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Coromandel International:

Key Pillars of Digital Manufacturing Process
enabled by AVEVA™ PI System™

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AVEVA

**COROMANDEL
INTERNATIONAL:
KEY PILLARS OF DIGITAL
MANUFACTURING
PROCESS ENABLED BY
AVEVA PI SYSTEM**



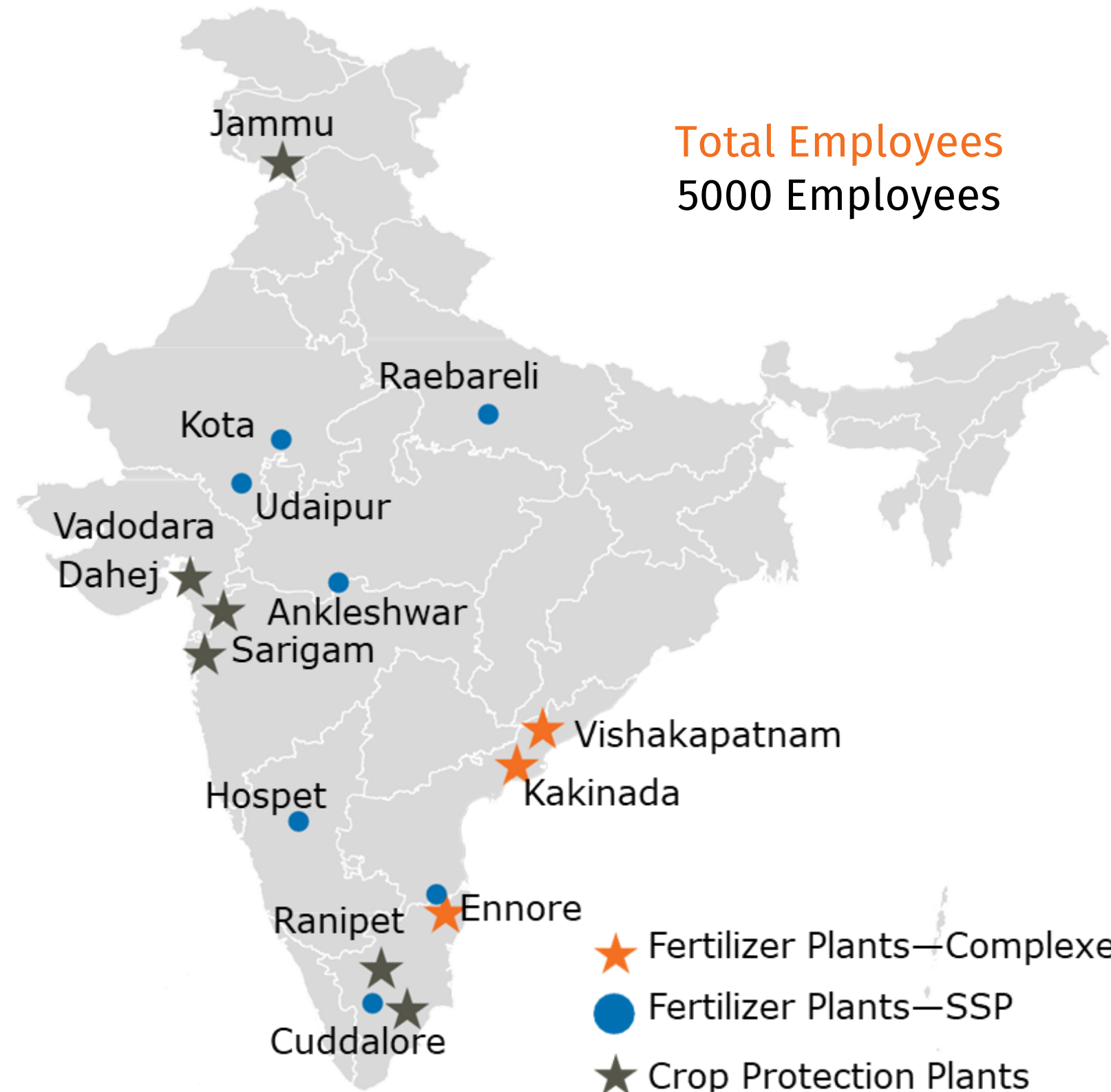
Table of Content

- About Coromandel
- Project Goal
- Project Implementation
- Realtime Dashboards
- Benefits



Coromandel: India footprint

- India's largest private sector Phosphatic Fertilizer company
- Pioneers & market leaders in Specialty Nutrients
- India's largest Single Super Phosphate (SSP) company
- 5th largest Crop Protection Indian company
- Worlds' largest Neem based Bio pesticide manufacturer
- No. 1 Organic Manure player in India
- Largest Rural Retail Chain in India



- 17 manufacturing locations
- ~750 Retail centres
- ~20,000+ dealers
- Presence across ~81 countries
- ~ 2,000+ strong market development team

Revenue in 2022-23
₹ 29,628 crores

Over 13,650 employees worldwide
Partnering with over 2 crore farmers

OUR VISION, MISSION and VALUES



VISION

To be the leader in farm solutions business in geography of choice, consistently delivering superior value to stakeholders through highly engaged employees, with a strong commitment towards sustainability and our values.



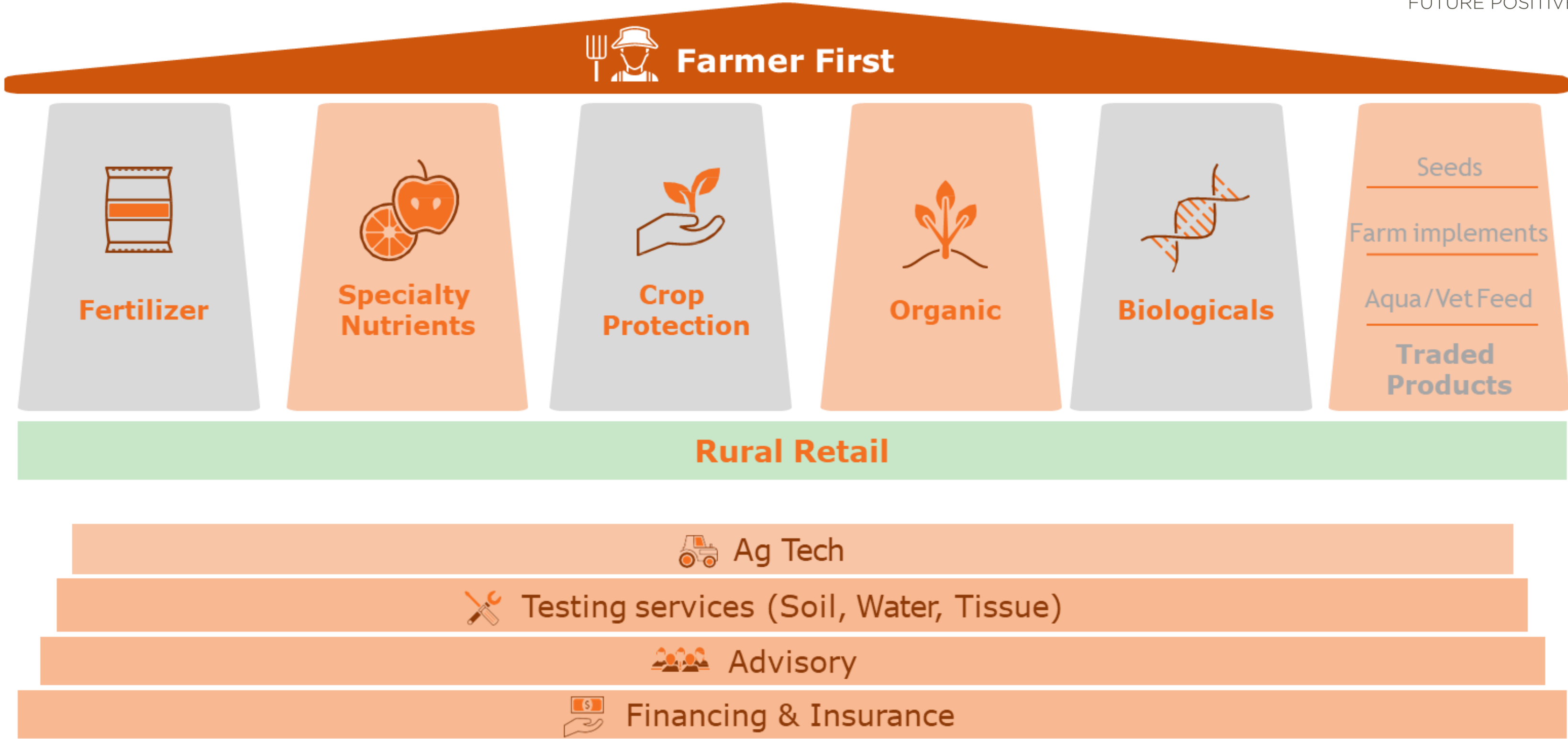
MISSION

To enhance prosperity of farmers through quality farm solutions with sustainable value for all stakeholders.



VALUES AND BELIEF

The fundamental principle of economic activity is that no man you transact with will lose then you shall not.



A 'Farmer First' winning business model

CereBulb: Driving Value with Velocity



Founded in 2013
In NJ (USA)



Industrial IOT and
Data Science/ Data
Analytics

Core Beliefs in

Disrupting from with-in,



US & India & Australia

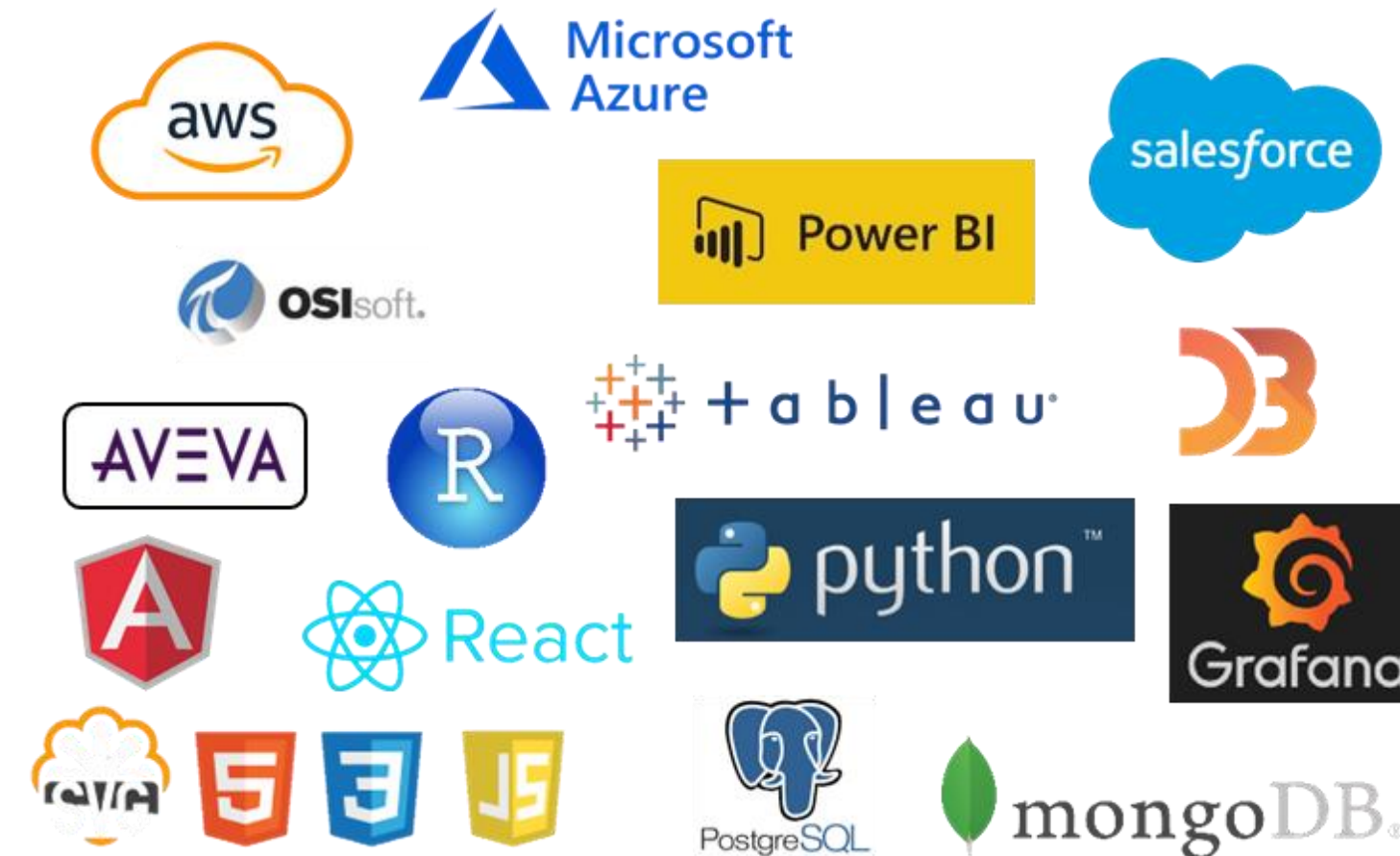


72 Creative Minds &
Expanding

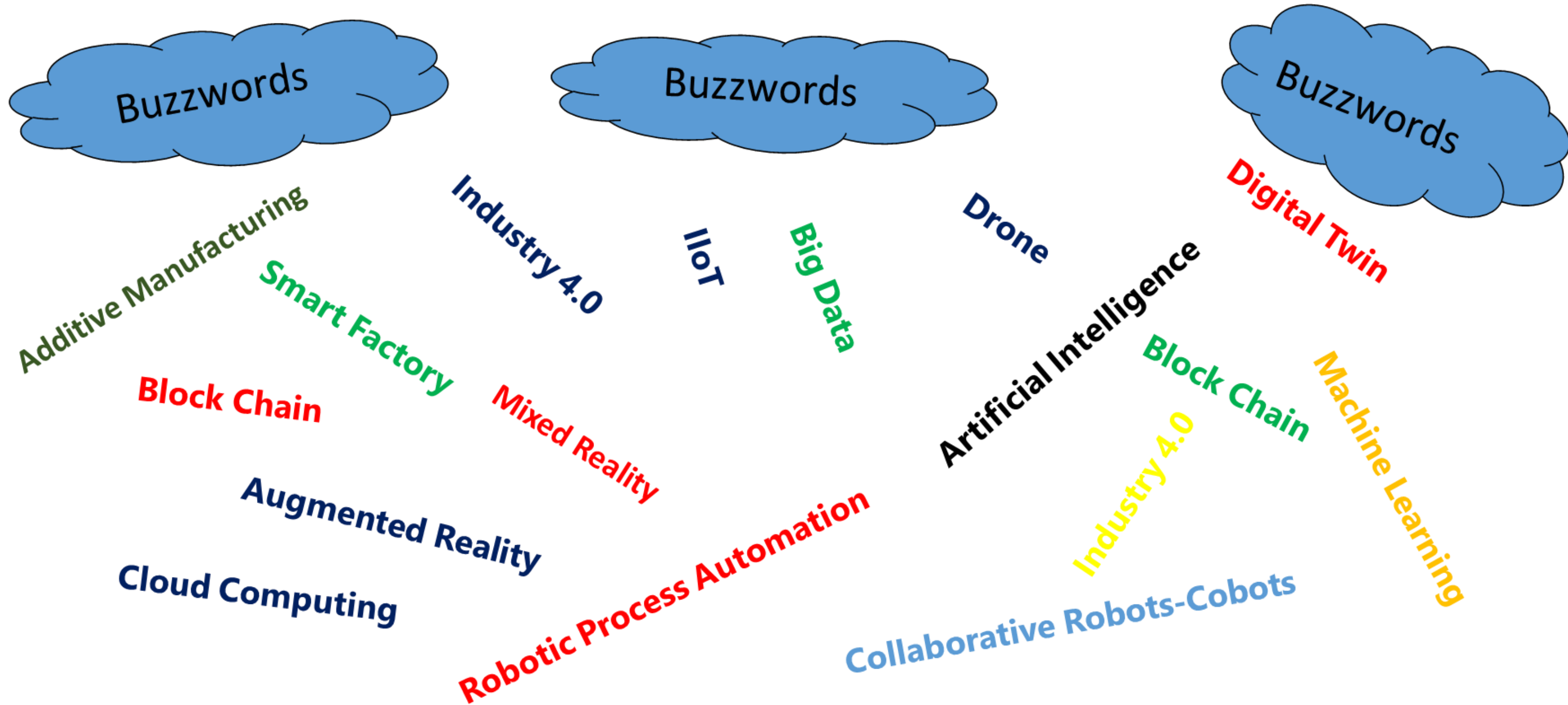
Young professionals to very experience
professionals with field experience

~ 70+ years of combined experience in
Industrial IOT solutions

Ever Growing Technology Portfolio

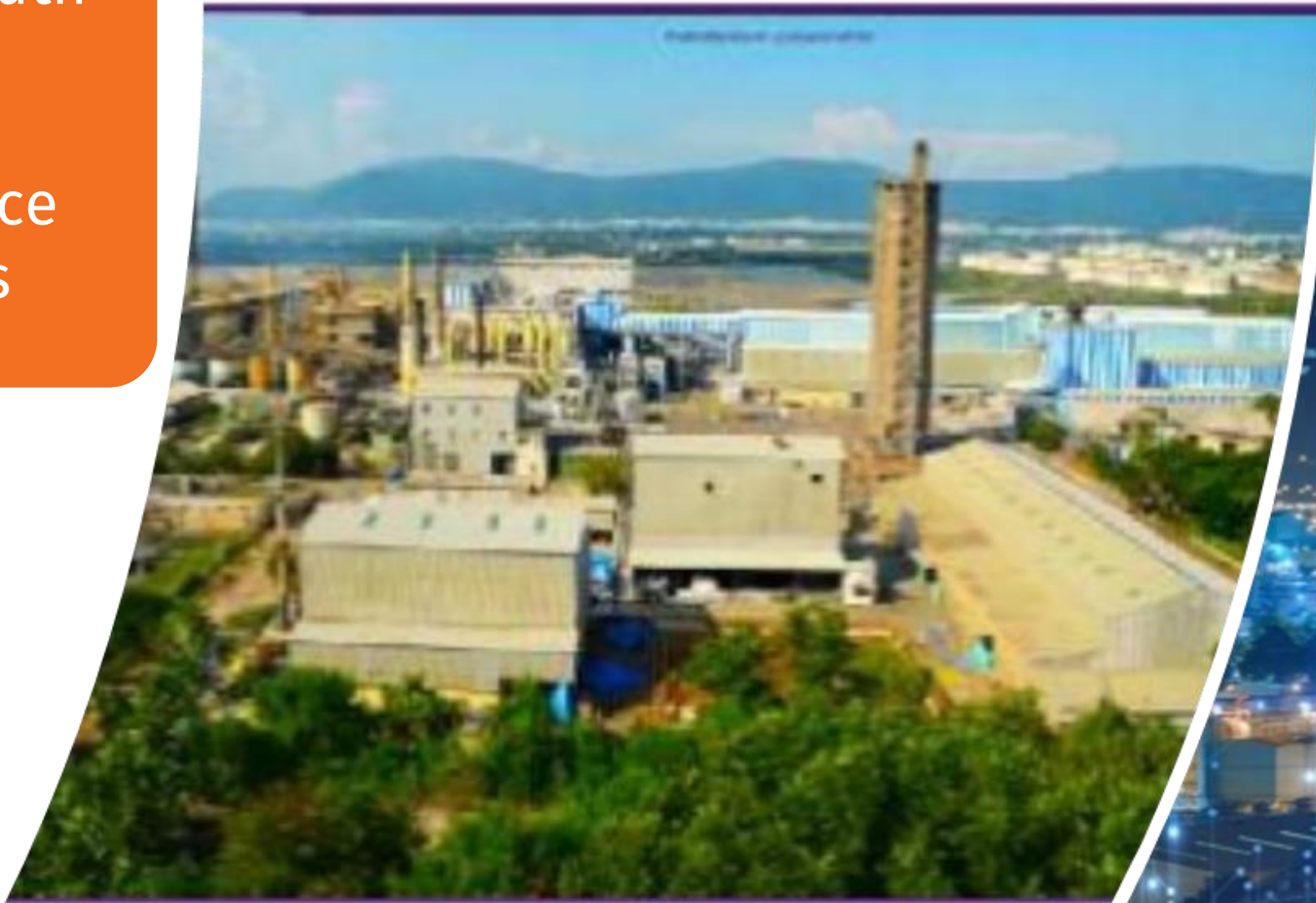


Buzzwords in Manufacturing

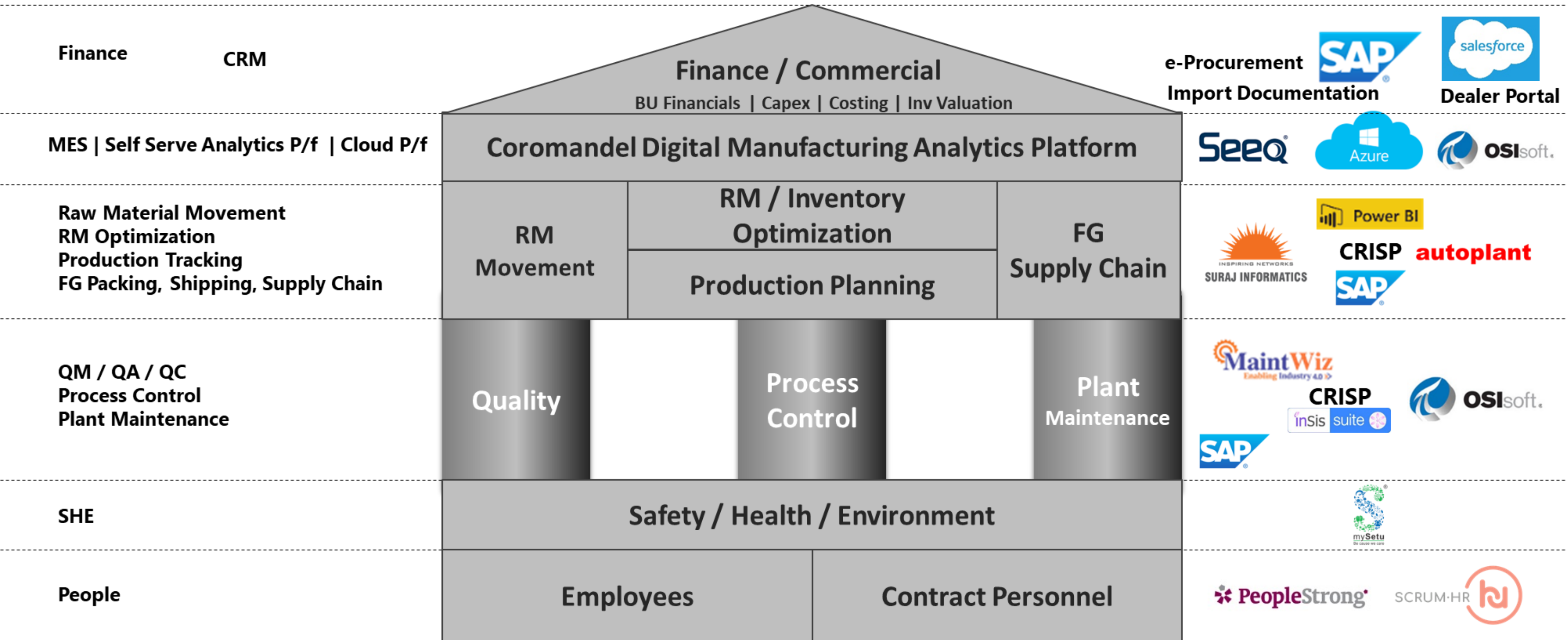


We just need to know How to utilize these technologies for improving our business processes and eliminating our pain points

The CDMP (Coromandel Digital Manufacturing Platform) at Coromandel is aimed at providing one version of truth around Manufacturing effectiveness on top of existing foundations in place through DDC 1&2 initiatives



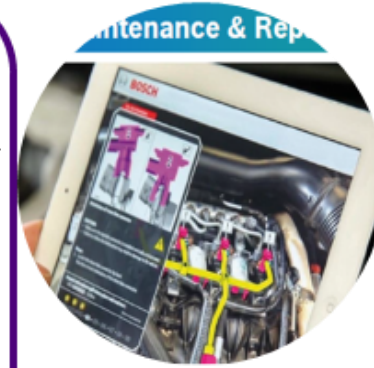
How we look at Manufacturing Digital



Brief Details of Digital Manufacturing Elements



Real Time Production and Process Monitoring: Collect all operational data in real-time from many sources for Auto determination of Production and analyze operational data in real-time to identify anomalies, quickly diagnose root causes.



Asset Reliability and Digital Maintenance: Asset Reliability and Digital Maintenance is for increasing the reliability of our assets to handle process performance (Throughput, Efficiency and Quality) and reliability (failures) in the same user environment



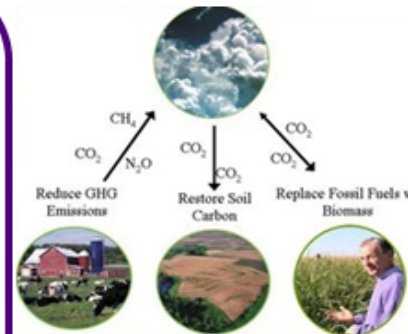
Digital Enabled Manpower: Connected manpower enable them to respond quickly to any stoppage, store real time data at source, quick access to documents and taking online permits. AR/ VR technology help them to get training, knowledge sharing and instant help form competent person in case of problem.



Production Optimization: Leverage the power of AI & ML to capture the nuances of our core manufacturing processes and influencers to prescribe optimized levels for process control to improved standard process control measures, balances capacity and RM consumption,

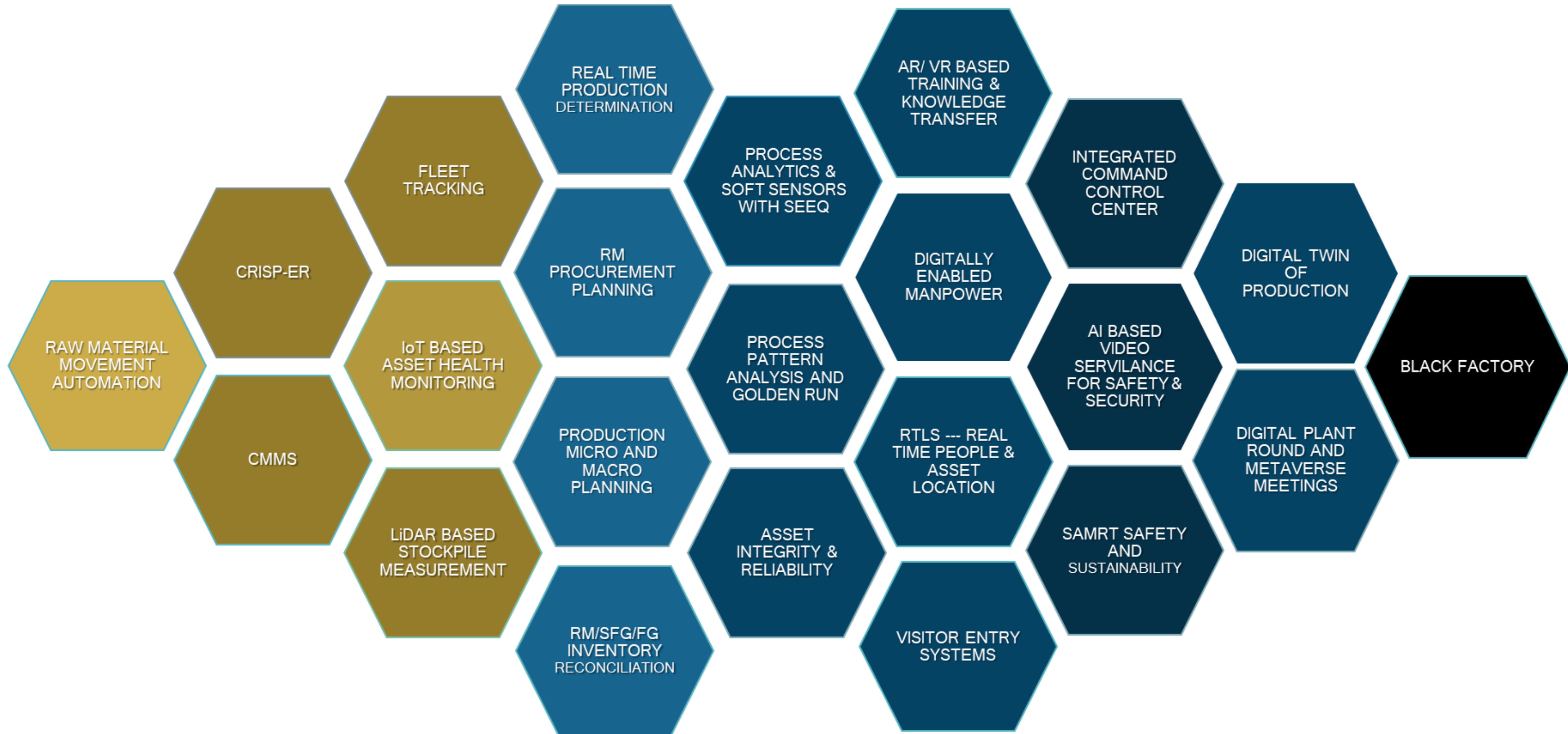


Digital Manufacturing Supply Chain: To get real time visibility of Inbound RM lead time, stock outs and overstock alerts, inventory positioning & in transit impacting the production, safety stock norms, Order status and run time for shift planning and Demand planning insights.



Smart Safety & Digital ESG: To improve shop floor safety practices and predicting forecastable near miss by Smart Safety System. Improve Global carbon footprint by optimizing energy usage, Social compliance tracking and control, emission and sustainability tracking.

CDMP-Applications under Digital Manufacturing Platform



Goals & Objective



Challenge

- Centralized data historian with first principle based analysis
- Integration with third party connectivity
- Data Access through data historian for Data Science & Advanced Data Analytics
- Customized Dashboard Utility



Solution

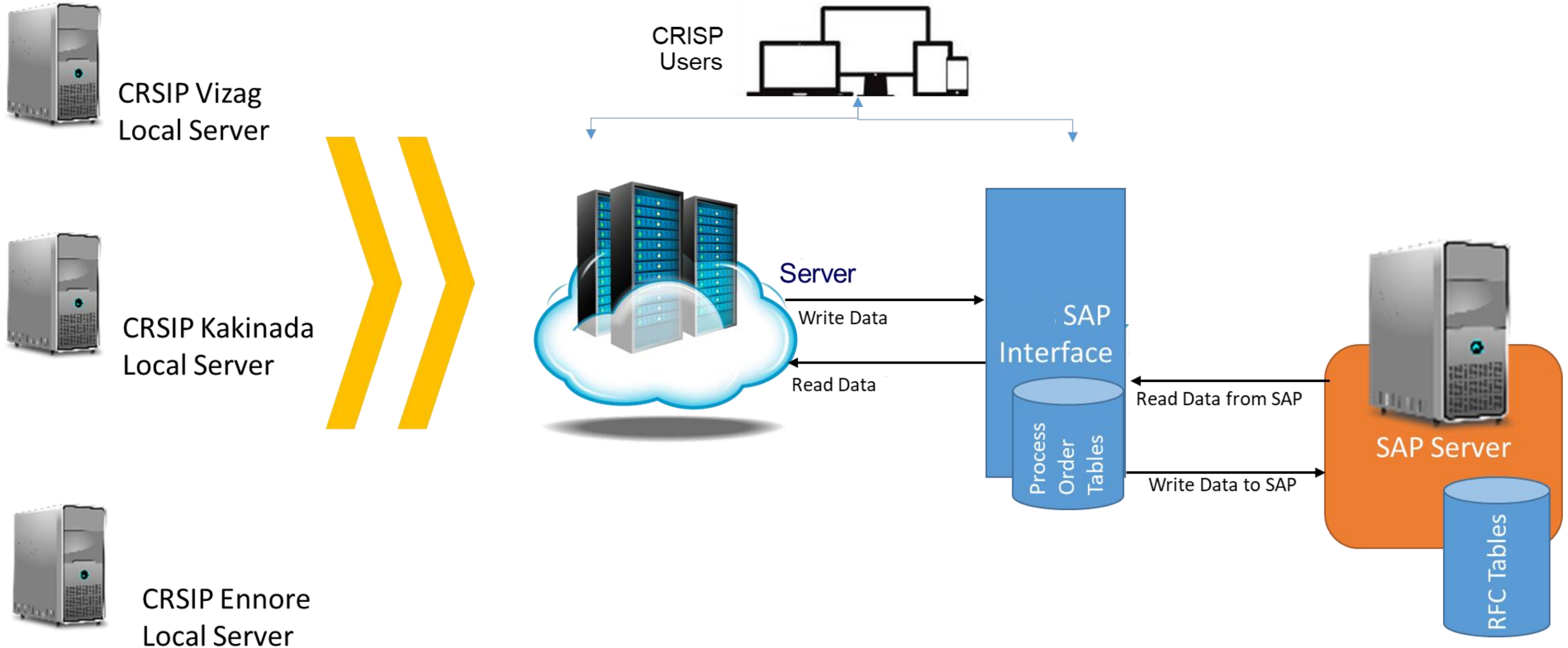
- Use the AVEVA PI system technology including PI AF, along with PI Integrations to create a platform for Data Historian as well as seamless data access through Data Science & Advance Data Analytics
- Use PIVision for drag & drop feature with HTML5 compliant dashboard



Potential Benefits

- Using templated structure of PI System, Integration of different plant become easy
- Set the stage for many advanced analytics & machine learning tools which utilizing by Coromandel
- Easy identification Increase operation throughput which will result in increased company profits.

Existing Infrastructure

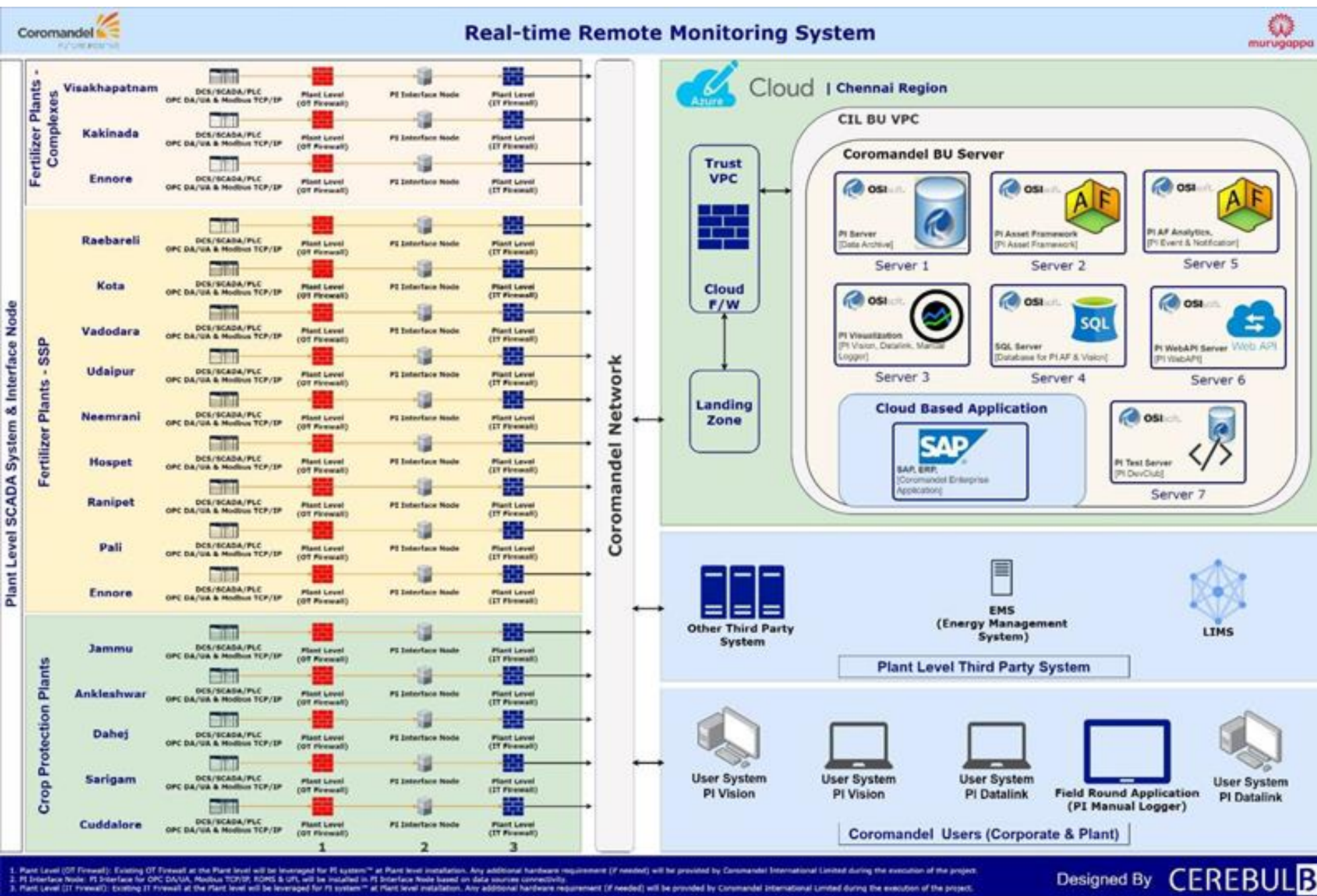


Issue with Previous Platform

- Insufficient/Improper interfacing and communication problems(integration with external applications)
- Parameter showing at dashboard front end not matched with backend calculation due to Front end Application not updating with the recorded history
- Services restart being recommended as solution for many problems, for which we need to go to OS level on server. Application designed with high dependency on server direct access
- Whenever there is Services restart/Patch upgradation intermittently, other parameters got affected.
- After patch updates historical problems resurfacing, new problems developing/surfacing.
- Overall GUI user friendliness below par.
- Privilege management is not well defined.
- SMS/Mail alerts issue reoccurring randomly, triggering to false data propagation during any application interventions.
- Excel export for data downloading and Excel based scheduled reports generation issues are frequently observed.
- Request gets killed from portal after prolonged response failure, but no notification or automatic action.
- Not very friendly front end widget customisation and configuration

New Project Architecture

- AVEVA is most Widely Deployed & Accepted solution across all Manufacturing Industries.
- It will be Single Point of Truth for all Manufacturing Data.
- It will connect all third party applications of Manufacturing with one system



1. Plant Level (OT Firewall): Existing OT Firewall at the Plant level will be leveraged for PI system™ at Plant level installation. Any additional hardware requirement (if needed) will be provided by Coromandel International Limited during the execution of the project.
 2. PI Interface Node: PI Interface for OPC DA/UA, Modbus TCP/IP, RS485 & I/O will be installed in PI Server Node based on data source connectivity.
 3. Plant Level (IT Firewall): Existing IT Firewall at the Plant level will be leveraged for PI system™ at Plant level installation. Any additional hardware requirement (if needed) will be provided by Coromandel International Limited during the execution of the project.

Why we choose AVEVA PI system?

Aveva PI System is a robust and comprehensive data management system, and there are several benefits that it provides over our existing traditional historians:

- **Scalability:** The PI System can handle large amounts of data and can easily scale up to meet the growing data needs of an organization.
- **Real-time Data Collection:** The PI System is capable of collecting data in real-time, which allows organizations to make quick and informed decisions based on the most current information.
- **Data Quality:** The PI System provides a centralized repository for data, which ensures data consistency and accuracy.
- **Integration:** The PI System can easily integrate with other systems and applications, providing a unified view of data from different sources.
- **Customization:** The PI System is highly customizable, allowing organizations to tailor the system to meet their specific needs and requirements.
- **Analytics:** The PI System provides a range of advanced analytics and reporting capabilities, allowing organizations to gain insights into their data and make data-driven decisions.
- **Data Security:** The PI System provides robust security features, including role-based access controls, audit trails, and encryption, ensuring the protection of sensitive data.

Connectivity with different systems

Vizag (Total: 30)

- SAP-1/SAP-2
- PAP-1
- PAP-2
- Complex AB
- Complex C
- AAST/WHARF
- Utilities & TG1
- ETP
- RG (PAP-1)
- TG-2/3 & Boiler
- SAP-3
- Desalination unit
- Liquid Fertilizer Plant
- Fertilizer pilot plant
- SND plant
- EMS SCADA
- LIDAR Server
- Analytical model processor
- Main Bagging Controller B1
- Main Bagging Controller B2
- Main Bagging Controller A1
- Main Bagging Controller A2
- Main Bagging Controller C1
- Main Bagging Controller C2
- Main Bagging Controller D1
- Main Bagging Controller D2
- Main Bagging Controller E1
- Main Bagging Controller E2
- Main Bagging Controller F1
- Main Bagging Controller F2

Kakinada (Total: 16)

- Complex AB
- Complex C
- Offsites
- Boiler-1
- Boiler-2
- Electrical
- Bagging-1A
- Bagging-2A
- Bagging-3A
- Bagging-1B
- Bagging-2B
- Bagging-3B
- Bagging-1C
- Bagging-2C
- Bagging-3C
- Complex AB

Ennore (Total: 8)

- SAP-1&2, PAP, MED, APS
- AAST
- Bagging
- CPP
- FWPH
- WTP
- Electrical
- Bagging

Third Party Systems (Total: 6)

- RMM
- CMMS System
- MySetu
- SAP
- Excel File
- Power BI

USE CASES

- Evaporator Predictive Maintenance
- Nutrient Prediction for High Yield



Use Case 1: Evaporator Predictive Maintenance

Problem statement

Coromandel site has forced circulation flash evaporator, operated under vacuum, which is used for increasing the concentration of H₃PO₄. While the operations plant team is facing various operational challenges due to frequent failures of the critical assets like evaporator.

Objectives

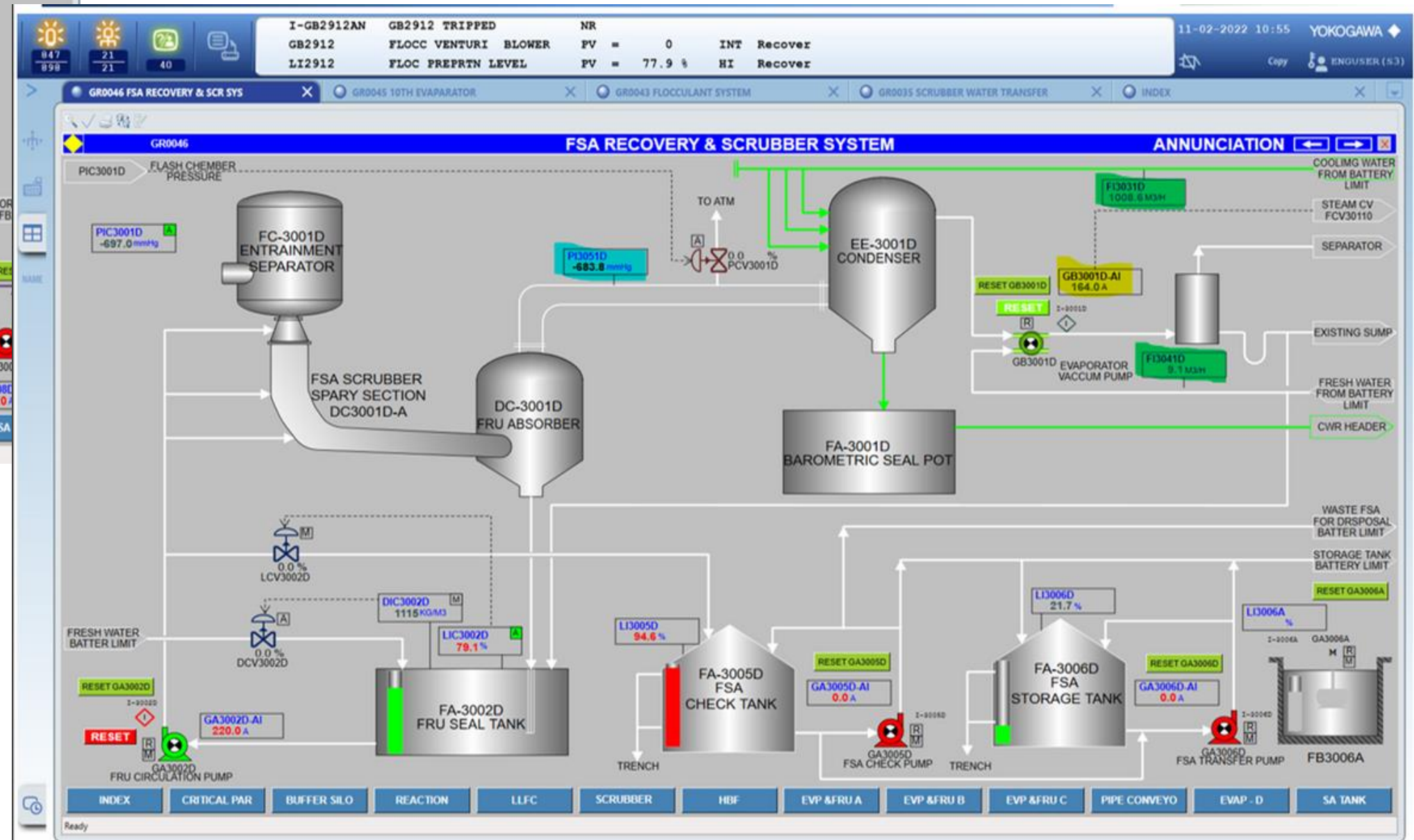
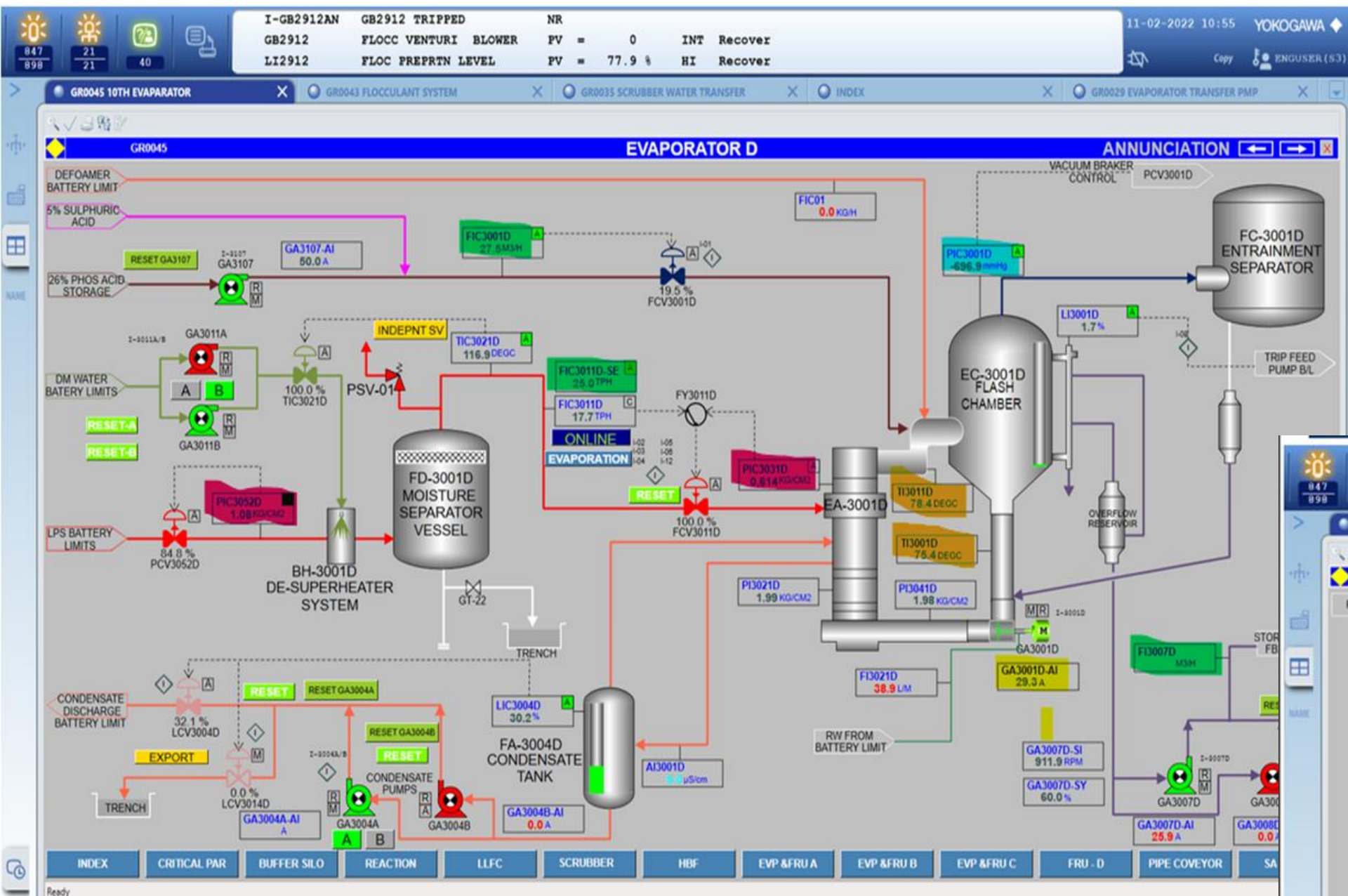
- Identification and Prediction of potential failures in evaporator section using digital twin approach
- Mapping the reasons for downtime by monitoring important KPI's to take preventive actions to reduce downtime

Results

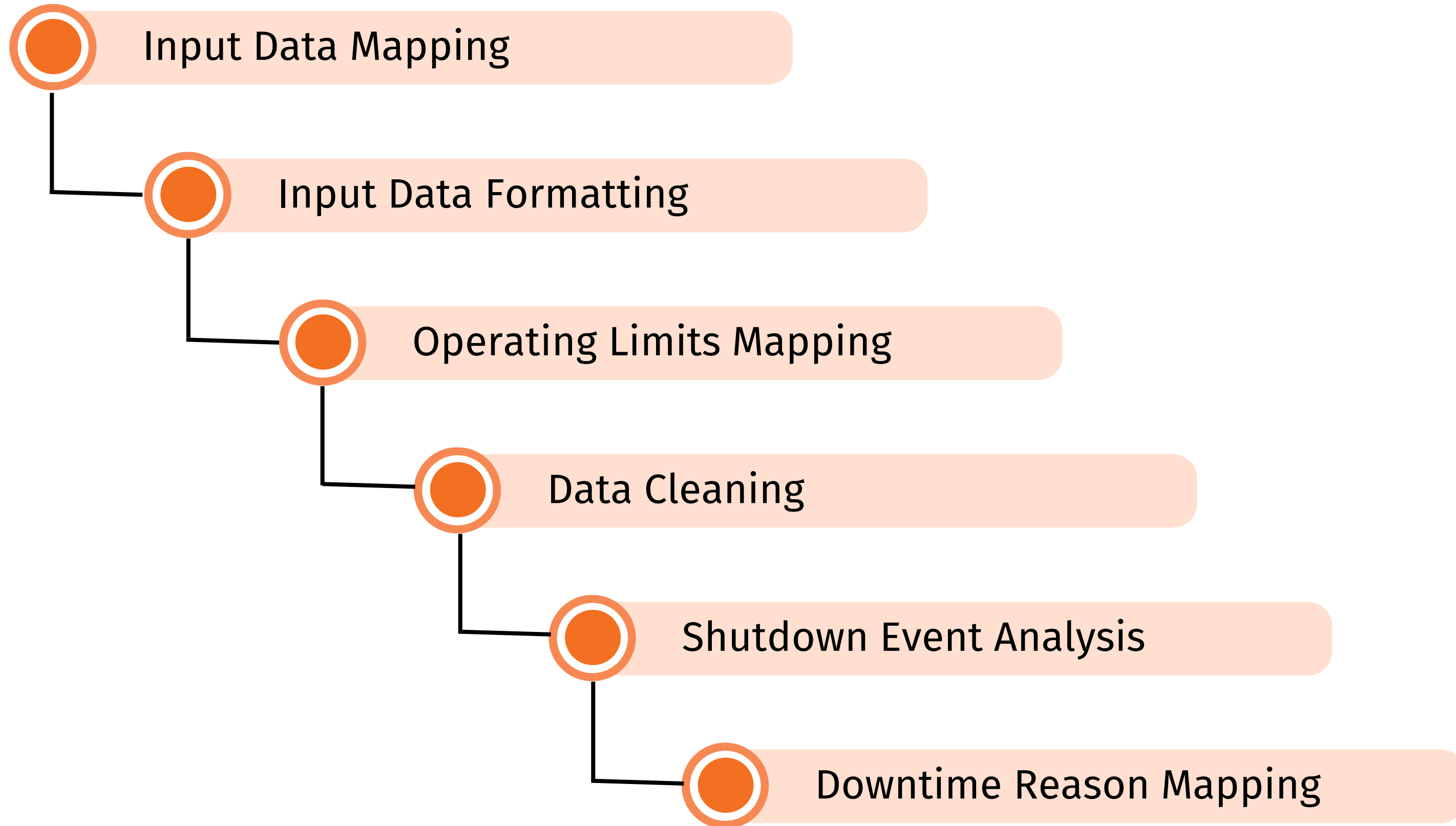
Advanced analytics solution results in long term improvements, as below :

- Evaporator predictive and prescriptive maintenance to avoid unplanned down time
- Tracked KPI's deviations to notify maintenance alerts (Industry claims to increase more than 20% of profit)

Process Flow Diagram



Our Approach



Predictive Maintenance (1st Principle = Data Driven)



- Overall heat transfer coefficient decreasing trend with duration
- Assumption for overall heat transfer coefficient threshold 450 W/m². C
- By using Ordinary Least Square regression algorithm in Seeq, Heat body tube cleaning, Scrubbing downtime prediction
- Predictive maintenance by using of Digital Twin (first principle model -Overall heat transfer coefficient + Data Driven Technique)

Overall Heat Transfer Coeff Calculations :

$$Q = U * A * LMTD$$

$$U = (Q / A * LMTD)$$

A = Surface area of Heat Body is 688 m² from Heat body ref. from datasheet.

Use Case 2: Nutrient Prediction

Objectives

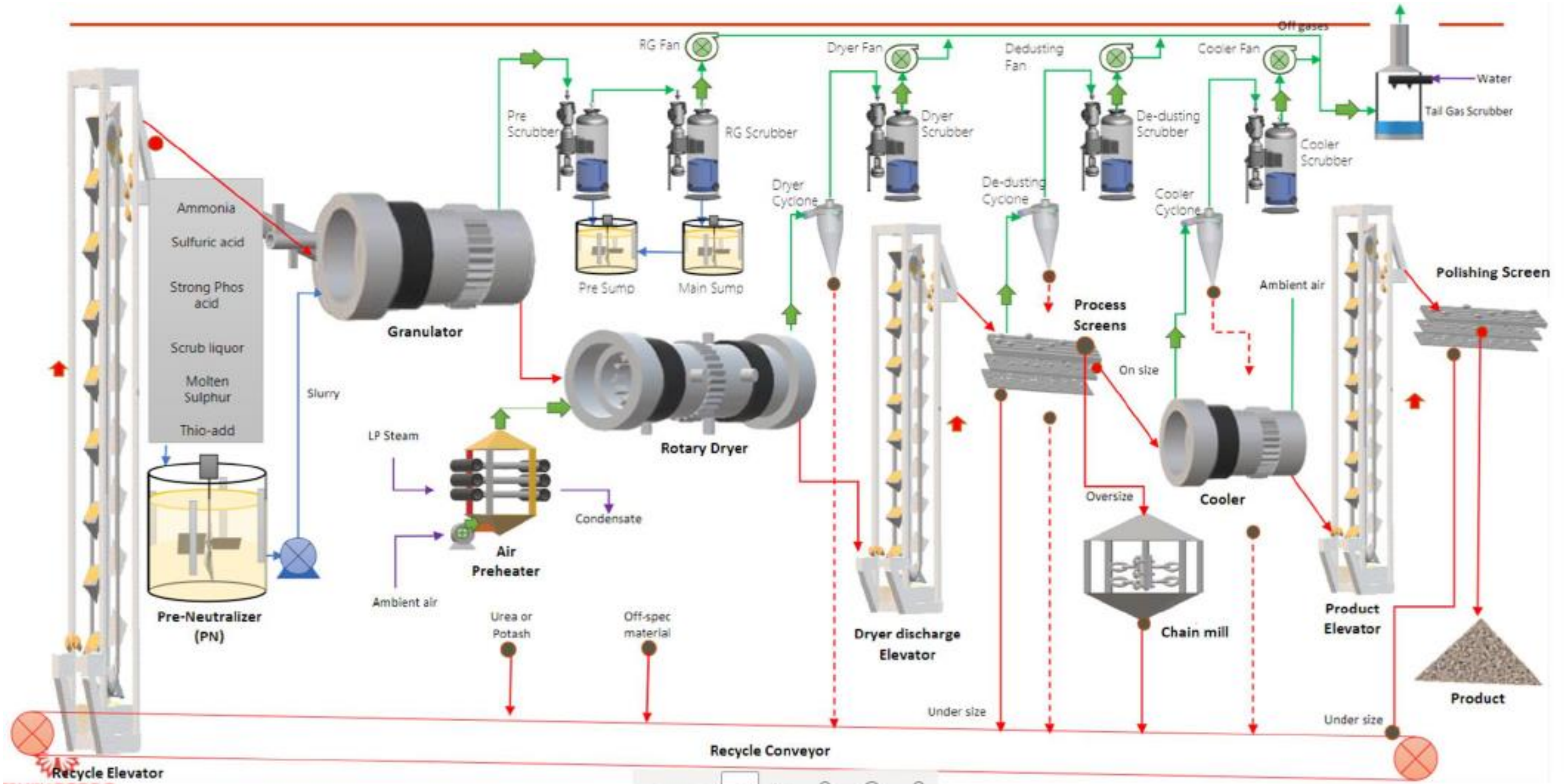
Nutrients Prediction during 28 28 0 Grade Continuous Fertilizer Production by using Seeq Workbench

- Ammoniacal Nitrogen (% AN)
- Urea Nitrogen (% UN)
- Total Nitrogen (% TN)
- Total Phosphate (% P2O5)

Quality Criteria

	% AN	% UN	% TN	% P2O5	Remarks
Quality Criteria (minimum)	-	-	27.50	27.50	Product as per specification ($\pm 0.5\%$)
Under-Nutrients	-	-	<27.50	<27.50	Off-spec and Reject Fertiliser (Grade Failed)
Over-Nutrients*	-	-	>28.00	>28.00	Maintaining over-nutrient product end up in raw material shortage
Range	-	-	27.5-28.5	27.5-28.5	

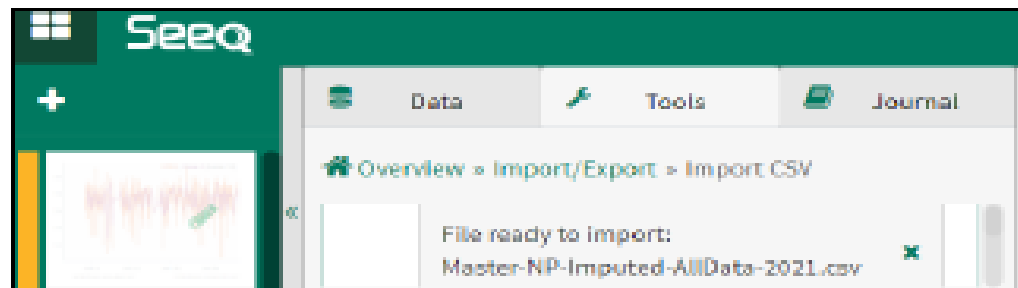
Process Flow Diagram



Our Approach

```
all_data = []
file = r'C:\Users\Wishal.Marje.TSPL\OneDrive - Tridagonal Solutions\Coromandel\NutriFe
all_df = pd.DataFrame()

for f in glob.glob(file):
    dct = pd.read_excel(f, usecols="A:AW", index_col=None, header=None, skiprows=4, nrows
    for df in dct.values():
```

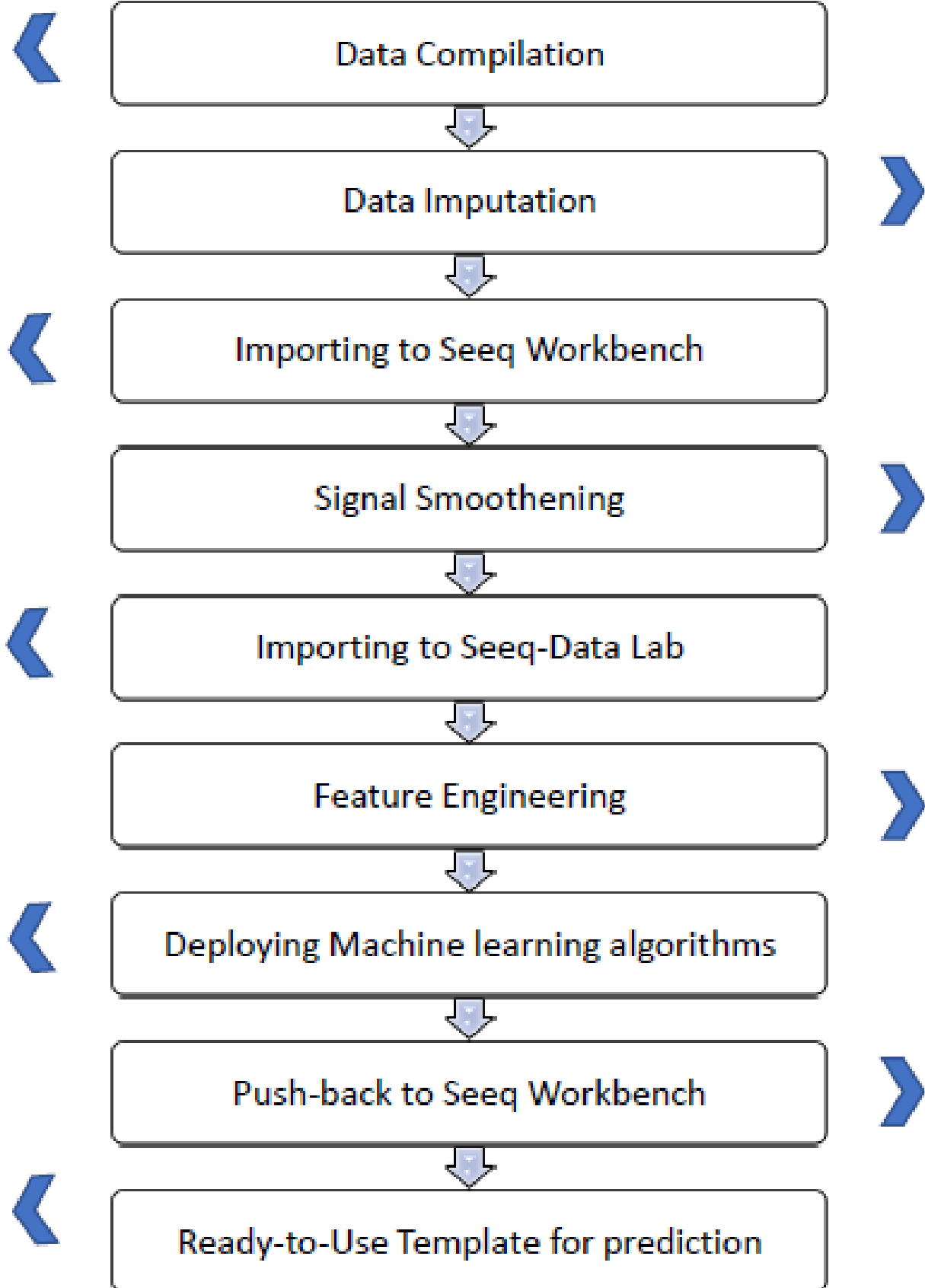
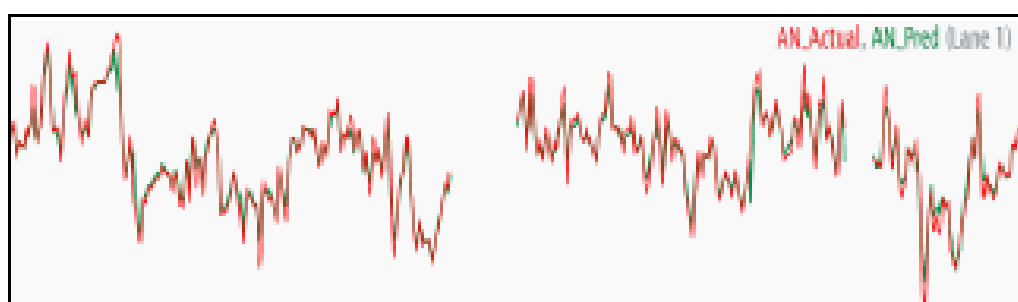


```
1 df = spy.pull(wb,
2 start='1/5/2021 9:52 PM',
3 end='11/13/2021 9:20 PM', tz_convert='Asia/Calcutta',
4 grid='hour')

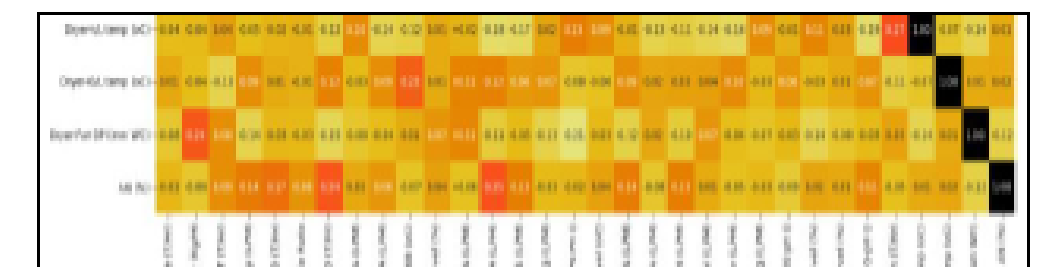
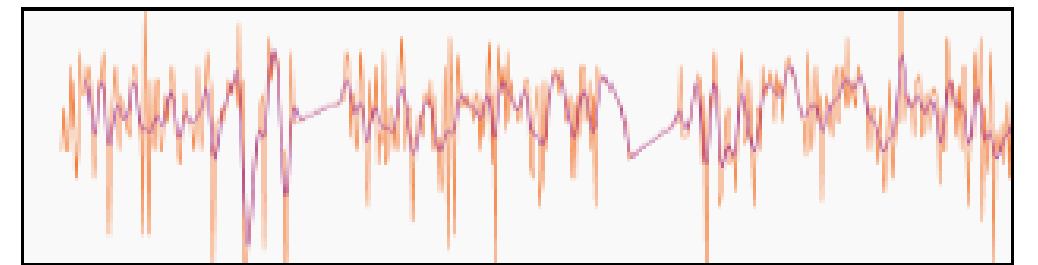
Pull successful from 2021-01-05 21:52:00+05:30 to 2021-11-13 21:20:00+05:30
```

ID	Path	Asset	Name	Time	Count	Pages	Result
8	TB010295-8817-4890-9618-C88291C745C4	nan	nan	AN-S	00:00:00:15	TABT	1 Success

```
1 X1_train, X1_test, y1_train, y1_test = train_test_split(X1, y1, test_size=0.30, random_state=12, shuffle=True)
2 rf1 = RandomForestRegressor(n_estimators=1000)
3 rf1.fit(X1_train, y1_train)
4 AN_pred = rf1.predict(X1_test)
5
```



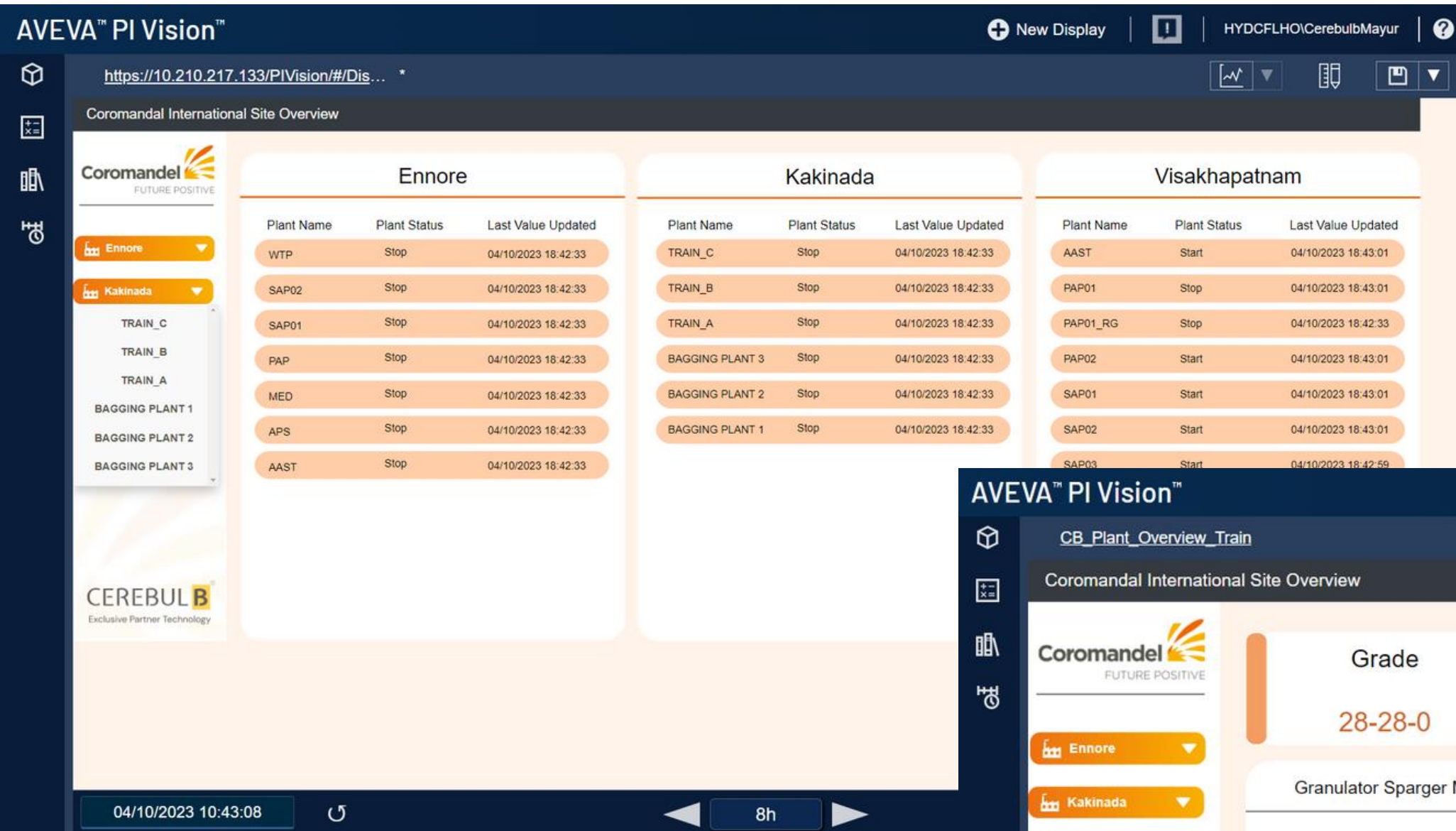
Feed-Urea (T/Hr)	Feed-G (Kg/M)	Flows-10-20-22 MED+ EAST (T/Hr)	GNLTR- Slurry (LPM)	GNLTR- NH3 (T/Hr)	GNLTR- Mole Ratio	PH- Liq + Vap NH3 (T/Hr)	PH-48% +0.448% (LPM)	PH- WA (LPM)	PH- Temp 30168 (°C)	PH- Level (%)	PS- 48% (LPM)	PS- H2SO4 (LPM)
14.50	57.00	0.00	300.00	0.80	-1.44	4.50	170.00	170.00	121.40	38.00	40.00	0.00
14.00	57.10	0.00	300.00	0.80	-1.44	4.50	170.00	170.00	122.40	38.00	40.00	0.00
16.00	57.10	0.00	300.00	1.00	-1.44	4.70	180.00	170.00	120.10	39.00	40.00	0.00
12.00	56.86	0.00	300.00	0.80	-1.41	4.50	180.00	160.00	122.00	38.00	40.00	5.80
16.50	58.00	0.00	300.00	1.20	-1.45	4.40	190.00	160.00	123.00	44.00	40.00	4.00



```
1 push_results = spy.push(data=015, wb=WORKBOOK_ID, asset='AN-S', worksheet='1')
2 push_results

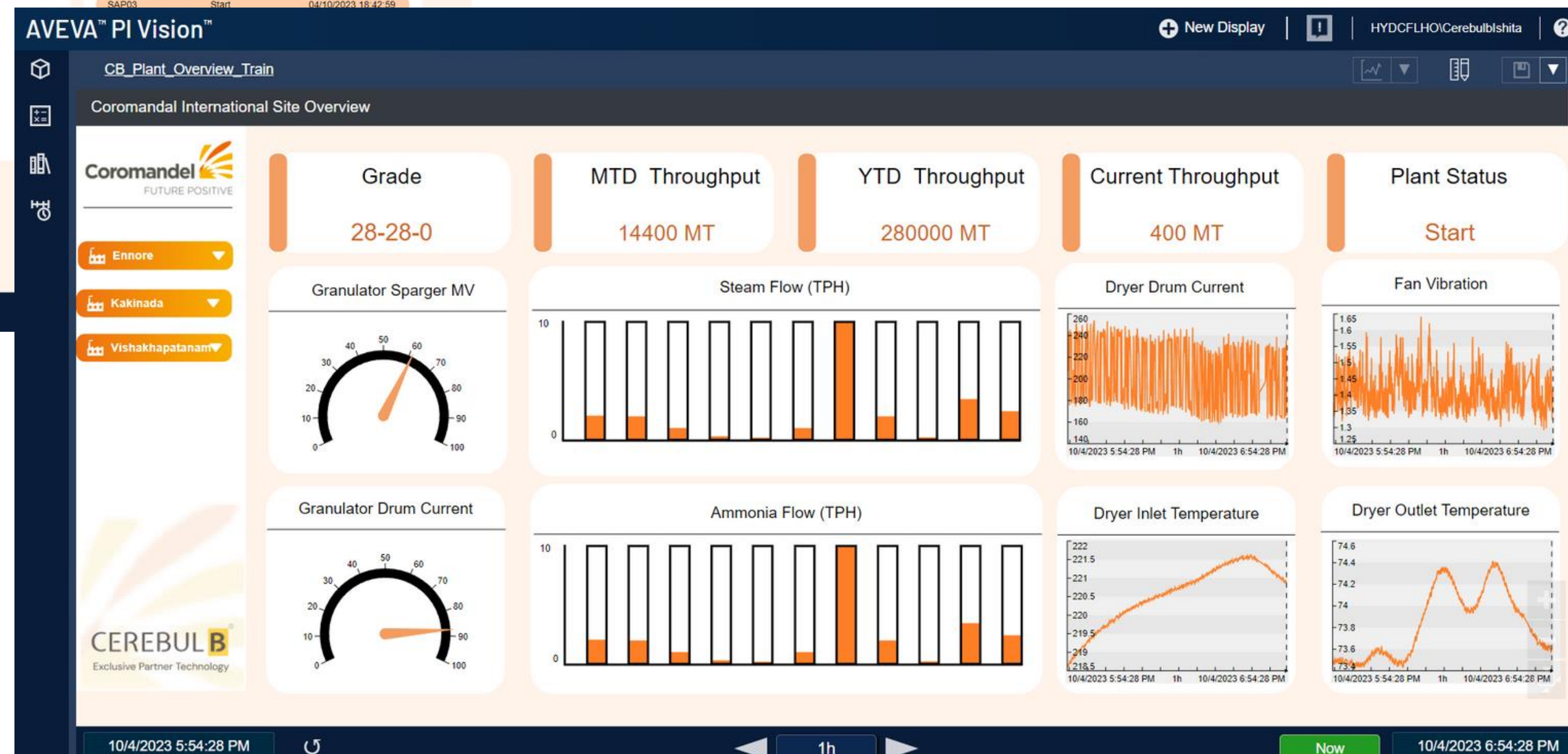
Pushed successfully to datasource Seeq Data Lab [Datasource ID: Seeq Data Lab] and scoped to workbook ID:AE48DA14-8B96-4B1F-A
C3683E2D26CF
Click the following link to see what you pushed in Seeq:
https://explore.seeq.com/7FC03C88-D8CD-4275-99EE-648E8CF127F2/workbook/AE48DA14-8B96-4B1F-A468-C3683E2D26CF/worksheet/0E7E-418D-8B96-4E0E7820300E
```

Realtime Dashboards



Plant Level Overview with different KPIs

Enterprise view to verify running status of different plants



Tangible Benefits



Proactive notification



Reduces unexpected downtime



ROI by catching failures before they happen

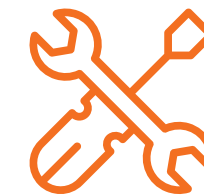


Performance & Reliability Improvements

Intangible Benefits



Reliable information



Prevent unnecessary labour & maintenance



Awareness of asset health versus time-based maintenance



Impact on performance improvement means additional revenues

Digitalization Roadmap



Connect & Visibility Performance

- Implementation of the Phase 2
- Benchmarking across the plant

Insights for Efficiency

- Equipment Performance monitoring in real time
- Advanced Statistical Techniques to Identify Failure/Root Causes

Process Analytics for operation

- Batch comparison
- Benchmarking
- SQC implementation

AI/ML implementation

- Real-time yield forecasting
- Production Optimization

Thank You

Digitalization Partners

AVEVA

CEREBULB



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Questions?

Please wait for the microphone.
State your name and company.



Please remember to...

Navigate to this session in the mobile app to complete the survey.



Thank you!

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ABOUT AVEVA

AVEVA is a world leader in industrial software, providing engineering and operational solutions across multiple industries, including oil and gas, chemical, pharmaceutical, power and utilities, marine, renewables, and food and beverage. Our agnostic and open architecture helps organizations design, build, operate, maintain and optimize the complete lifecycle of complex industrial assets, from production plants and offshore platforms to manufactured consumer goods.

Over 20,000 enterprises in over 100 countries rely on AVEVA to help them deliver life's essentials: safe and reliable energy, food, medicines, infrastructure and more. By connecting people with trusted information and AI-enriched insights, AVEVA enables teams to engineer efficiently and optimize operations, driving growth and sustainability.

Named as one of the world's most innovative companies, AVEVA supports customers with open solutions and the expertise of more than 6,400 employees, 5,000 partners and 5,700 certified developers. The company is headquartered in Cambridge, UK.

Learn more at www.aveva.com