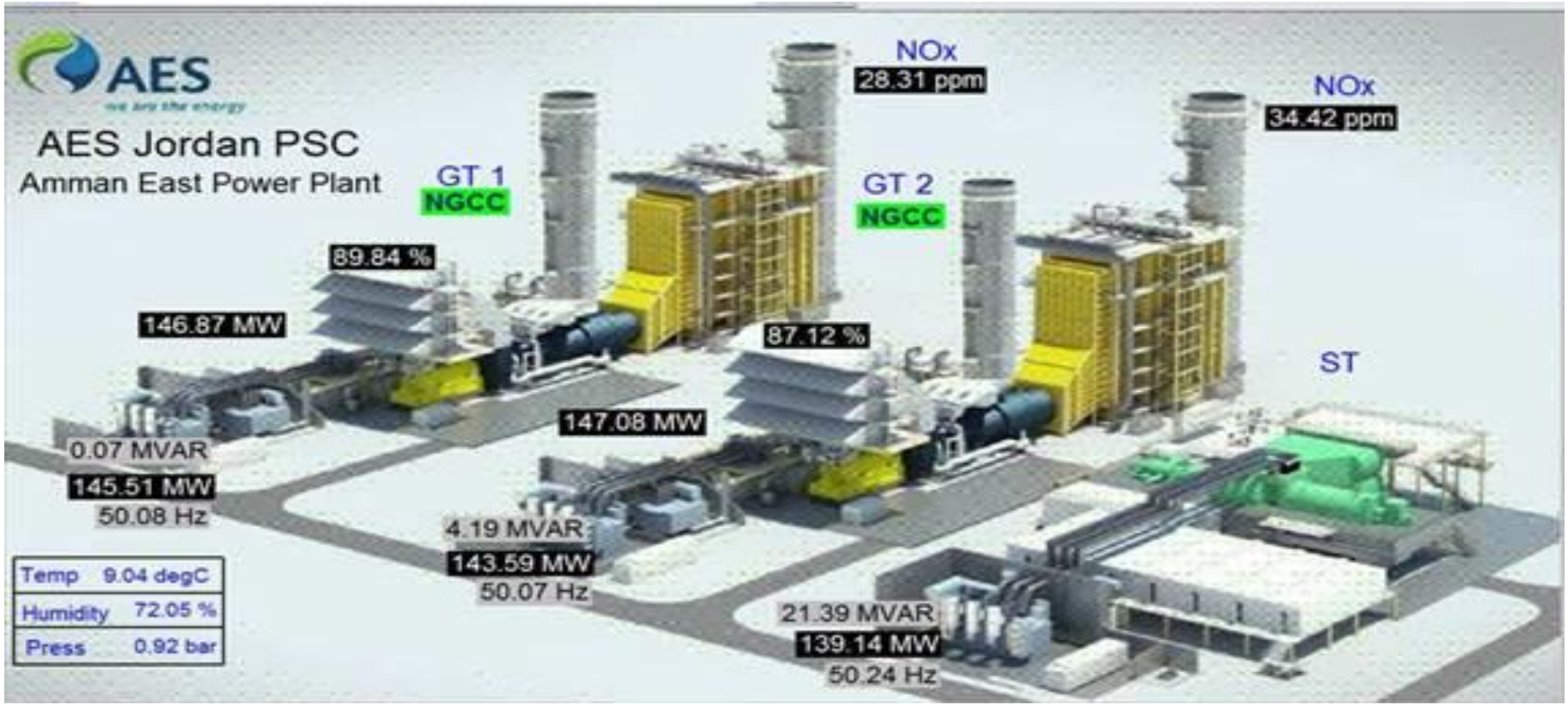
Technical problems solved by the PI System

Reduced Plant forced derating during winter

- IPP1 as per PPA has to deliver 370 MW corrected to ambient condition when plant on baseload.
- In winter, the plant fails to achieve that. Since no online monitoring for plant capacity our operator did not notice.
- Inlet Guide Vane (IGV) was not 100% Open
- EFOF was 0.7% with 243 MW deration during month of Jan

Technical problems solved by PI System

Before Modification



Technical problems solved by the PI System

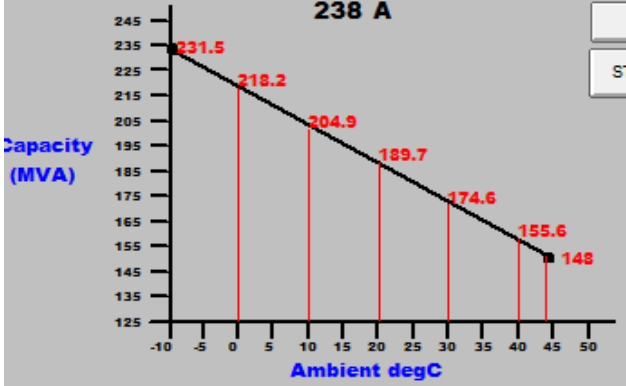
Transformer Monitoring

Transformer can be loaded	163.52	MVA
GT1 Transformer actual load	117.22	MVA
GT2 Transformer actual load	121.20	MVA

AmbiTemp: 35.68 degC

NOW TR capacity: 164 MVA

238 A



AEPP

ST Transformer

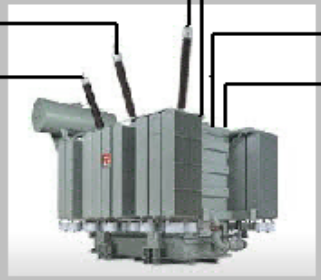
GT Transformer Sizing Vs Ambient Temp

GT1 Main transformer

TR Load 117 MVA

169 A	396 KV	15.4 KV	4504 A
171 A	395 KV	15.4 KV	4615 A
172 A	394 KV	15.4 KV	4495 A

GT base load



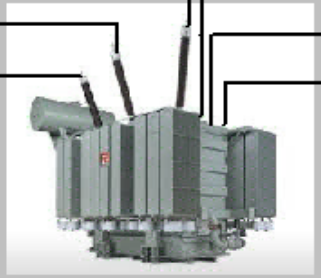
HV-WT:	84 degC
LV-WT:	84 degC
Oil Temp:	69 degC
OLTC Tap#:	12 NO

GT2 Main transformer

TR Load 121 MVA

178 A	396 KV	15.4 KV	4690 A
178 A	395 KV	15.3 KV	4791 A
178 A	394 KV	15.4 KV	4715 A

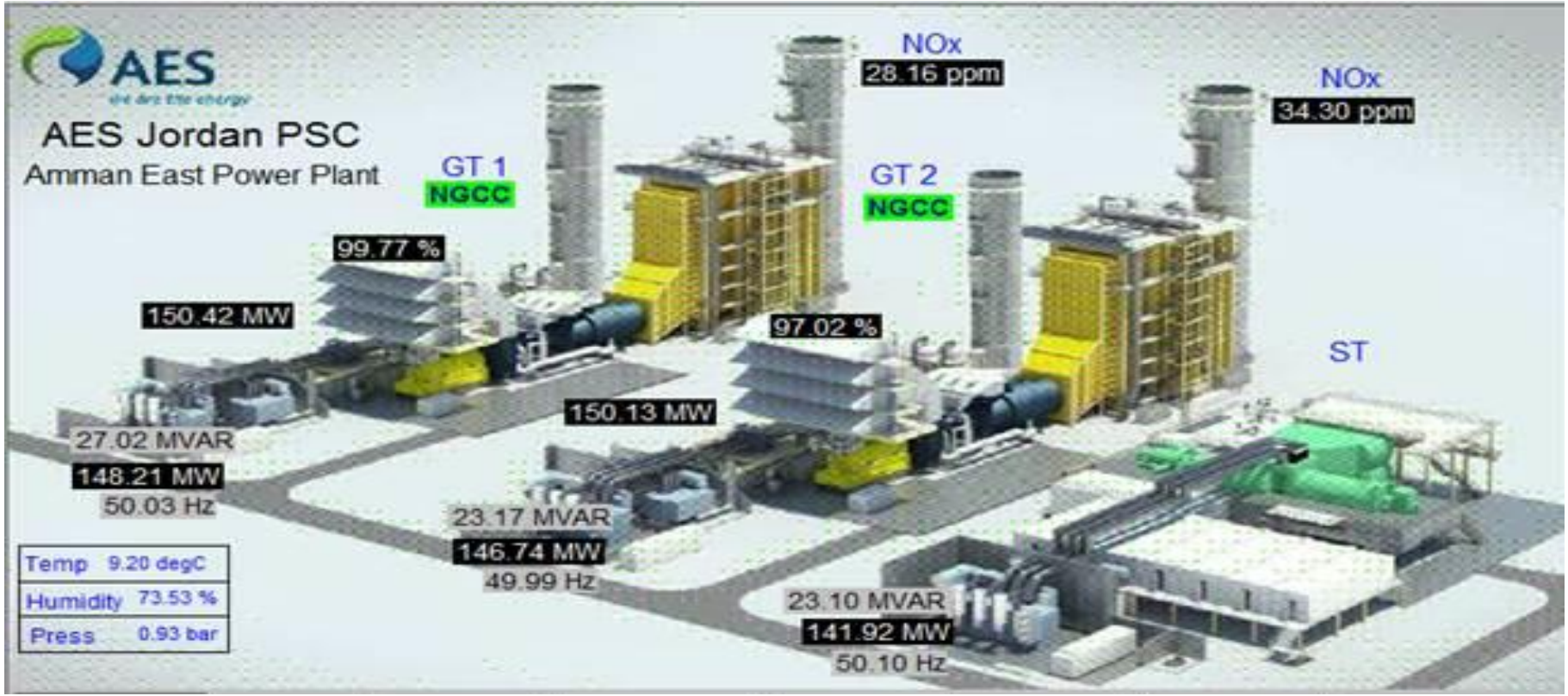
GT base load



HV-WT:	90 degC
LV-WT:	86 degC
Oil Temp:	66 degC
OLTC Tap#:	11 NO

Technical problems solved by PI System

After Modification

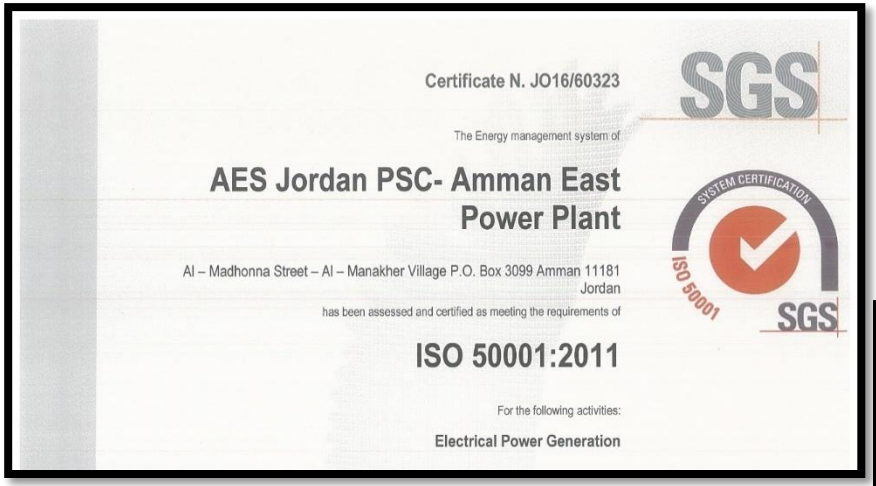


PI System Benefits

	Before	After	
	6-Feb-16	11-Feb-16	Improvement
Ambient temp C	9.04	9.2	
Ambient humidity %	72.05	73.53	
Plant Corr Load MW	376.26	383.49	7.23
GT1 Gross MW	146.87	150.42	3.55
GT2 Gross MW	147.08	150.13	3.05
ST Gross MW	139.14	141.92	2.78
Total Gross MW	433	442	9
Total Net MW	428.17	436.43	8.26
Heat Rate kJ/kWh	8142.53	8098.43	-44.1
GT1 IGV open %	89.84	99.77	9.93
GT2 IGV open %	87.12	97.02	9.9
VOMC (USD/hr)	55.66	56.74	1.07
Fuel Charge (USD/hr)	294.57	353.75	59.19
Water Charge (USD/hr)	19.30	19.67	0.37
Total (USD/hr)	369.53	430.16	**60.63**

60 $/hr saving
For 3 months the saving will be
8hrs/day x 60$/hrs x 90 days
$43,200 USD.

PI System Benefits



Certificate N. JO16/60323

SGS

The Energy management system of

AES Jordan PSC- Amman East Power Plant

Al – Madhonna Street – Al – Manakher Village P.O. Box 3099 Amman 11181 Jordan

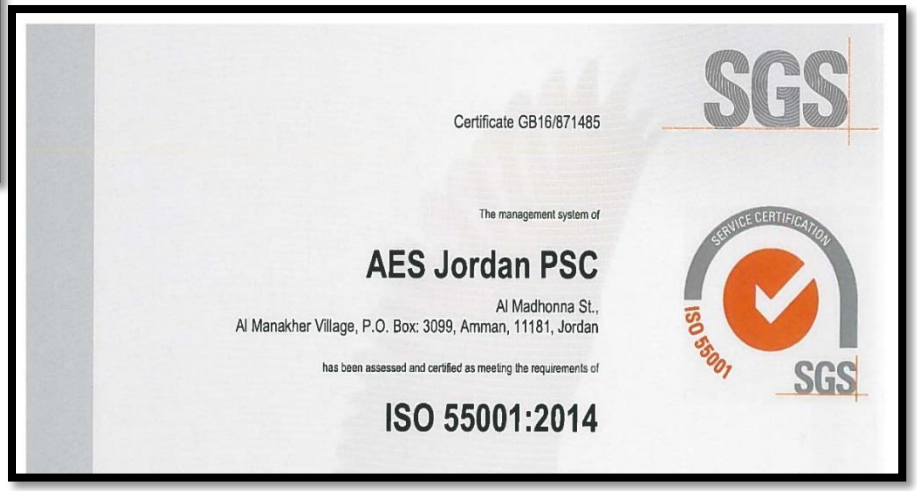
has been assessed and certified as meeting the requirements of

ISO 50001:2011

For the following activities:

Electrical Power Generation

SYSTEM CERTIFICATION ISO 50001 SGS



Certificate GB16/871485

SGS

The management system of

AES Jordan PSC

Al Madhonna St.,
Al Manakher Village, P.O. Box: 3099, Amman, 11181, Jordan

has been assessed and certified as meeting the requirements of

ISO 55001:2014

SERVICE CERTIFICATION ISO 55001 SGS

PI System is our strength

Our Strengths

- 1- Using SAP for Predictive ,Corrective and Preventive Maintenance
- 2- PI system –from OSIsoft- Performance software
- 3- APEX- AES Performance Excellence Program
- 4- Familiar with ISO certificates
- 5- Management commitments and enforcement

SAP

APEX
wired to win

OSIsoft.

Contains Forward Looking Statements

Embedded Benefits of the PI System

- PI System is considered as backup for existing DCS Historian
- PI System can be configured to be used as billing system to issue monthly invoice

What next?

- PI System installed recently in both plants- hence still we need time to reach full optimization of PI System our plan for next year:
- Configuration of Asset Framework, PI Coresight and Notifications
- Monthly Statistics reports, KPI reporting
- Develop HSE Reports showing emissions
- Develop PEMS program for emission prediction

Summary

COMPANY and GOAL

AES Jordan considered as one of the most reliable and efficient power plants in the Kingdom of Jordan.

PI System creates value to AES Jordan Business through supporting AES to be an Energy Star company

CHALLENGE

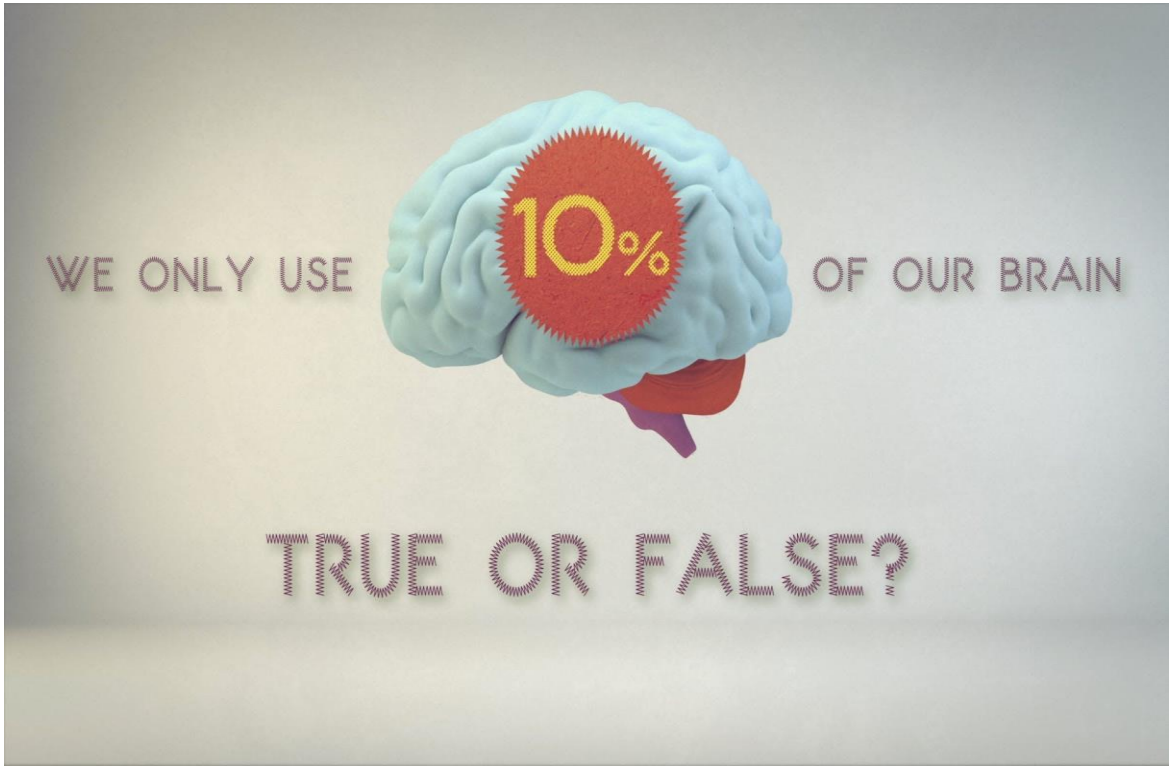
A. House load reduction
B. Data accessibility
C. Online plant HR
D. DCS Back up Historian
E. Billing system renewal
F. Availability of operational data

SOLUTION

A. Implemented PI system with powerful analysis tools
B. Real time data access
C. Monitor plant performance any where , any time
D. Backup data

RESULTS

A. Real time data availability
B. Implementation PI Process Book to monitor plant technical and financial performance
C. Monitoring plant efficiency and HR improvement (20 K USD/ Annum)
D. Generation of Daily & Monthly reports
E. Reduced CAPEX (300 K USD)



Contact Information

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AES Jordan

Questions

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

State your **name & company**

Please remember to…

Complete the Online Survey for this session

http://ddut.ch/osisoft

감사합니다

谢谢

Danke

Gracias

Merci

Thank You

Shukran

ありがとう

Спасибо

Obrigado