


B/S/H/

neuraTub 

*AI-Optimized Excellence in
Tub Production*

 *inspired by neural network of AI*



First description

Starting position:

Before initiating the digital transformation in our plastic factory, we lacked **data tracking and traceability**. Quality controls were **manually** conducted by operators, the tub stacking process was performed **1,100 times** per shift by operators and pallet transportation was done by **forklifts**.

Characteristics:

Our innovation utilizes **cameras, robots, and AGVs (w/ Lidar sensor)** for zero defect, automated tub stacking. The key is digitizing the workflow, **employing AI for real-time data analysis**, and **creating anomaly models** for proactive issue resolution.

In summary, our project transforms manual processes into seamless automation, emphasizing precision. The pivotal aspects include advanced technology integration and a holistic approach to enhance overall factory efficiency.

Picture



Customer benefit

Our digital transformation ensures a higher level of quality control, preventing subpar products from leaving our facility and reaching our customers. This is not only safeguards the **reputation** of our brand but also establishes **trust** and **reliability** in our products.

Economic benefit for BSH

	FLCI	TR	LC
Tub Automation (incl. visual quality control, automatic stacking, AGV)	180k € w/ 2 IMM of 9 IMM	Great potential for FLCI w/ 30 IMM	Great potential for global w/ 57 IMM
Data Digitalization (traceability, data monitoring, analysis, anomaly creation and machine control)	90k € w/ 9 IMM		

Degree of novelty / Innovation potential

In this project, we're doing things that haven't been done before in BSH like; **visual inspection** of tubs, **connecting injection machines** in a new way, **using AI** to detect anomalies with updated models from historical data, and **give feedback** to machines.

The unique solution lies in the comprehensive digitization of the workflow, employing AI for real-time data analysis and anomaly detection. This sets the project apart by not only optimizing current processes but also proactively addressing potential issues, ensuring higher quality and efficiency compared to conventional methods.

Strategic fit

The project seamlessly aligns with BSH's corporate strategy of **'We. Accelerate. Impactful Innovation'**, with creating anomaly models that is learning from historical data and update model in real-time. Optimizing **operational efficiency**, ensuring **product quality**, and contributing to environmental **sustainability** through **innovative, eco-friendly** product generation.



The Genesis of Innovation (2020)

Birth of the first tub at new plastic injection building!

neuraTub

AI-Optimized Excellence in Tub Production

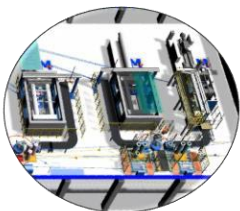


DIGITAL HISTORY



VR Headset / Plant Simulation

we started using VR headsets to see equipment like a real world. It helped with getting pre-acceptance process.



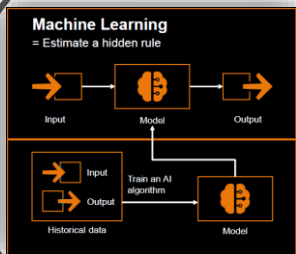
Introducing the Dark Plastic Factory Concept

AI-powered visual inspections, automatic stacking of tubs and AGVs for efficient transportation—a futuristic solution for enhanced production.



Tub Automation

We've automated our tub production by using cameras for visual inspections, eliminating operator mistakes. Robot handle tub stacking, and AGVs take care of transportation, streamlining our operations for increased efficiency.



AI Anomaly Detection

We've created anomaly models based on collected parameters. The system follows these models, continuously learning and generating results by comparing real-time data with historical data.



Traceability / Process Monitoring

By assigning a unique ID to each tub and collecting associated parameters, we've enabled the transfer of data to AWS & BSH MES for comprehensive traceability.



Machine Connectivity

We've seamlessly connected our injection machines to the system using the Euromap interface, establishing links with peripheral equipment through the Siemens Edge solution



AI Based Machine Control

Controlling machines based on anomaly results, we can halt production or take preventive measures in the digital age, where we shape the manufacturing landscape.



Smart Plastic Factory | Target State (Automation Cell)

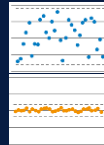
neuraTub

AI-Optimized Excellence in Tub Production



Manual Quality Check

Service, appliance replacement and in-house scrap cost;



Weight Tracking

Plastic raw material stock differences;



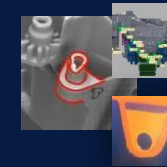
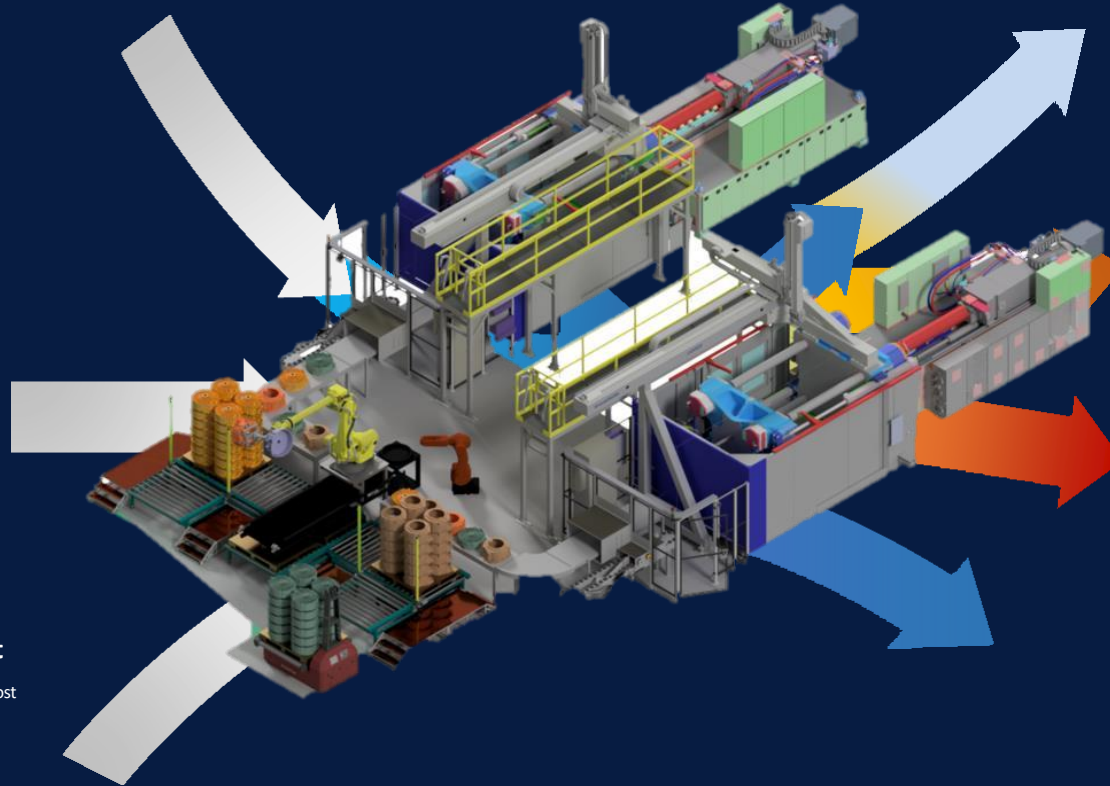
Manual Stacking

PDI HC and Ergonomical improvements avoiding;



Forklift Movement

SC HC and forklift rental cost reduction;



Automated Inspection

Hybrid solution consist of 2D camera and 3D profile sensor to detect defects on the tub

2D (camera) >> miss injection etc.
3D (laser) >> hole check and measurement



Weight Check

%100 weight control to stay always within tolerances



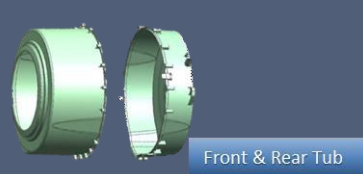
Automatic Stacking

A central robot will serve the tubs to visual inspection cabinet and according to decision to NOK conveyor or pallet.



AGV

Laser navigated conveyor type AGV will carry empty and full pallets



Lifetime Tracking

E2E Traceability

 Machinery >Process Parameters	 Weight Checker >Plastic Weight	 RFID Reader >Mould ID
 PLC >Automation	 Automated Inspection >Quality Result	 DMC Reader >Code Reading Performance
 PACs >Energy Consumption	 ProManage >Production outputs	 SAP >Production plan



Edge Computing



Field/Control

Unique ID Creation
>DMC Code is marked on tub surface

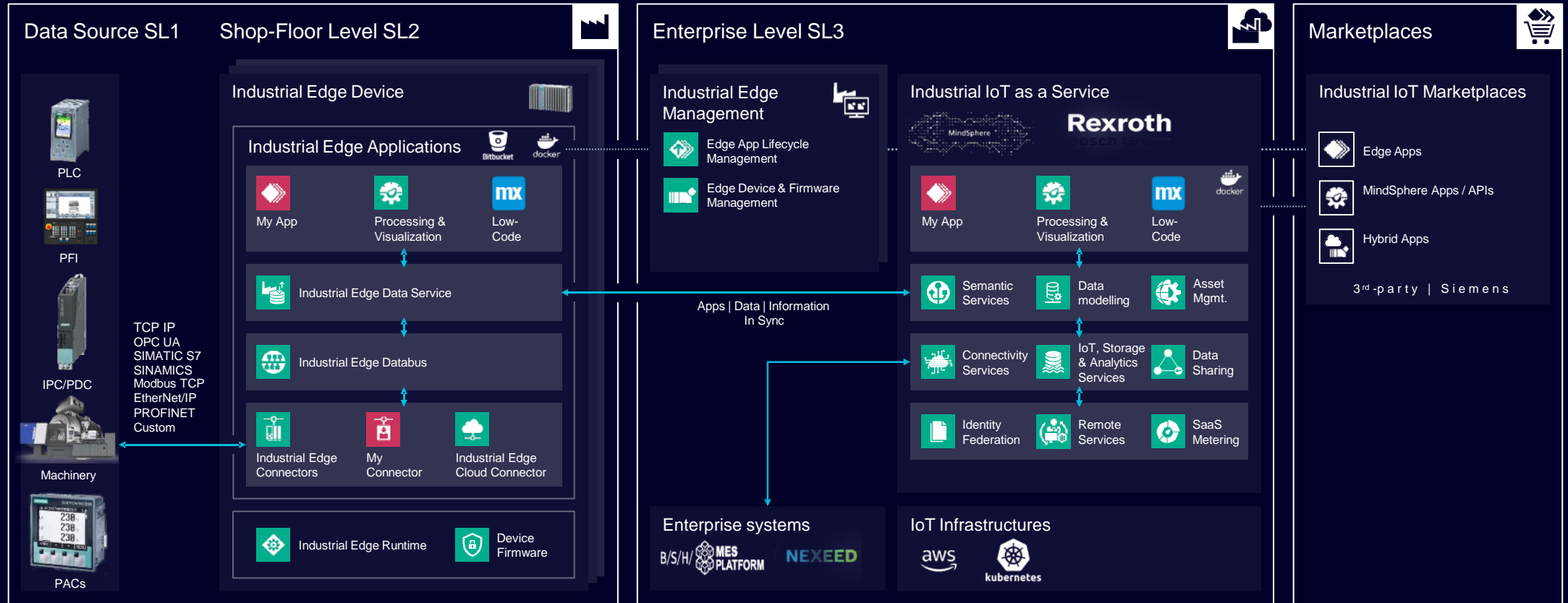
<IMM> <Mould> <Part description>
 <Production Date> <Production Time>
 <Material Number>
 IMM 10 K15 F490 04 ARKA
 09-03-23 15:09
 8001211039



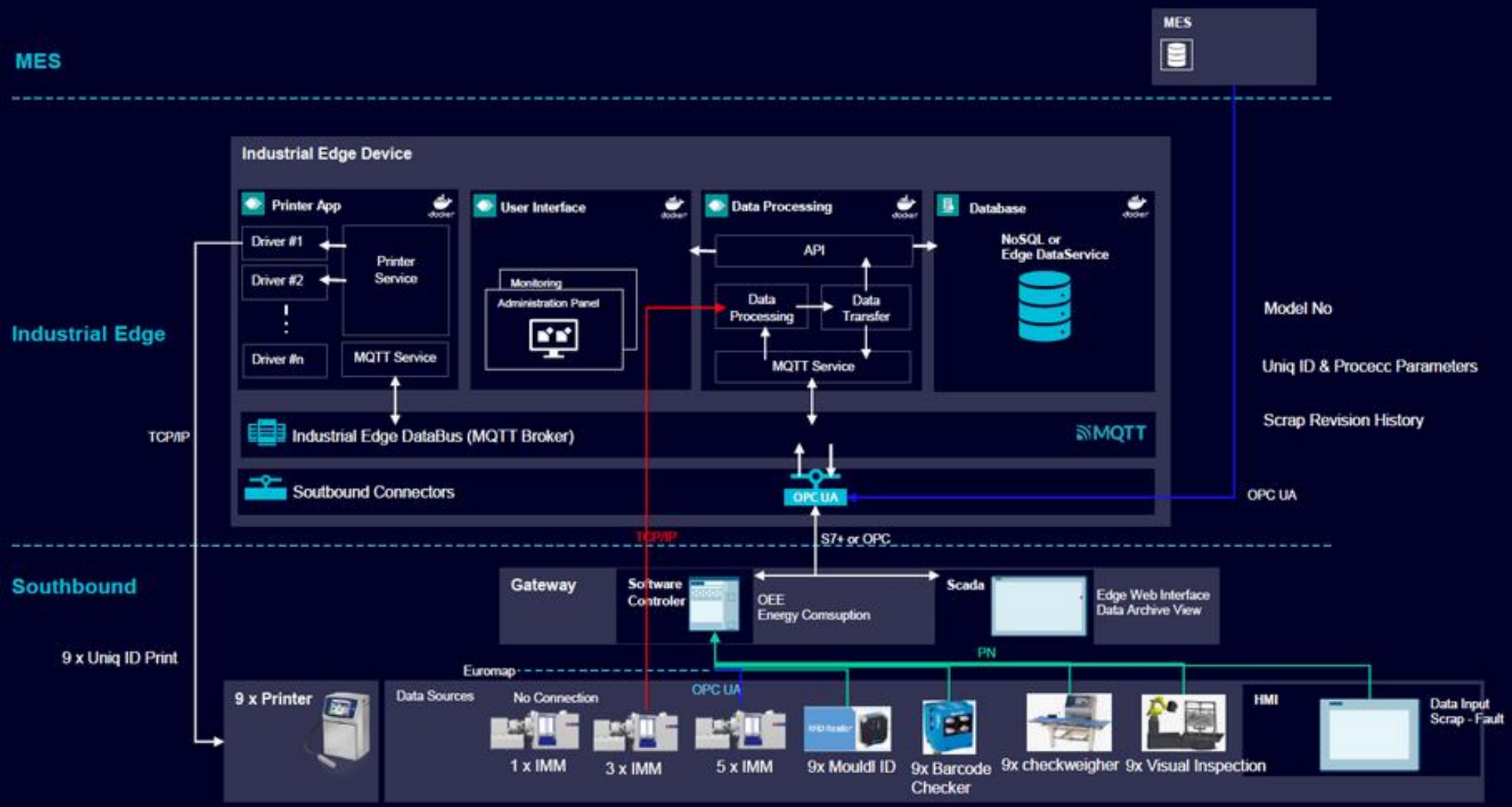
Data Modelling
>Collected data is identified with an ID and sent to MES



B/S/H/ Single-Truth of Digital Manufacturing & Excellence



■ Platform services & apps
 ■ Individual apps



Injection Molding Machine

Injection Molding Machine

Injection Molding Machine

Injection Molding Machine

Injection Molding Machine

Injection Molding Machine

Injection Molding Machine

Injection Molding Machine

Injection Molding Machine

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Inkjet

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Process

Barcode	IMM	Mould ID	Mould Description	Material Number	Material Description	Barcode Read	Production Date
250339228	IMM5	4057011	F14 Arka Kazan 3-4	8001211039	Rearpart MS F490 C4 PPGF30	250339228	23.05.2024 15:03:54
130290911	IMM3	4083275	F14 Ön Kazan 5-10 (60 L)	8001138864	TUB, FRONT F490 Frontpart F1	Read Error	23.05.2024 15:03:55
250339227	IMM5	4057011	F14 Arka Kazan 3-4	8001211039	Rearpart MS F490 C4 PPGF30	250339227	23.05.2024 15:03:54
130290910	IMM3	4083275	F14 Ön Kazan 5-10 (60 L)	8001138864	TUB, FRONT F490 Frontpart F1	Read Error	23.05.2024 15:03:55
360228729	IMM6	4080239	F510 Ön Kazan 4	8001015088	MS F510 FRONT PART 233	360228729	23.05.2024 15:03:53
390193878	IMM9	4082920	F510 Ön Kazan 5	8001015088	MS F510 FRONT PART 233	390193878	23.05.2024 15:03:59
470175054	IMM7	4080238	F510 Arka Kazan 4	8001213620	Rearpart MS F510 C5 3P PPGF40	470175054	23.05.2024 15:03:31

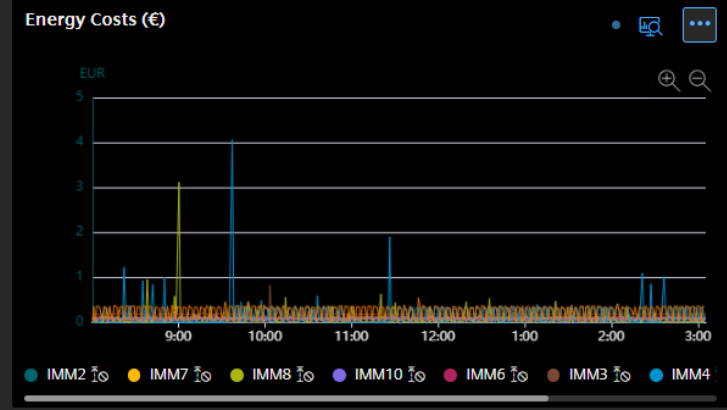
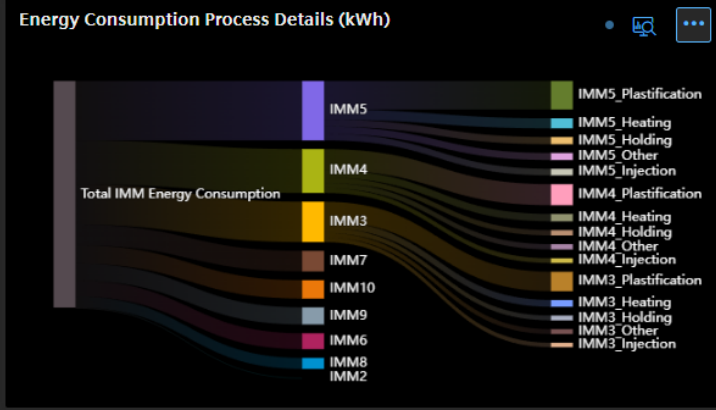
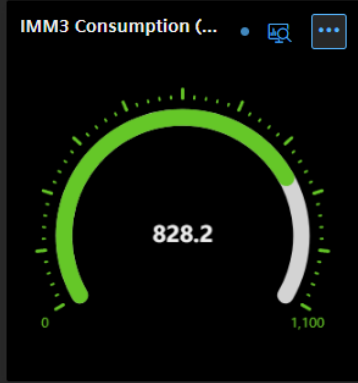
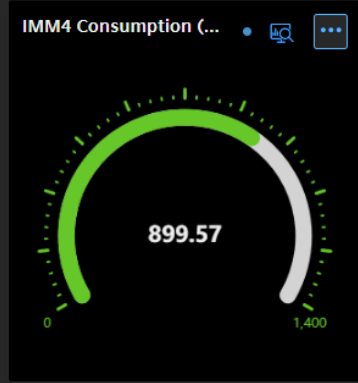
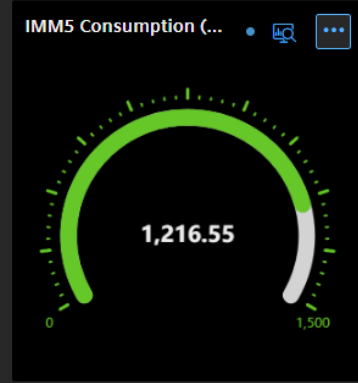
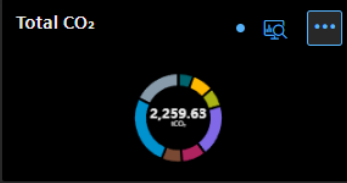
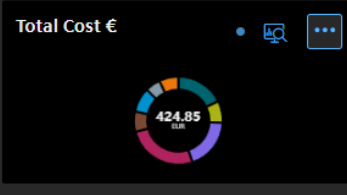
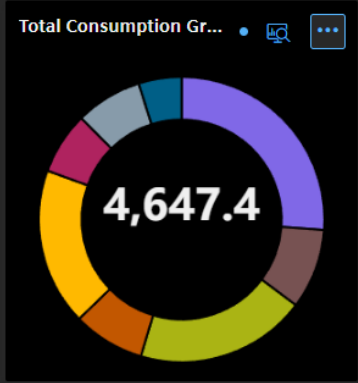
My Plant / FLCI Smart Plastic Factory / Dashboard / Shiftly IMM Energy Consumption

Assets

- FLCI Smart Plastic Factory 3
 - IMM Parameters 2
 - IMM_Single_Temp
 - IMM_Status_Energy (Sin... 5
 - IMM_Status_Energy (Twin) 3
 - IMM_Twin_Temp
- OEE IMM10 1
- OEE IMM2
- OEE IMM3
- OEE IMM4
- OEE IMM5
- OEE IMM6
- OEE IMM7
- OEE IMM8
- OEE IMM9
- StockData

Shiftly IMM Energy Consumption

5/23/24 8:00 AM → 5/23/24 4:00 PM



Total Production

Parameter	Value
IMM2	-
IMM7	324
IMM10	325
IMM9	438
IMM6	443
IMM8	457
IMM4	460
IMM5	630

Assets   

FLCI Smart Plastic Factory

- OEE IMM10
- OEE IMM3
- OEE IMM4
- OEE IMM5
- OEE IMM6
- OEE IMM7
- OEE IMM8
- OEE IMM9

[Back](#)

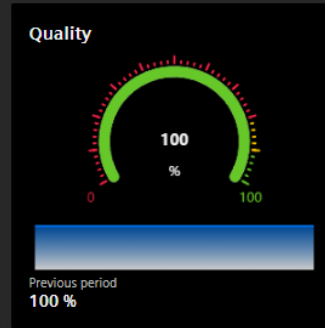
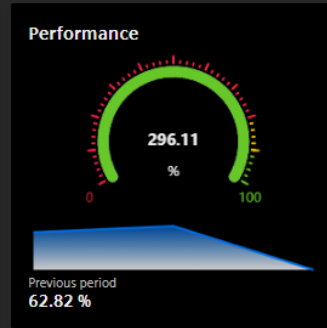
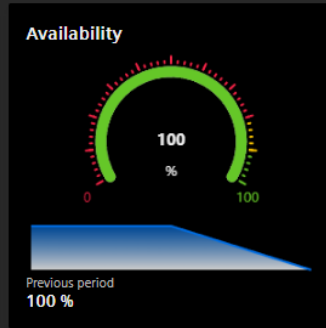
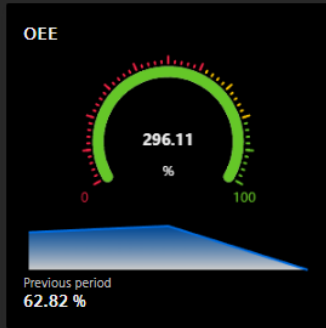
OEE

KPIs

[OEE overview](#)
[Error analysis](#)
[Analysis of sub assets](#)

[5/23/24 1:00 PM](#)
[5/23/24 9:00 PM](#)

[Details](#)



Other KPIs Current / previous period

TEEP	296.11% / 62.82%
MTTR	0sec / 0sec
MTBF	0sec / 0sec

Machine status

[Details](#)
[Change machine status](#)

Machine status for current data

Overview	Microstop events
Running	0
Stop (Planned)	0
Shutdown	0
Stop (Unpl...)	0
undefined	0

Distribution

- Running: 2:34:18 / 1
- Stop (Planned): 0:00:00 / 0
- Shutdown: 0:00:00 / 0
- Stop (Unplanned): 0:00:00 / 0
- undefined: 0:00:00 / 0

My Plant / StockData / Dashboard / Tub Stock Dashboard

Assets

- FLCI Smart Plastic Factory 5
 - IMM Parameters 5
 - IMM_Single_Temp
 - IMM_Status_Energy (Sin...
 - IMM_Status_Energy (Twin)
 - IMM_Twin_Temp 3
 - OEE IMM10 1
 - OEE IMM2
 - OEE IMM3 1
 - OEE IMM4 1
 - OEE IMM5 3
 - OEE IMM6 1
 - OEE IMM7 1
 - OEE IMM8 1
 - OEE IMM9 3
 - StockData 1

← Back

Tub Stock Dashboard ★

5/23/24 12:00 AM → 5/24/24 12:00 AM

Tub Stock Amount

Parameter	Value
F490 Front Tub	10.75K pcs
• F490 FT (PPTV)	6,697 pcs
• F490 FT (PPGF20)	4,056 pcs
F490 Rear Tub	3,920 pcs
F510 Front Tub	3,576 pcs
F510 Rear Tub	3,840 pcs

Stock Availability

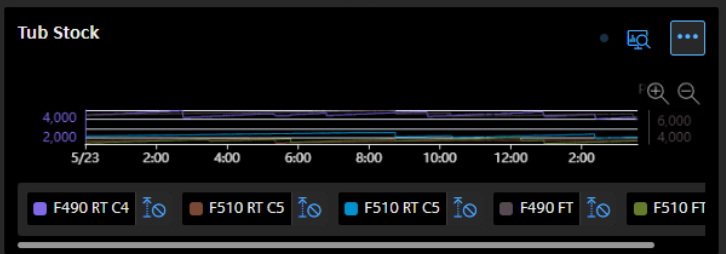
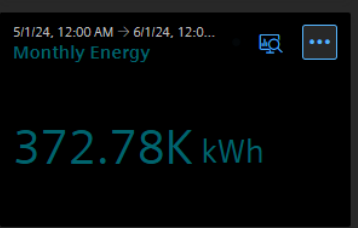
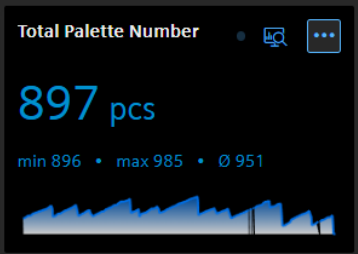
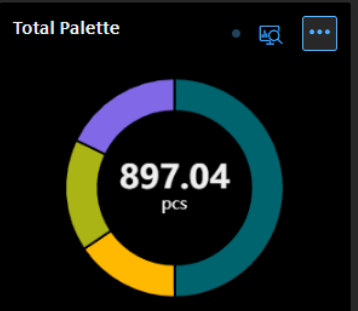
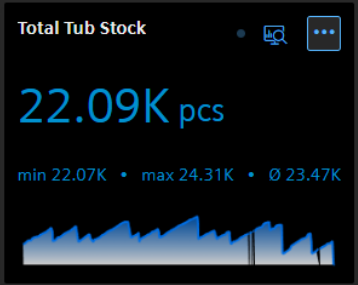
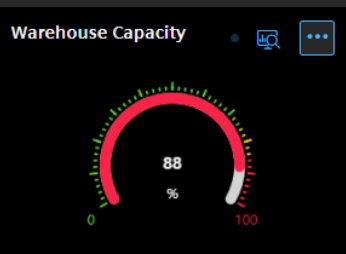
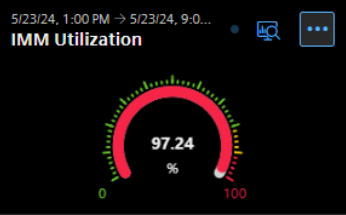
Parameter	Value	Min	Max	Ø
F490 Front Tub	11.32 line	11.29 line	12.25 line	11.94 line
• F490 FT PPTV	7.05 line	7.05 line	7.96 line	7.53 line
• F490 PPGF20	4.27 line	4.07 line	4.75 line	4.4 line
F490 Rear Tub	4.13 line	4.13 line	5.13 line	4.69 line
F510 Front Tub	3.76 line	3.41 line	4.24 line	3.81 line
F510 Rear Tub	4.04 line	3.94 line	4.62 line	4.27 line

IMM Status

Parameter	Value
IMM4	4
IMM9	1
IMM3	1
IMM10	1
IMM6	1
IMM5	1
IMM8	1
IMM7	1

IMM Active Plan

Parameter	Value
IMM9	MS F510 FRON...
IMM5	Rearpart MS F4...
IMM6	MS F510 FRON...
IMM4	Rearpart MS F4...
IMM2	F490 Talcum Fr...
IMM3	TUB, FRONT F4...
IMM10	Rearpart MS F5...
IMM7	Rearpart MS F5...
IMM8	F490 Talcum Fr...



Anomalies

Search ... 🔍

- May 23, 2024, 08:01:49.000 AM**
 Anomaly detected! The reconstruction error amounts to 1.00 times the anomaly threshold. The main contributor is: DB_EDGE.IMM5.PartData.cycleParameters.specPressureTrnsfr
- May 23, 2024, 07:59:16.000 AM**
 Anomaly detected! The reconstruction error amounts to 1.00 times the anomaly threshold. The main contributor is: DB_EDGE.IMM5.PartData.cycleParameters.specPressureTrnsfr
- May 23, 2024, 06:00:13.000 AM**
 Anomaly detected! The reconstruction error amounts to 1.00 times the anomaly threshold. The main contributor is: DB_EDGE.IMM5.PartData.cycleParameters.specPressureTrnsfr
- May 23, 2024, 12:01:51.000 AM**
 Anomaly detected! The reconstruction error amounts to 1.00 times the anomaly threshold. The main contributor is: DB_EDGE.IMM5.PartData.cycleParameters.specPressureTrnsfr
- May 22, 2024, 11:59:24.000 PM**
 Anomaly detected! The reconstruction error amounts to 1.00 times the anomaly threshold. The main contributor is: DB_EDGE.IMM5.PartData.cycleParameters.specPressureTrnsfr
- May 22, 2024, 06:26:45.000 PM**
 Anomaly detected! The reconstruction error amounts to 1.00 times the anomaly threshold. The main contributor is: DB_EDGE.IMM5.PartData.cycleParameters.specPressureTrnsfr
- May 22, 2024, 03:59:43.000 PM**
 Anomaly detected! The reconstruction error amounts to 1.00 times the anomaly threshold. The main contributor is: DB_EDGE.IMM5.PartData.cycleParameters.specPressureTrnsfr
- May 22, 2024, 10:55:49.000 AM**
 Anomaly detected! The reconstruction error amounts to 1.00 times the anomaly threshold. The main contributor is: DB_EDGE.IMM5.PartData.cycleParameters.specPressureTrnsfr
- May 22, 2024, 07:59:06.000 AM**
 Anomaly detected! The reconstruction error amounts to 1.00 times the anomaly threshold. The main contributor is: DB_EDGE.IMM5.PartData.cycleParameters.specPressureTrnsfr
- May 21, 2024, 11:59:32.000 PM**
 Anomaly detected! The reconstruction error amounts to 1.00 times the anomaly threshold. The main contributor is: DB_EDGE.IMM5.PartData.cycleParameters.specPressureTrnsfr

May 23, 2024, 08:01:49.000 AM

IMM5_Energy_Consumption

[Go to Analysis View](#)

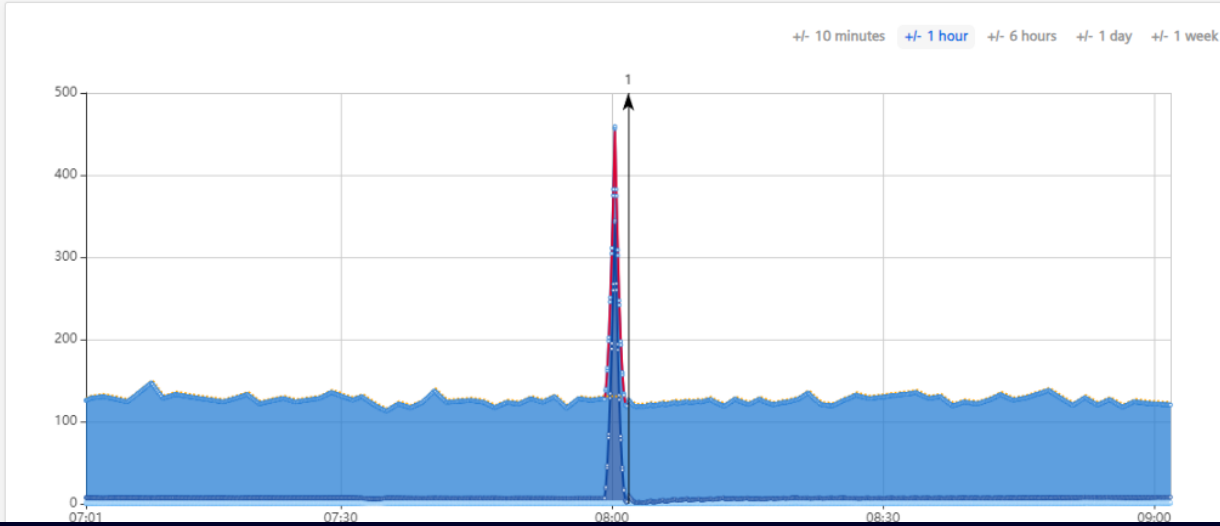
Overview

Status Unresolved	Assigned Not assigned	Calculated deviation 123.79	Exceeding of threshold 0.15	Number of features 4
-----------------------------	---------------------------------	---------------------------------------	---------------------------------------	--------------------------------

Message

⚠️ Anomaly detected! The reconstruction error amounts to 1.00 times the anomaly threshold. The main contributor is: DB_EDGE.IMM5.PartData.cycleParameters.specPressureTrnsfr

Calculated deviation



Contribution of features

Main contributors

DB_EDGE.IMM5.PartData.cycleParameters.specPressureTrnsfr
 -11.73 / 131.13%

Minor contributors

DB_EDGE.IMM5.PartData.energy.shiftkWh_kg
 3.24 / -36.19%

DB_EDGE.IMM5.PartData.cycleParameters.cycleTime
 0.01 / -0.16%

DB_EDGE.IMM5.PartData.cycleParameters.plasTime
 -0.47 / 5.22%



Anomalies

Search ...



May 07, 2024, 12:54:18.000 AM

Anomaly detected! The reconstruction error amou to 13.32 times the anomaly threshold. The main

May 06, 2024, 07:50:21.000 PM

Anomaly detected! The reconstruction error amou to 13.32 times the anomaly threshold. The main

May 06, 2024, 07:26:28.000 PM

Anomaly detected! The reconstruction error amou to 13.32 times the anomaly threshold. The main

May 06, 2024, 03:47:39.000 PM

Anomaly detected! The reconstruction error amou to 13.32 times the anomaly threshold. The main

May 06, 2024, 11:50:53.000 AM

Anomaly detected! The reconstruction error amou to 13.32 times the anomaly threshold. The main

May 06, 2024, 11:27:14.000 AM

Anomaly detected! The reconstruction error amou to 13.32 times the anomaly threshold. The main

Apr 24, 2024, 08:08:48.000 AM

Anomaly detected! The reconstruction error amou to 1.01 times the anomaly threshold. The main

Apr 23, 2024, 01:47:53.000 PM

Anomaly detected! The reconstruction error amou to 1.00 times the anomaly threshold. The main

Apr 23, 2024, 01:24:15.000 PM

Anomaly detected! The reconstruction error amou to 1.00 times the anomaly threshold. The main

Apr 23, 2024, 01:22:03.000 PM

May 06, 2024, 07:26:28.000 PM

IMM8_Miss_Injection

[Go to Analysis View](#)

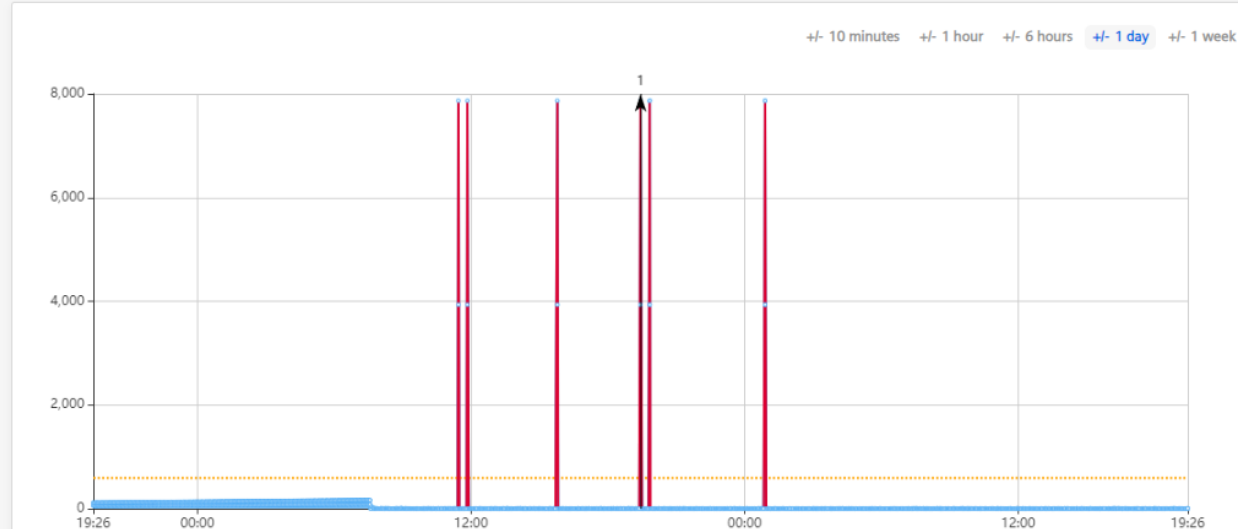
Overview

Status Unresolved	Assigned Not assigned	Calculated deviation 7,867.46	Exceeding of threshold 7,276.82	Number of features 2
-----------------------------	--------------------------	----------------------------------	---	-------------------------

Message

⚠️ Anomaly detected! The reconstruction error amounts to 13.32 times the anomaly threshold. The main contributor is: DB_EDGE.IMM8.PartData.cycleParameters.meltCushion

Calculated deviation

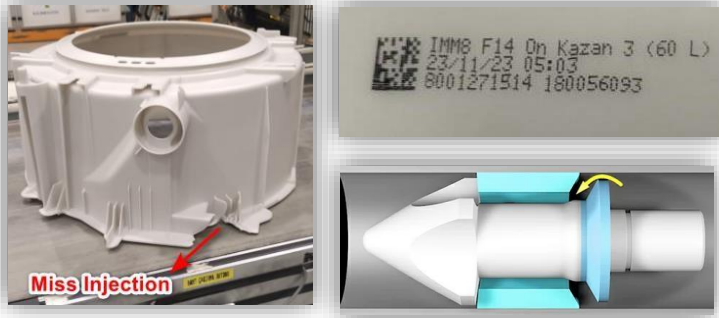


Contribution of features

Main contributors	
DB_EDGE.IMM8.PartData.cycleParameters.meltCushion	-62.8 / 50%
Minor contributors	
DB_EDGE.IMM8.PartData.cycleParameters.meltCushion_2	-62.8 / 50%

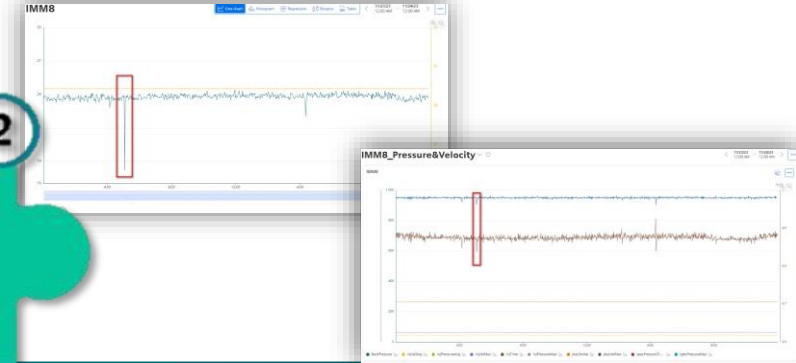
Problem Description

- Miss injection problem faced during production at 23.11.23,
- Checked with maintenance dept. health check planned for screw.



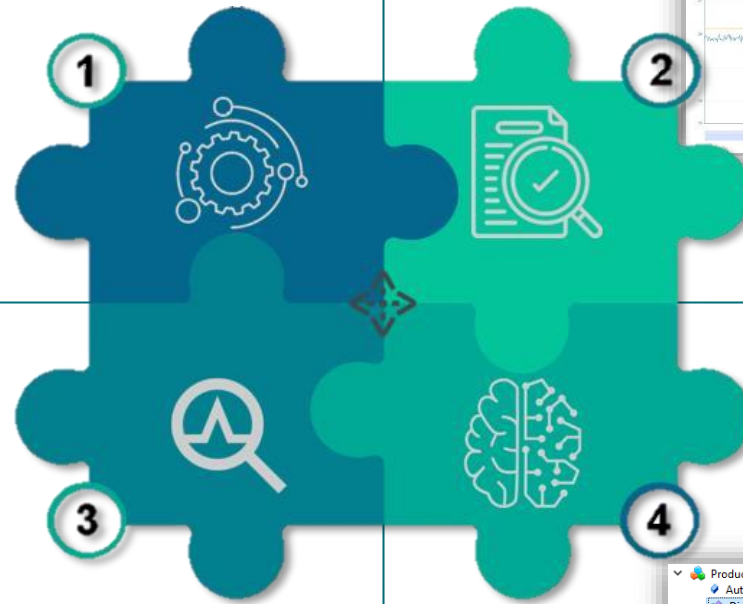
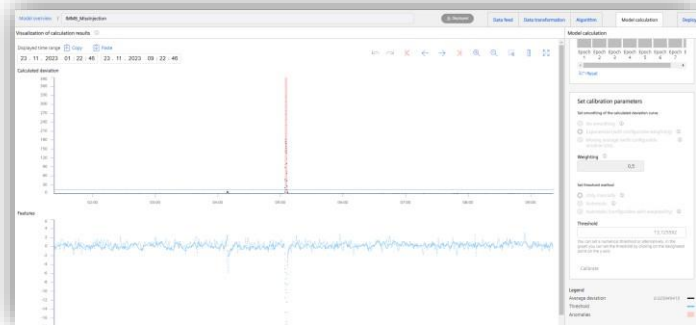
Performance Insight Analysis

- Behavior of parameters melt cushion and specific pressure is strange at problematic part ID.



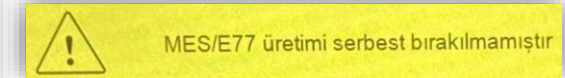
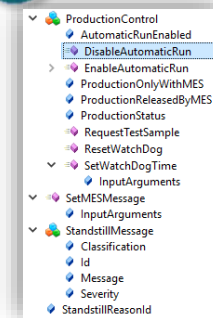
Model Training & Edge AI Computing

- Dataset trained with model creation,

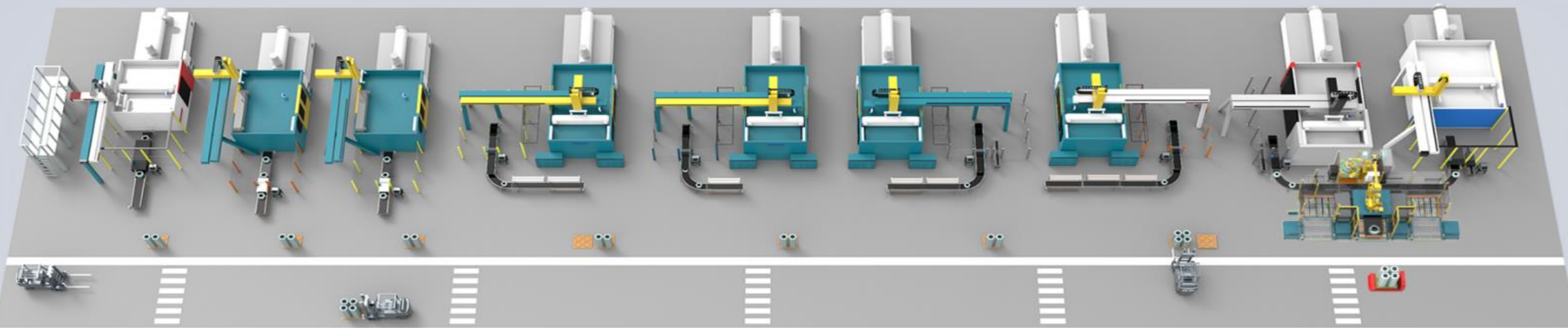


Machine Control with MES

- Machine blocked with Euromap77, studies for automatic feedback to IMM is ongoing.

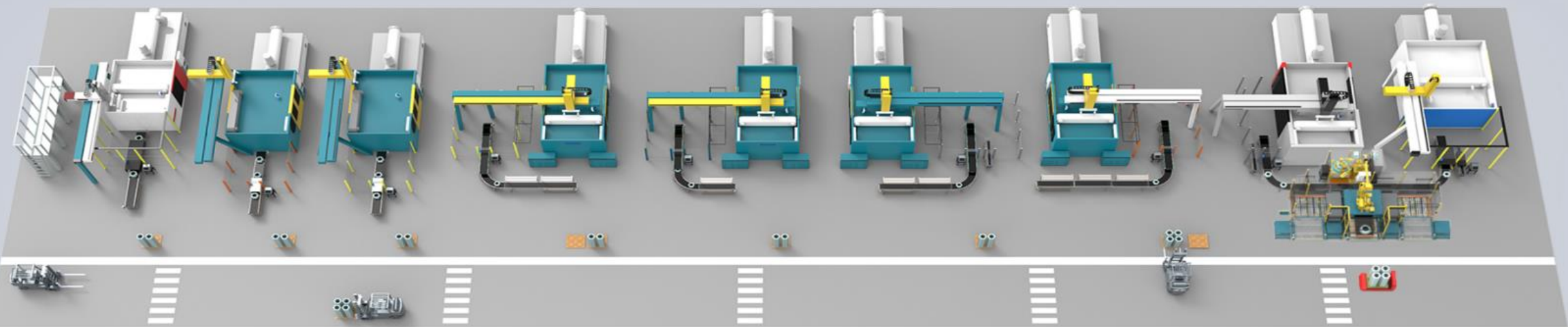


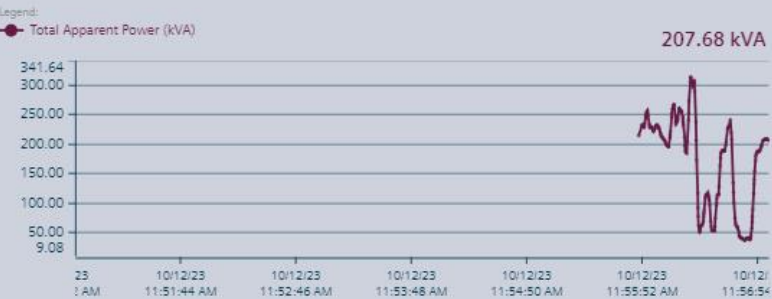
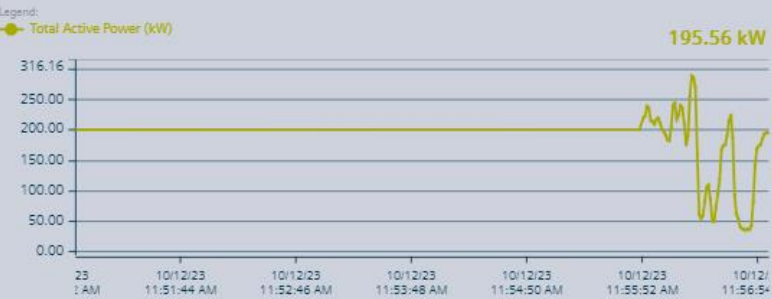
*Production blocked by E77.



IMM8	IMM7	IMM6	IMM3	IMM4	IMM5	IMM2	IMM9	IMM10
Running	Running	Running	Running	Running	Running	Running	Running	Running
Material Number 8001271514	Material Number 8001213620	Material Number 8001213620	Material Number 8001138864	Material Number 8001211039	Material Number NoPlan	Material Number 8001271514	Material Number 8001015088	Material Number 8001211039
Material Description 90 Talcum FrontTub 60lt w/o	Material Description Rearpart M5 F510 C5 3P PPGF40	Material Description Rearpart M5 F510 C5 3P PPGF40	Material Description TUB, FRONT F490 Frontpart F1	Material Description Rearpart M5 F490 C4 PPGF30	Material Description NoPlan	Material Description F490 Talcum FrontTub 60lt w/o	Material Description M5 F510 FRONT PART 233	Material Description Rearpart M5 F490 C4 PPGF30
Mould ID F14 Ön Kazan 3 (60 L)	Mould ID F510 Arka Kazan 4	Mould ID F510 Arka Kazan 5	Mould ID F14 Rear 17-18	Mould ID F14 Arka Kazan 3-4	Mould ID F14 Arka Kazan 1-2	Mould ID F14 Ön Kazan 1-2 (60 L)	Mould ID F510 Ön Kazan 5	Mould ID F14 Arka Kazan 15
Barcode ReadError	Barcode 000055531	Barcode 460005873	Barcode 123723237	Barcode 000150370	Barcode 250010654	Barcode 120012013	Barcode 390008219	Barcode ReadError
Total Power (kVA) 	Total Power (kVA) 	Total Power (kVA) 	Total Power (kVA) 	Total Power (kVA) 	Total Power (kVA) 	Total Power (kVA) 	Total Power (kVA) 	Total Power (kVA)

IMM8	IMM7	IMM6	IMM3	IMM4	IMM5	IMM2	IMM9	IMM10
🟢 Online	🟢 Online	🟢 Online	🟢 Online	🟢 Online	🟢 Online	🟢 Online	🟢 Online	🟢 Online
Last Read Time 12.10.2023 11:48:05	Last Read Time 12.10.2023 11:47:43	Last Read Time 12.10.2023 11:47:36	Last Read Time 11.10.2023 17:17:36	Last Read Time 12.10.2023 11:47:48	Last Read Time 12.10.2023 11:47:57	Last Read Time 12.10.2023 11:48:29	Last Read Time 12.10.2023 11:47:39	Last Read Time 12.10.2023 11:47:17
Last Read Result ReadError	Last Read Result 000055532	Last Read Result 460005873	Last Read Result 123723237	Last Read Result 000150371	Last Read Result 250010655	Last Read Result 120012015	Last Read Result 390008219	Last Read Result ReadError
Shift Reading Counts 🟢 223 🚩 22	Shift Reading Counts 🟢 175 🚩 0	Shift Reading Counts 🟢 174 🚩 2	Shift Reading Counts 🟢 0 🚩 0	Shift Reading Counts 🟢 333 🚩 5	Shift Reading Counts 🟢 210 🚩 16	Shift Reading Counts 🟢 398 🚩 31	Shift Reading Counts 🟢 214 🚩 18	Shift Reading Counts 🟢 0 🚩 33
Shift Success Rate % 	Shift Success Rate % 	Shift Success Rate % 	Shift Success Rate % 	Shift Success Rate % 	Shift Success Rate % 	Shift Success Rate % 	Shift Success Rate % 	Shift Success Rate %
Last Shift Success Rate % 	Last Shift Success Rate % 	Last Shift Success Rate % 	Last Shift Success Rate % 	Last Shift Success Rate % 	Last Shift Success Rate % 	Last Shift Success Rate % 	Last Shift Success Rate % 	Last Shift Success Rate %





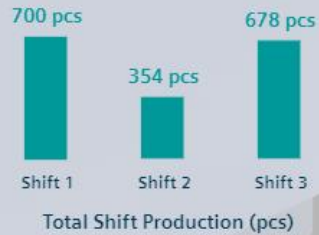
Consumption : Total Not In Production

Daily : 1956.17 kWh 6.92 kWh

Shift 1 : 1304.85 kWh 2.65 kWh
(00:00:00 - 08:00:00)
(12.10.2023)

Shift 2 : 650.73 kWh 4.27 kWh
(08:00:00 - 11:56:59)
(12.10.2023)

Shift 3 : 1275.08 kWh 19.60 kWh
(16:00:00 - 00:00:00)
(11.10.2023)



IMM04

