Digitization: Sustainable Approach to optimize Energy Efficiency in Chlor-Alkali

February 2024

Speaker: Mayank Shukla Grasim Industries Limited

(27 February 2024)

Agenda

- Digitization in Grasim
- Governing Principle
- Central Manufacturing Cockpit
- Circle of Digitization Excellence
- Used Cases

Grasim Chemical Overview

- In 1972, Grasim's chemicals business was set up to manufacture caustic soda for the company's VSF unit. Today, it is one of India's largest caustic soda producers and is a market leader in the chlor-alkali segment.

- Strong foothold (caustic soda capacity is 1,147 KTPA) in the industry and offers a wide range of products from chlorine derivatives (SBP, PAC, CSA, CPW, CaCl2, HSBP, CMS and AlCl,) to epoxy.

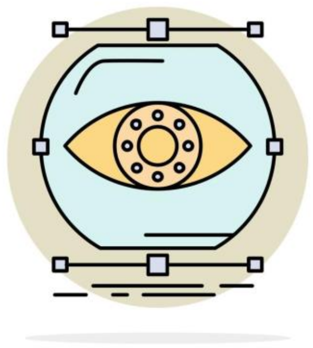
8 caustic soda manufacturing units across India

1,147 KTPA total caustic soda capacity

123 KTPA capacity epoxy plant

~1 million tonnes of caustic sales

Digitization



Improve & Optimize

Plant operation

Optimize the value of incoming data by collecting & analyzing the data

Visualize & Monitor

Plant Insights

Enable & informed team (management) to make quick and strategic decision

Performance Assessment

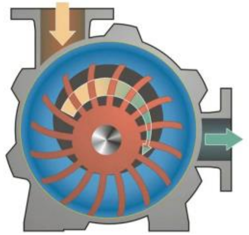
Data Analysis

Drive faster root cause analysis on daily basis & weekly basis to prepare action plan

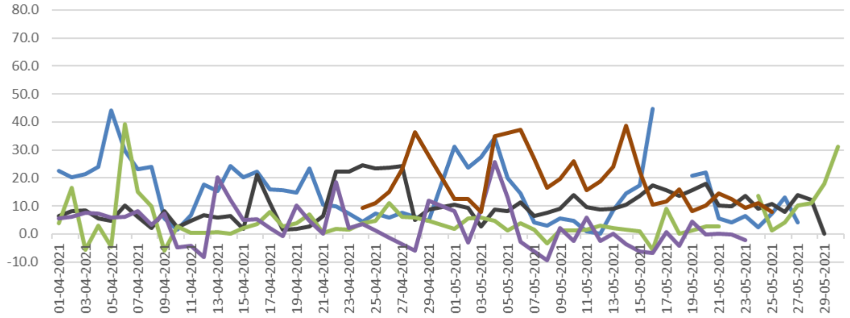
Governing Principle

Governing Principle	Why
The 80/20 Way	*Focus on Top 80% to derive the first wave of benefits*
Golden Excellence	*Define the best operating envelope of plant operations for energy and production using combination of sources like best achieved figures of past as reference, P&B, theoretical, licensor etc.*
Compliance Management	*Compliance with defined Norms in Real-Time*
Energy Project Identification Management	*Data driven decision making for Identification & Ranking of Capital Projects for Energy Improvement Outcome*
Measuring Outcomes	*Data driven tracking of Impact of Non-Compliance & Tracking of Energy Improvement Schemes*

Benchmarking



Chlorine compressors Battery



Actual Baseline/Exiting baseline

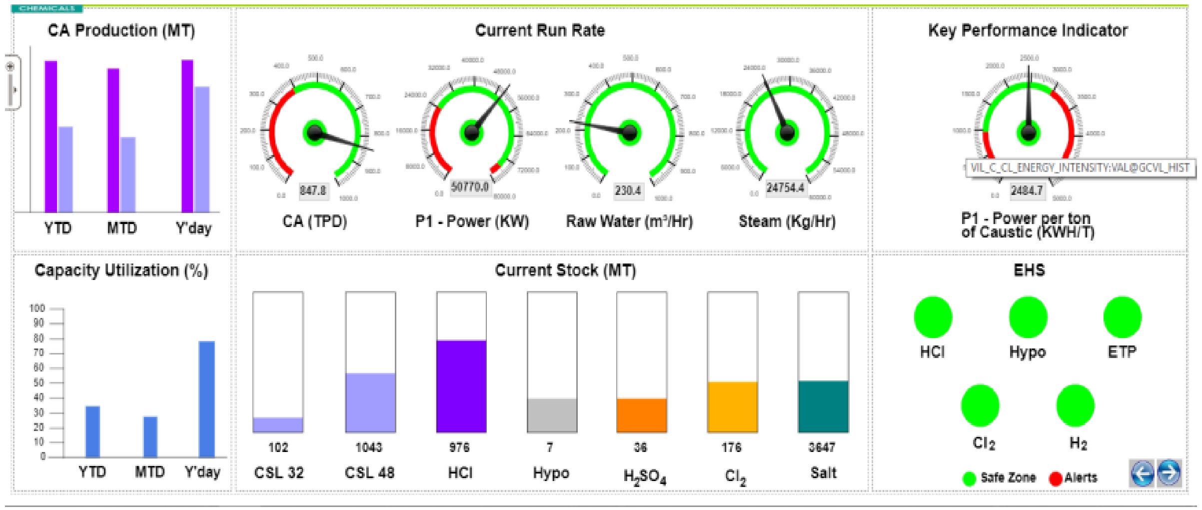
Gap Identification

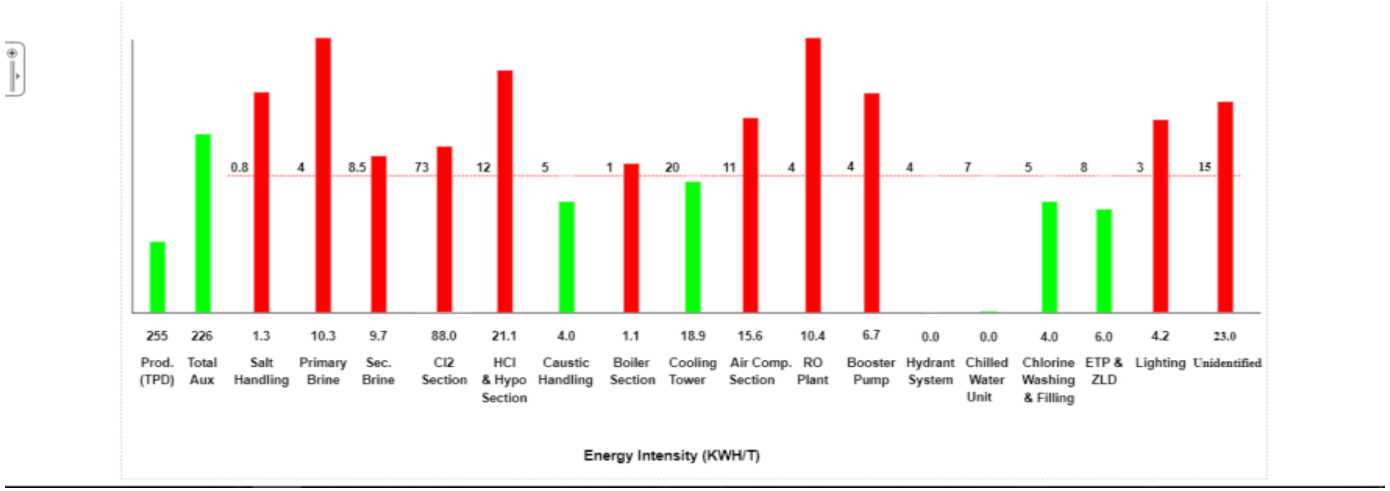
Customize reporting and gap filling

Benchmarking and established new baseline

Results review and continual improvement

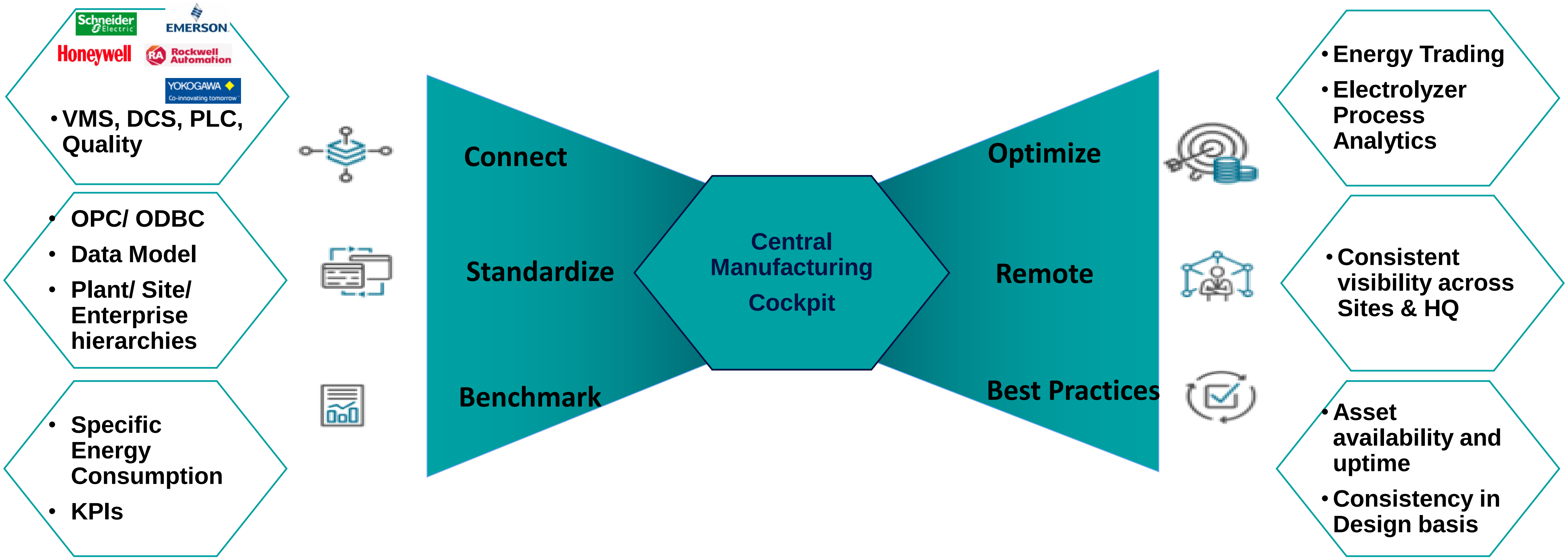
Central Manufacturing Cockpit





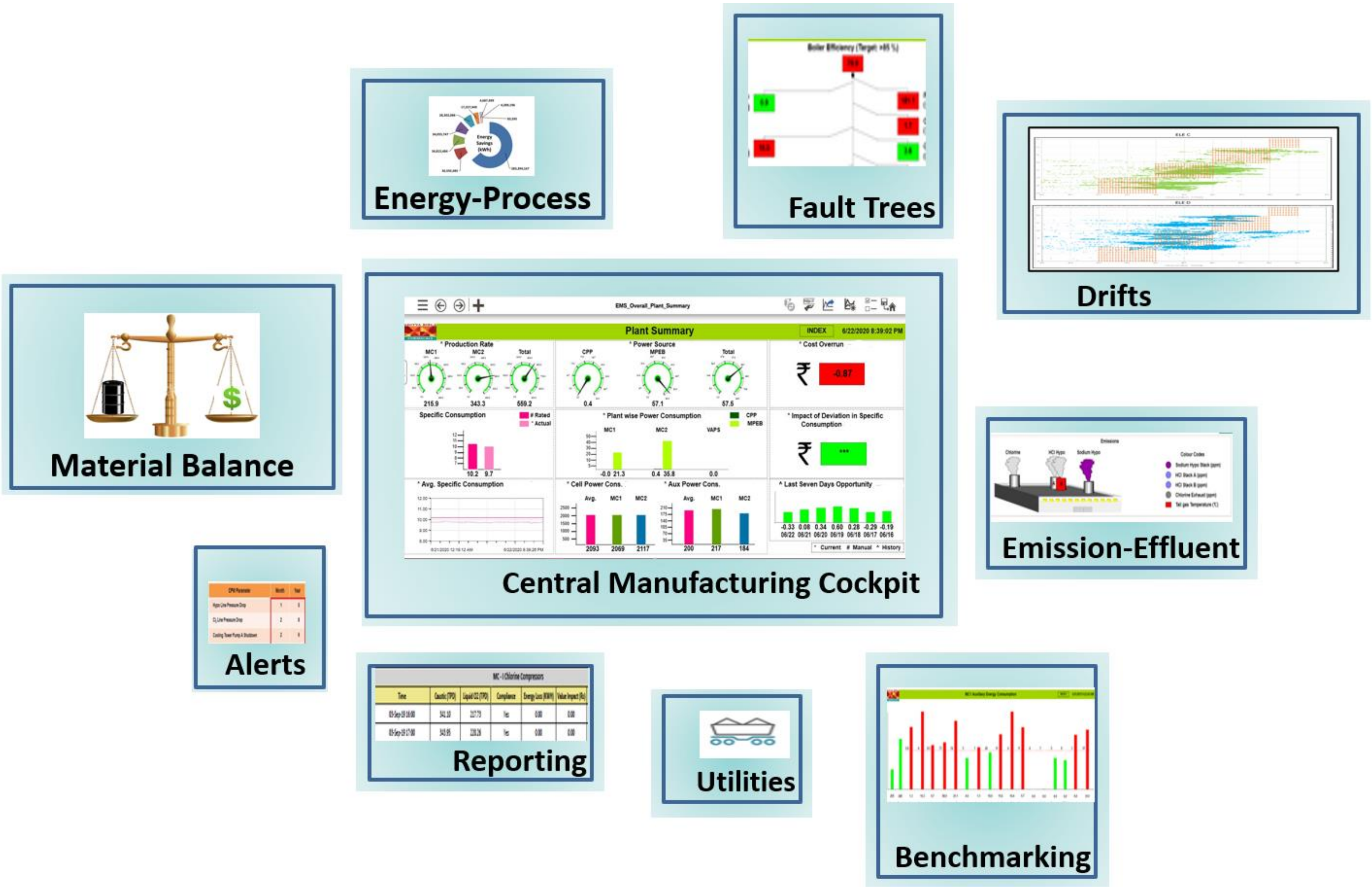
Real time Visibility and drilldown by getting data from **different DCS / PLC / Environmental Sensors** and SAP

Solution structure



- Implement OPC across units.
- Implement AspenTech IP21 in each unit.
- Energy Management Dashboard
- Golden Batch (Cycle time, Material consumption, Process)
- Automate unit DPR and Reports.
- Integration of Sales information from SAP into IP21.
- Central Manufacturing Cockpit in SSRS.
- SPC

Circle of digitization excellence



Used case

1. Reduction in specific energy Consumption
2. Process KPI Control
3. Hydrogen Management
4. Process Analytics & control
5. Process Score card

Reduction in Specific Energy

Specific Energy reduction per ton of Caustic or Chorine

Plant operation

1. Auxiliary Power consumption-Caustic
2. Chlorine derivative power consumption
3. Captive power plant auxiliary power consumption

Reduction in Specific Energy

1 How

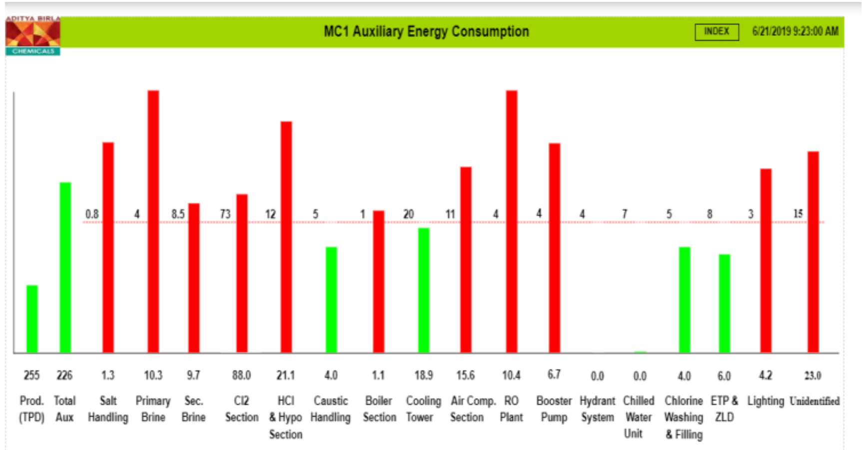
- Real time view of specific energy consumption
- Continuous internal & industry benchmarking
- Workflow and Escalation of significant deviation and potential lost opportunity

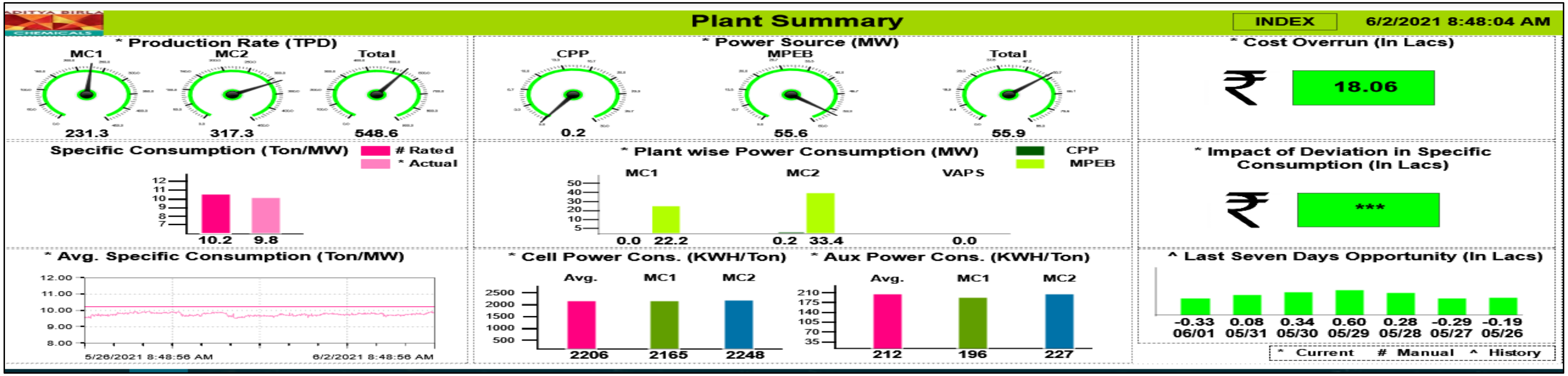
2 What changed

Process Operators are able to identify the key area of improvement with significant deviations to act upon in real time.

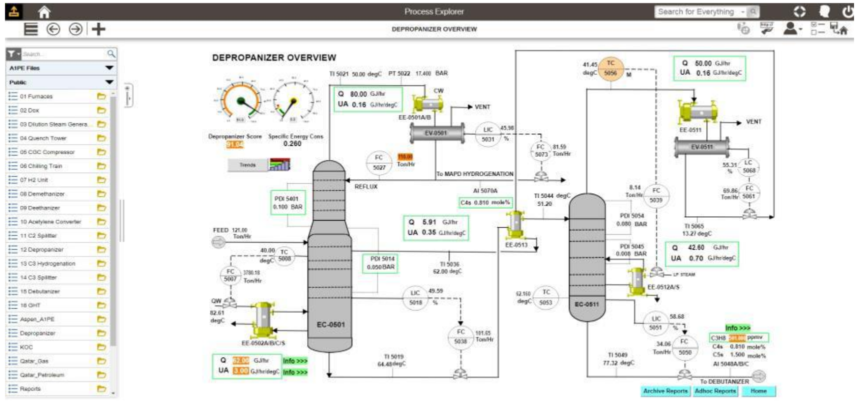
3 Value

Cost savings - 4% reduction in aux power specific energy consumption





Process KPI control



Process KPI Control

Plant operation

1. Fast evaluation of performance
2. Enhance & new monitoring system which identified in gap analysis
3. Decrease reaction time to problems
4. Increase asset utilization & productivity

Process KPI control

1

How

- One page real time view of factors which impact the KPI.
- Section wise critical reporting real time.
- Quick action on data flow management.
- Training and awareness session

2

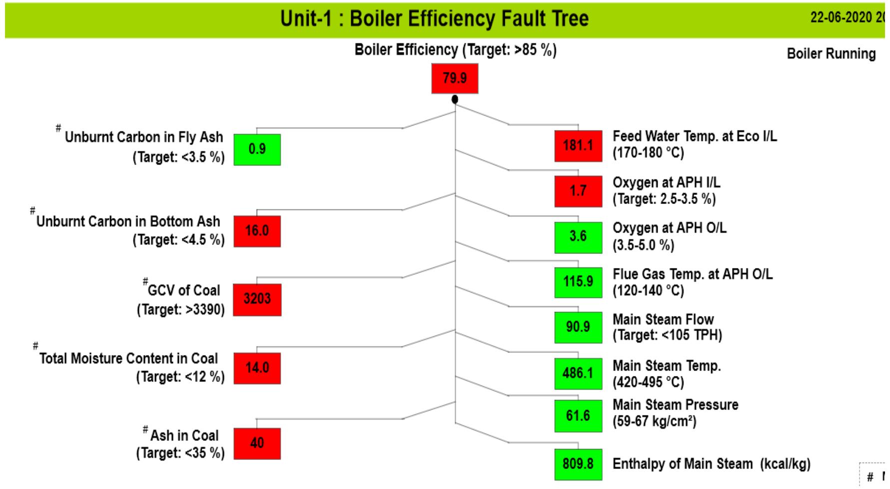
What changed

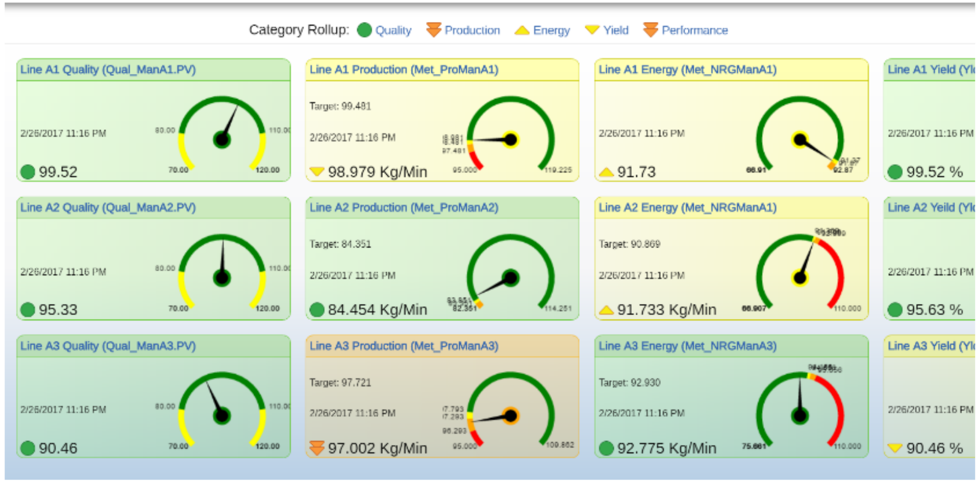
- Delivery of real time view and sensitization of potential lost opportunity
- Capability to take immediate corrective course action.
- Advance planning of asset utilization and combination.on in real time.

3

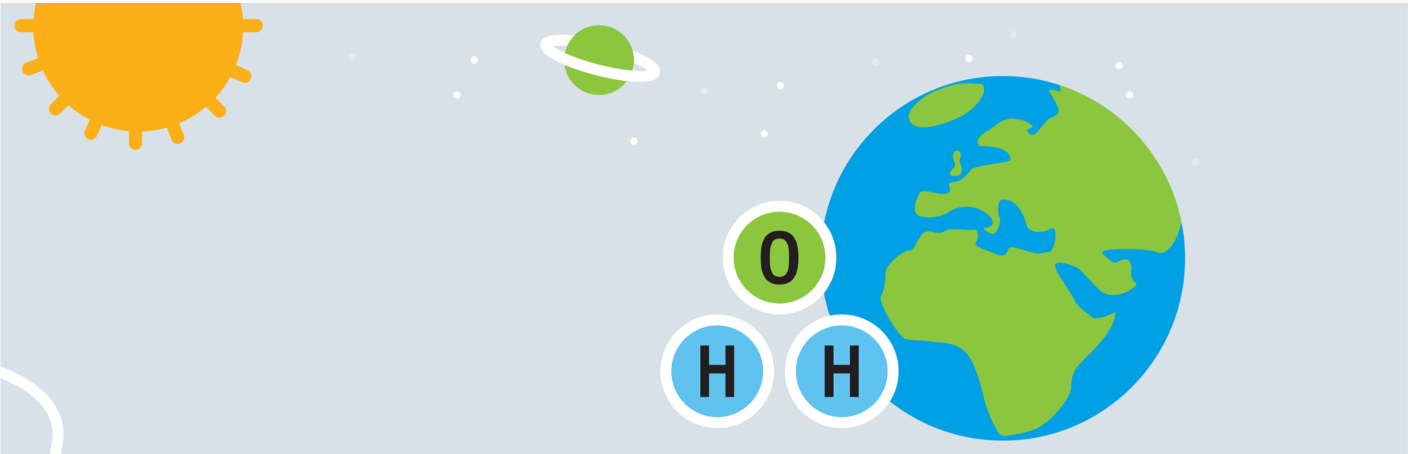
Value

- Operational excellence
- More data base discussions and gap identification





Hydrogen Management



Hydrogen Management

1. Optimal use of hydrogen in processes
2. Hydrogen balance for the plant
3. Line up bottling and compressor management
4. Generate more revenue

Hydrogen Management

1

How

- One page real time view of H2 generation, consumption(process, bottling) and venting; data sourced from multiple DCS/PLC systems
- Autonomous alerts to relevant engineer to take action with visibility on potential opportunity
- Feedback and response tracking on why a certain corrective action was not taken

2

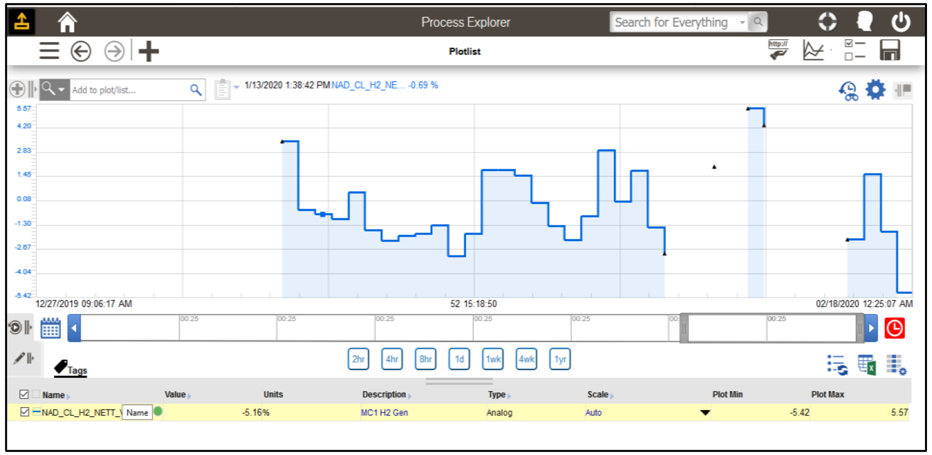
What changed

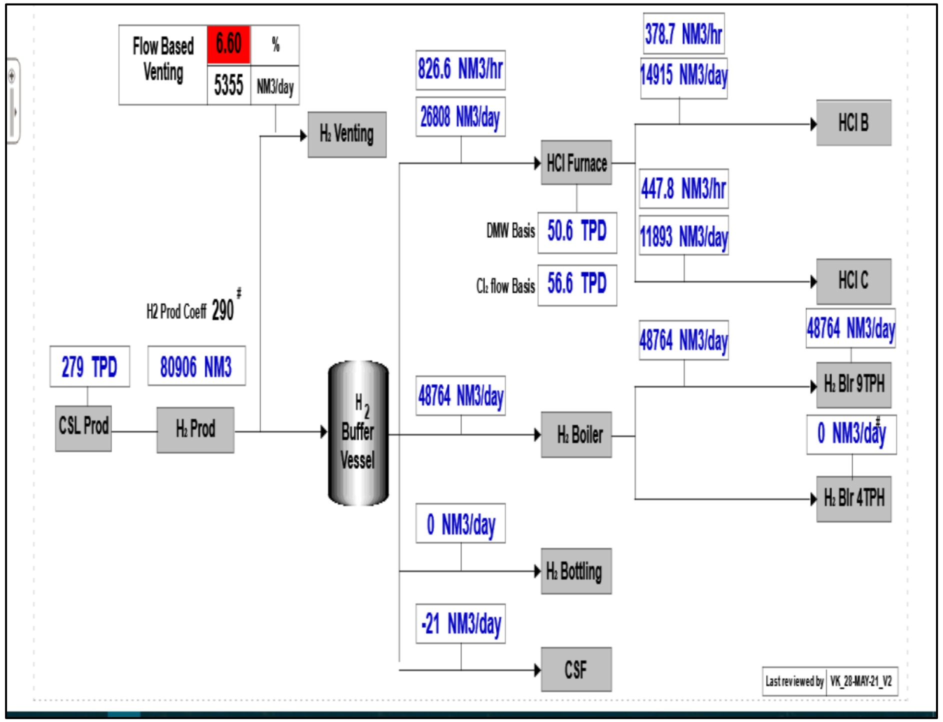
- Delivery of Crisp actionable information to the process engineer.
- Created a pre-planned hydrogen management on particular load in real time.

3

Value

- Reduction in hydrogen venting
- Cost Savings - 4% in overall reduction in H2 venting





Process Analytics & control

Process Analytics & control

1. Unit Operation wise KPI check
2. Historical Pattern Monitoring
3. Root cause and relative correction
4. Cost reduction
5. Monthly Audit to control the cost

Process Analytics & control

1 How

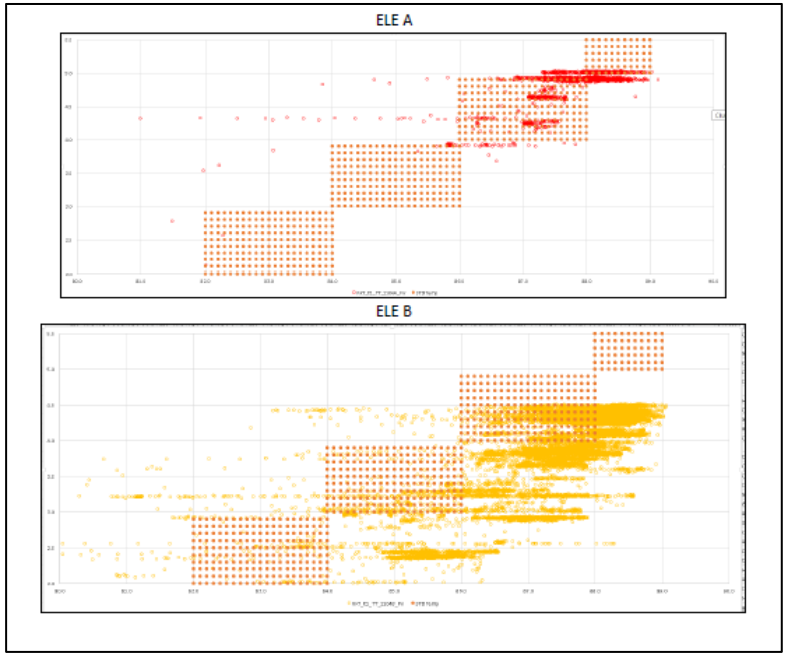
- Application of analytics on very long term data to identify significant process drifts
- Quick root cause analytics on contributing factors in upstream an downstream of the process

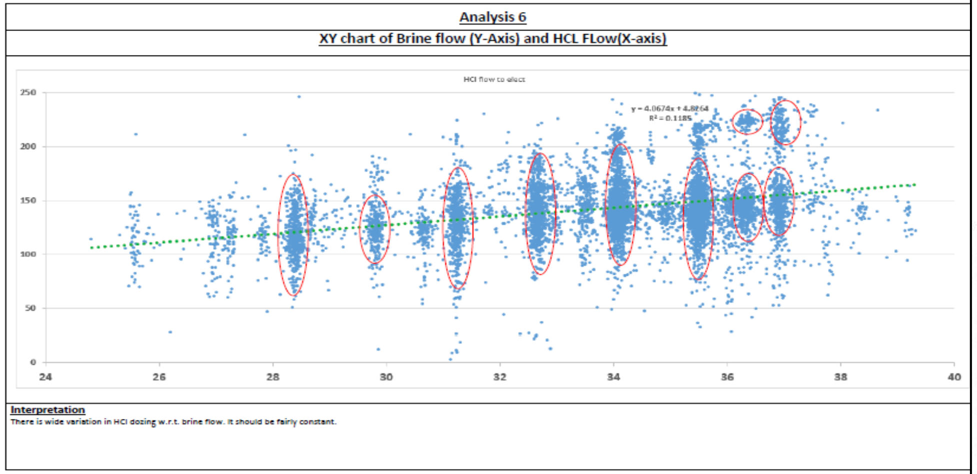
2 What changed

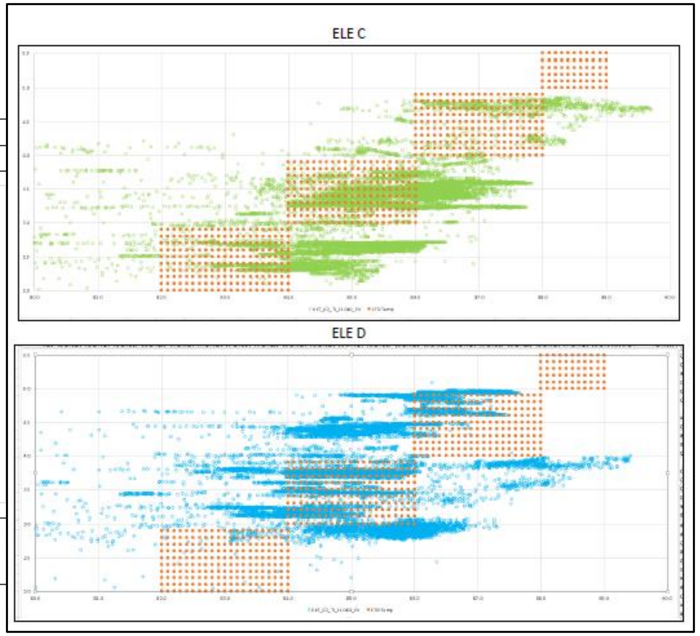
- Capability to apply ad-hoc analytics on very long term data(2Yrs – 1 min frequency data).
- Quick visual reasoning of change .

3 Value

- Operation Excellence

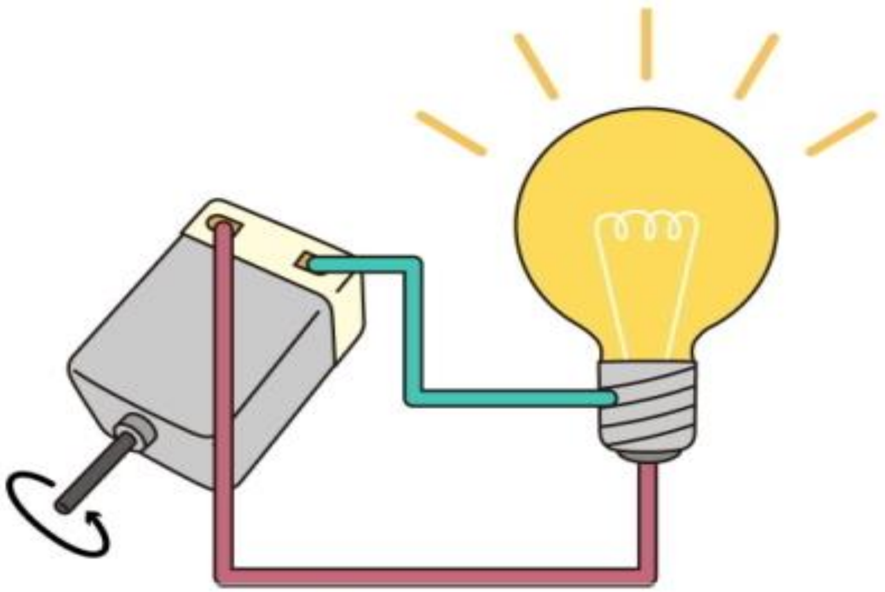






Process Drift (temp & Current)

Power Management



Process Score Card

1. Identify gaps
2. Minimize fluctuation
3. Maximize production
4. Optimal range of operation

Shift Basis Process Score card and its monitoring

ADITYA BIRLA CHEMICALS

Process Score Card

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#	Process Parameter	UOM	Unit1	Unit 2
1	**Unit Load**	MW	26.4	18.2
2	**Runnung Hours**	Hours	8.0	8.0
3	**PLF**	%	88.0	60.0
4	**Aux Power**	%	10.5	11.5
5	**Net KPI Score**	%	79	86

#	Process Parameter	UOM	Unit1 Range	Unit1 Actual Parameters	Unit1 Score (Actual/Target)	Unit 2 Range	Unit 2 Actual Parameters	Unit 2 Score (Actual/Target)
1	MS Inlet Temp - Boiler	°C	485 (480 to 490)	493.5	0 / 5	540 (535 to 545)	538.5	5 / 5
2	MS Press - Boiler	kg/cm^2	66 (64 to 67)	68.1	0 / 5	109 (107 to 110)	109.4	5 / 5
3	SPM in flue gas	mg/Nm^3	<100 (20 to 100)	77.0	5 / 5	<100 (20 to 100)	43.2	5 / 5
4	Condenser vacuum	kg/cm^2	-0.9 (-0.890 to -0.915)	-0.900	5 / 5	-0.905 (-0.890 to -0.915)	-0.900	5 / 5
5	Steam to CAP Temp	°C	185 (175 to 195)	189.4	5 / 5	185 (175 to 195)	189.4	5 / 5
6	Steam to CAP press	kg/cm^2	10 (9.5 to 12.5)	11.2	5 / 5	10 (9.5 to 12.5)	11.2	5 / 5
7	Economiser Feed water Inlet Temp	°C	180 (165 to 182)	167.1	5 / 5	235 (230 to 240)	215.1	0 / 5
8	Bed Temp	°C	890 (850 to 910)	883.4	5 / 5	855 (825 to 880)	846.7	5 / 5
9	Furnace Press	mmWC	- 30 (- 40 to - 15)	-35.7	5 / 5	- 15 (- 35 to - 5)	-17.9	5 / 5
10	Generator Winding Temp	°C	95 (30 to 105)	89.0	5 / 5	85 (30 to 100)	69.8	5 / 5
11	Specific steam consumption	Ton/MW	4.1 (3.5 to 4.25)	4.1	5 / 5	4.85 (4 to 4.95)	4.8	5 / 5
12	Primary Air Temp after APH	°C	255 (240 to 270)	222.3	0 / 5	205 (200 to 225)	179.3	0 / 5
13	Secondary Air Temp after APH	°C	260 (240 to 275)	250.8	5 / 5	215 (200 to 240)	224.6	5 / 5
14	Oxygen level in Flue gas	%	4 (2.5 to 5)	3.2	5 / 5	3.5 (2.5 to 4.5)	2.9	5 / 5
15	CW I/L Temp	°C	33 (20 to 36)	39.5	2 / 2	35 (20 to 36)	31.6	2 / 2
16	CW outlet Temp	°C	42.4 (22 to 44)	53.2	2 / 2	42 (23 to 43)	40.5	2 / 2
17	Flue gas exit Temp	°C	145 (120 to 145)	133.8	2 / 2	140 (120 to 145)	124.1	2 / 2
18	Unburnt in bottom Ash#	%	4 (0 to 6)	0.5	2 / 2	4 (0 to 5)	0.3	2 / 2
19	Unburnt in fly Ash#	%	1.6 (0 to 2.5)	3.9	0 / 2	1.5 (0 to 2.5)	0.9	2 / 2
20	Sp Power Consumption (CHP)	kWh/Ton	2 (0 to 2.5)	0.0	4 / 4	2 (0 to 2.5)	4.4	4 / 4
21	Sp Power Consumption (Boiler)	kWh/Ton	16 (0 to 17)	15.0	4 / 4	17 (0 to 18)	16.3	4 / 4
22	Sp Power Consumption (Turbine)	kWh/MW	23 (0 to 25)	25.0	4 / 4	31 (0 to 32.5)	30.3	4 / 4
23	Sp Power Consumption (ESP)	kWh/MW	1.8 (0 to 2)	1.0	4 / 4	1.1 (0 to 1.2)	1.5	0 / 4
24	Sp Power Consumption (Comp)	kWh/MW	5.2 (0 to 6)	8.0	0 / 4	6 (0 to 6.5)	0.6	4 / 4

Power Management

1

How

- One page real time view of power sourcing
- Realtime Opportunity visibility of best power scouring option
- Power availability real time
- Total Energy inflow

2

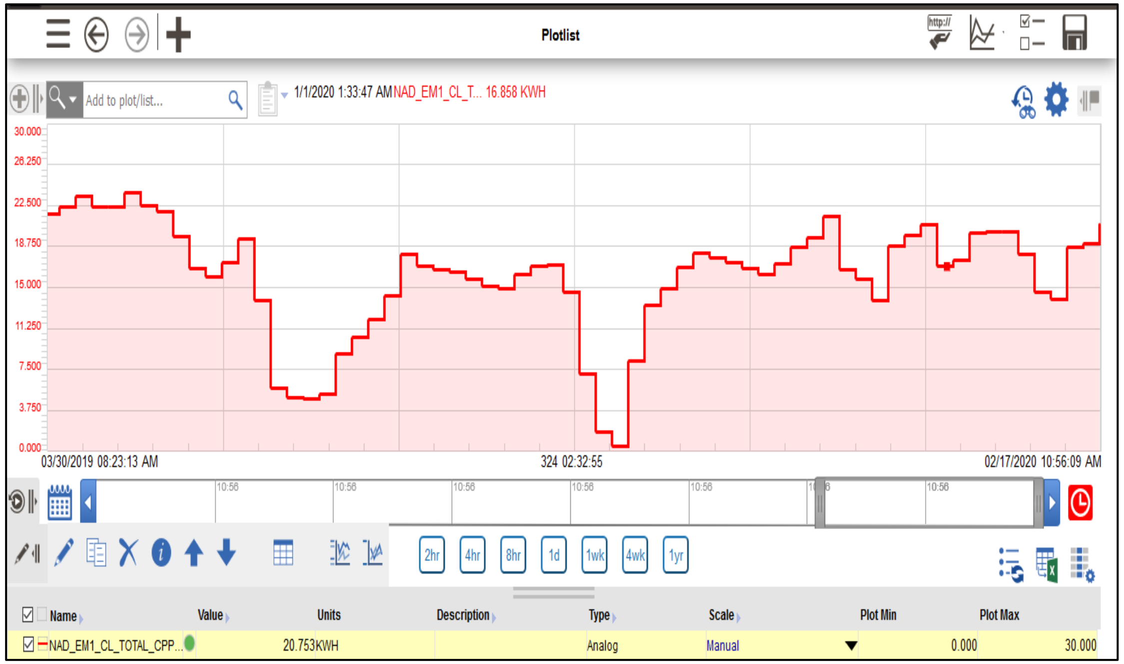
What changed

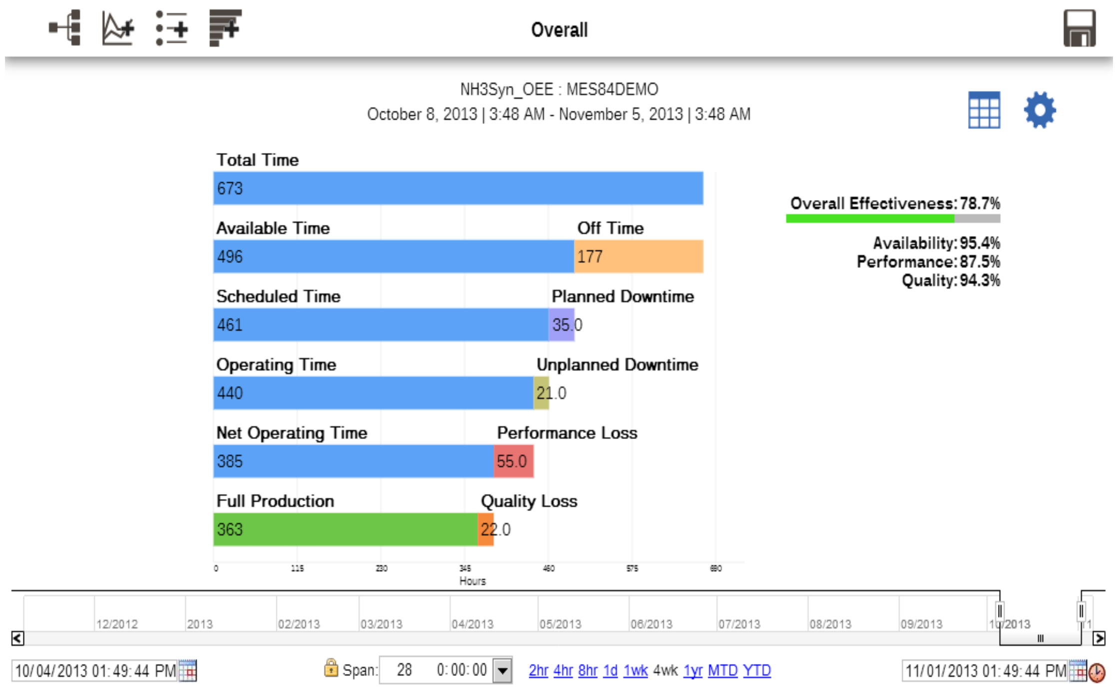
- Delivery of real time view and sensitization of potential lost opportunitye.

3

Value

- Cost Savings - 5% Reduction in costlier power sourcing





Cell House Optimizer

1

How

Analysing AC KWH/MT of each electrolyser and suggesting the best combination of Load on each electrolyser for least Specific Cell Power consumption per MT of CSL production

2

What changed

Load distribution amongst battery of Electrolyser was a human decision which is now recommended by the optimizer to set optimum load on each electrolyser.

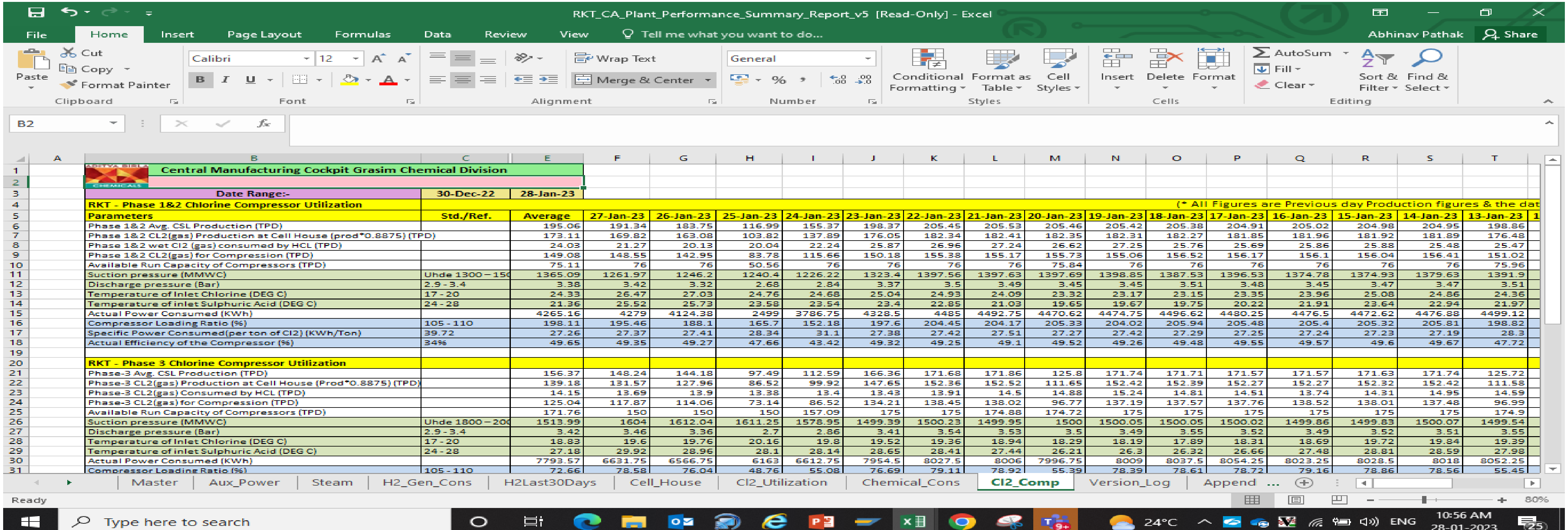
3

Value

The difference in AC power consumption per MT CSL is around 0.32% for same production.

Daily Basis Automated Reporting system

1	How	• Daily generation of Automated performance reports of different sections across different DCA units
2	What changed	• Capability to take corrective course actions on area of improvement in a focussed way.
3	Value	Operational excellence



Parameters	Std./Ref.	Average	27-Jan-23	26-Jan-23	25-Jan-23	24-Jan-23	23-Jan-23	22-Jan-23	21-Jan-23	20-Jan-23	19-Jan-23	18-Jan-23	17-Jan-23	16-Jan-23	15-Jan-23	14-Jan-23	13-Jan-23
RKT - Phase 1&2 Chlorine Compressor Utilization																	
Phase 1&2 Avg. CSL Production (TPD)		195.06	191.34	183.75	116.99	155.37	198.37	205.45	205.53	205.46	205.42	205.38	204.91	205.02	204.98	204.95	198.86
Phase 1&2 CL2(gas) Production at Cell House (prod*0.8875) (TPD)		173.11	169.82	163.08	103.82	137.89	176.05	182.34	182.41	182.35	182.31	182.27	181.85	181.96	181.92	181.89	176.48
Phase 1&2 wet Cl2 (gas) consumed by HCL (TPD)		24.03	21.27	20.13	20.04	22.24	25.87	26.96	27.24	26.62	27.25	25.76	25.69	25.86	25.88	25.48	25.47
Phase 1&2 CL2(gas) for Compression (TPD)		149.08	148.55	142.95	83.78	115.66	150.18	155.38	155.17	155.73	155.06	156.52	156.17	156.1	156.04	156.41	151.02
Available Run Capacity of Compressors (TPD)		75.11	76	76	50.56	76	76	76	76	75.84	76	76	76	76	76	76	75.96
Suction pressure (MMWC)	Uhde 1300 – 15	1365.09	1261.97	1246.2	1240.4	1226.22	1323.4	1397.56	1397.63	1397.69	1398.85	1387.53	1396.53	1374.78	1374.93	1379.63	1391.9
Discharge pressure (Bar)	2.9 - 3.4	3.38	3.42	3.32	2.68	2.84	3.37	3.5	3.49	3.45	3.45	3.51	3.48	3.45	3.47	3.47	3.51
Temperature of Inlet Chlorine (DEG C)	17 - 20	24.33	26.47	27.03	24.76	24.68	25.04	24.93	24.09	23.32	23.17	23.15	23.35	23.96	25.08	24.86	24.36
Temperature of inlet Sulphuric Acid (DEG C)	24 - 28	21.36	25.52	25.73	23.58	23.54	23.4	22.85	21.03	19.65	19.67	19.75	20.22	21.91	23.64	22.94	21.97
Actual Power Consumed (KWh)		4265.16	4279	4124.38	2499	3786.75	4328.5	4485	4492.75	4470.62	4474.75	4496.62	4480.25	4476.5	4472.62	4476.88	4499.12
Compressor Loading Ratio (%)	105 - 110	198.11	195.46	188.1	165.7	152.18	197.6	204.45	204.17	205.33	204.02	205.94	205.48	205.4	205.32	205.81	198.82
Specific Power Consumed(per ton of Cl2) (KWh/Ton)	39.72	27.26	27.37	27.41	28.34	31.1	27.38	27.42	27.51	27.27	27.42	27.29	27.25	27.24	27.23	27.19	28.3
Actual Efficiency of the Compressor (%)	34%	49.65	49.35	49.27	47.66	43.42	49.32	49.25	49.1	49.52	49.26	49.48	49.55	49.57	49.6	49.67	47.72
RKT - Phase 3 Chlorine Compressor Utilization																	
Phase-3 Avg. CSL Production (TPD)		156.37	148.24	144.18	97.49	112.59	166.36	171.68	171.86	125.8	171.74	171.71	171.57	171.57	171.63	171.74	125.72
Phase-3 CL2(gas) Production at Cell House (Prod*0.8875) (TPD)		139.18	131.57	127.96	86.52	99.92	147.65	152.36	152.52	111.65	152.42	152.39	152.27	152.27	152.32	152.42	111.58
Phase-3 CL2(gas) Consumed by HCL (TPD)		14.15	13.69	13.9	13.38	13.4	13.43	13.91	14.5	14.88	15.24	14.81	14.51	13.74	14.31	14.95	14.59
Phase-3 CL2(gas) for Compression (TPD)		125.04	117.87	114.06	73.14	86.52	134.21	138.45	138.02	96.77	137.19	137.57	137.76	138.52	138.01	137.48	96.99
Available Run Capacity of Compressors (TPD)		171.76	150	150	150	157.09	175	175	174.88	174.72	175	175	175	175	175	175	174.9
Suction pressure (MMWC)	Uhde 1800 – 20	1513.99	1604	1612.04	1611.25	1578.95	1499.39	1500.23	1499.95	1500	1500.05	1500.05	1500.02	1499.86	1499.83	1500.07	1499.54
Discharge pressure (Bar)	2.9 - 3.4	3.42	3.46	3.36	2.7	2.86	3.41	3.54	3.53	3.5	3.49	3.55	3.52	3.49	3.52	3.51	3.55
Temperature of Inlet Chlorine (DEG C)	17 - 20	18.83	19.6	19.76	20.16	19.8	19.52	19.36	18.94	18.29	18.19	17.89	18.31	18.69	19.72	19.84	19.39
Temperature of inlet Sulphuric Acid (DEG C)	24 - 28	27.18	29.92	28.96	28.1	28.14	28.65	28.41	27.44	26.21	26.3	26.32	26.66	27.48	28.81	28.59	27.98
Actual Power Consumed (KWh)		7793.57	6631.75	6566.75	6163	6612.75	7954.5	8027.5	8006	7996.75	8009	8037.5	8054.25	8023.25	8028.5	8018	8052.25
Compressor Loading Ratio (%)	105 - 110	72.66	78.58	76.04	48.76	55.08	76.69	79.11	78.92	55.39	78.39	78.61	78.72	79.16	78.86	78.56	55.45

Thanks

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Grasim Industries Limited (Indian Rayon, Veraval)