



PI System (and PI AF) – Enabling Business Transformation

The Journey from Refinery Business Unit to Group Downstream Level...and the Enterprise

Presented by **Tibor Komróczki (remote)**
Craig Harclerode O&G Industry Principal



MOL Group Downstream

6 production units

~500KBPD refining capacity

2.1 mtpa petrochemicals capacity

>1,900 filling stations

under 8 brands in 11 CEE

370 000 PI Tag capacity in 4 PI systems

Extensive use of PI AF

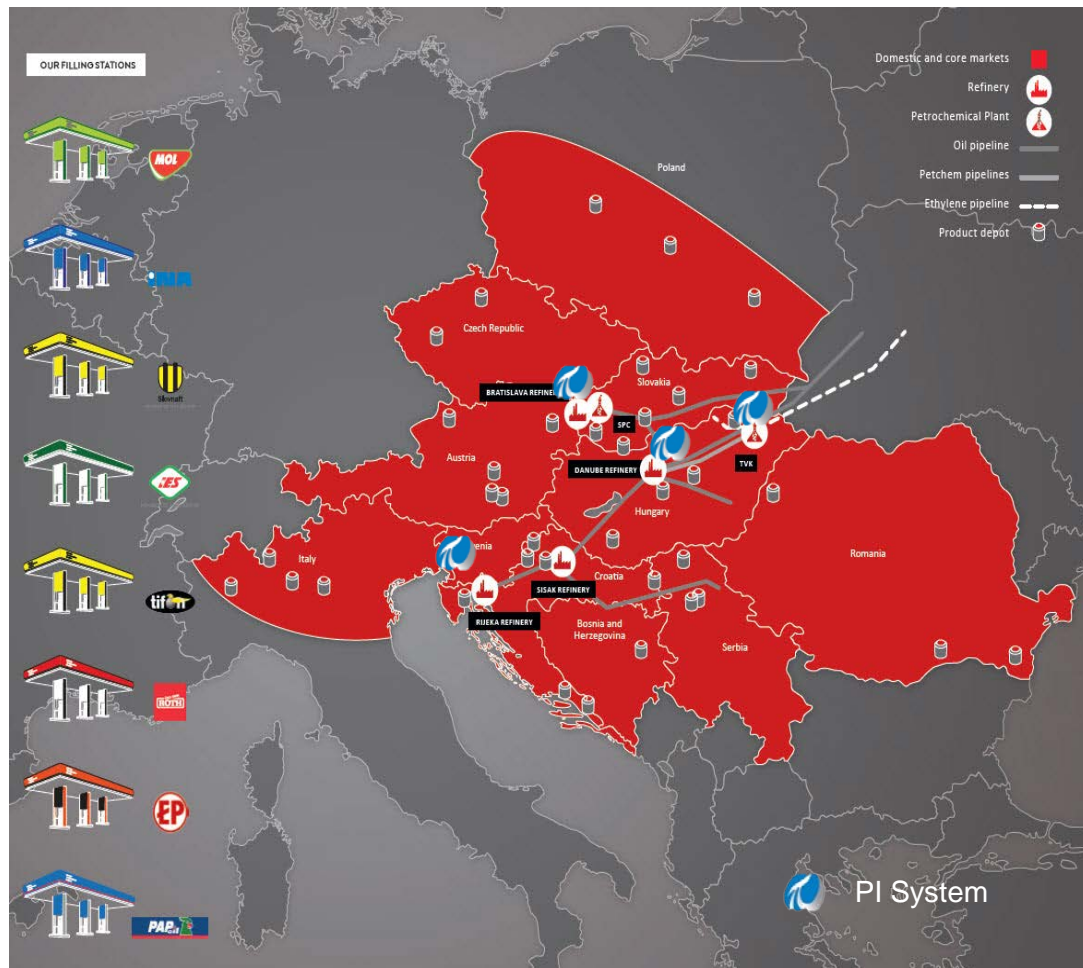
> 6 500 Elements

70 Element templates

30 Event Frame templates

11 Notification templates

~ 105 000 Attributes



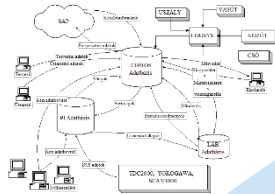


PI System Journey

PI System Evolution in MOL



1998



2002



2006



2010



2015+

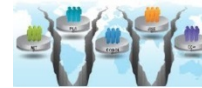
Individual



Team



Division



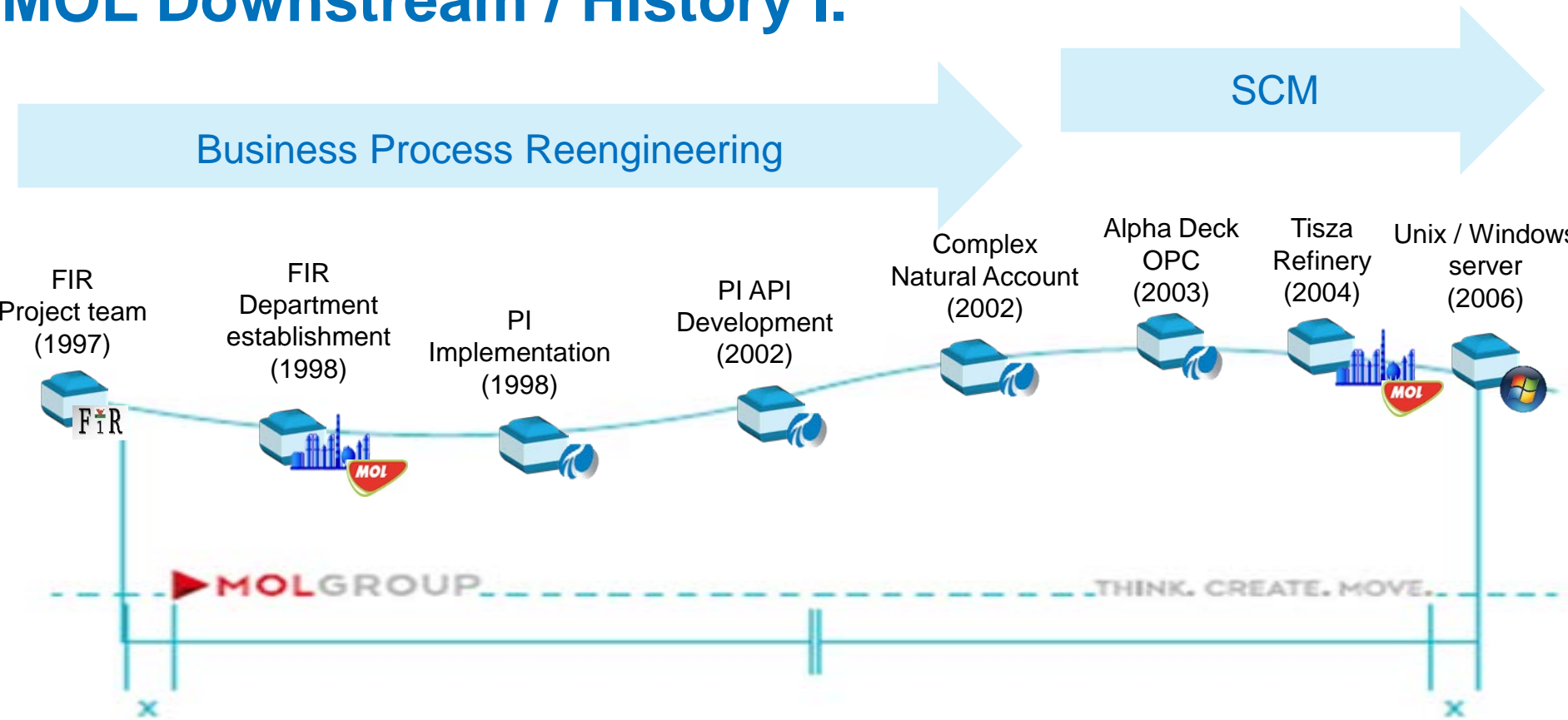
Enterprise



IoT
Machine learning



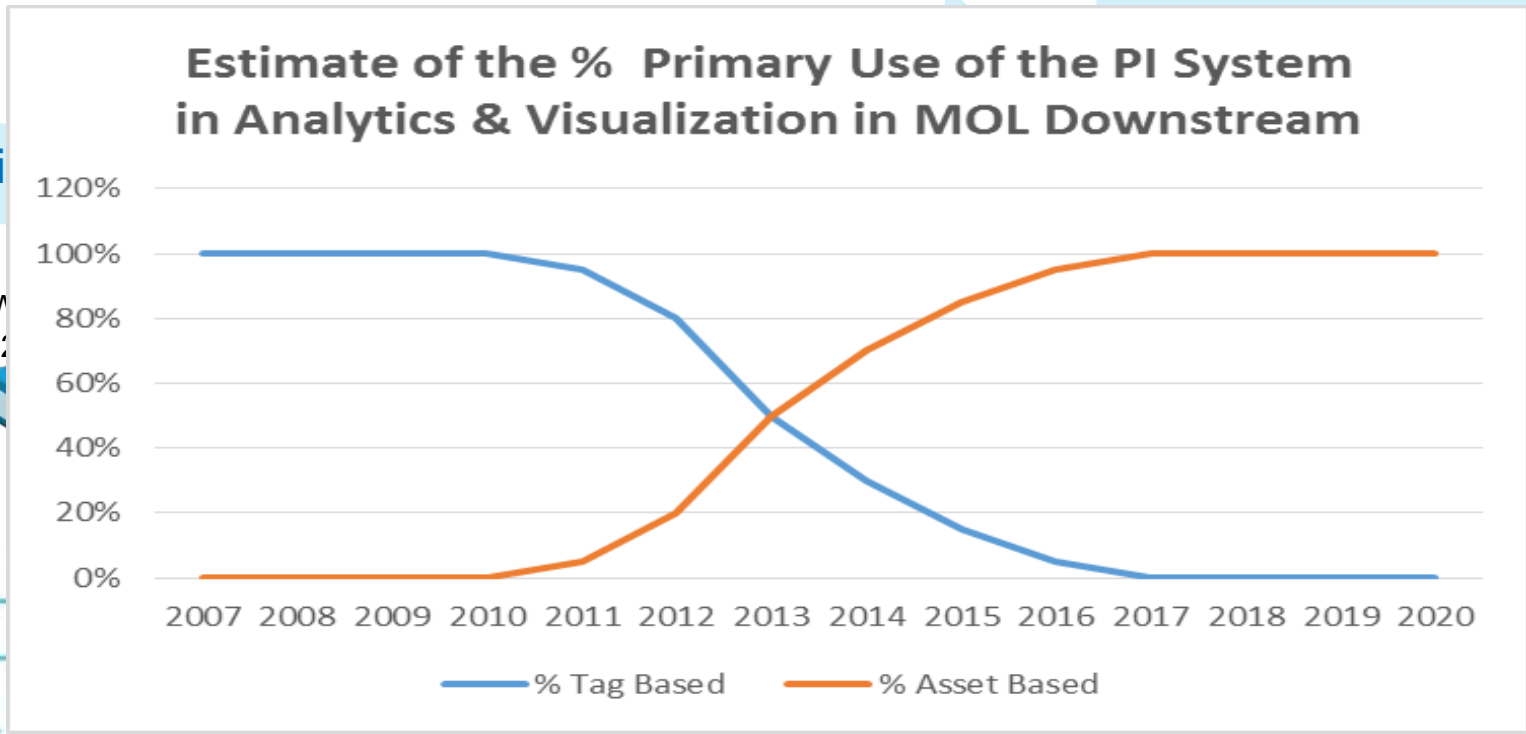
MOL Downstream / History I.



MOL Downstream / History II.


Visi

Slovnaft
(2007) Rt V
(%)



Program

SN
Upgrade
(2015)



Focus areas of New Downstream Program (NDP)

NDS is targeting \$500M-550M EBITDA improvement by 2016



MOL Downstream PI AF Based Applications

Safety and Asset Integrity

- Interlock statuses
- Operating envelopes
- Corrosion control (HTHA)
- Alarm management
- Control rooms' temperature

Energy

- Energy Monitoring and Management
- Energy KPI breakdown (6 tiers)
- Column Energy Efficiency Dashboards
- Hydrogen, Utilities, and Energy balances
- Flaring

Yields

- Crude Blending Control
- Yield Optimization/Reporting
- Product Quality
- Analyser Reliability

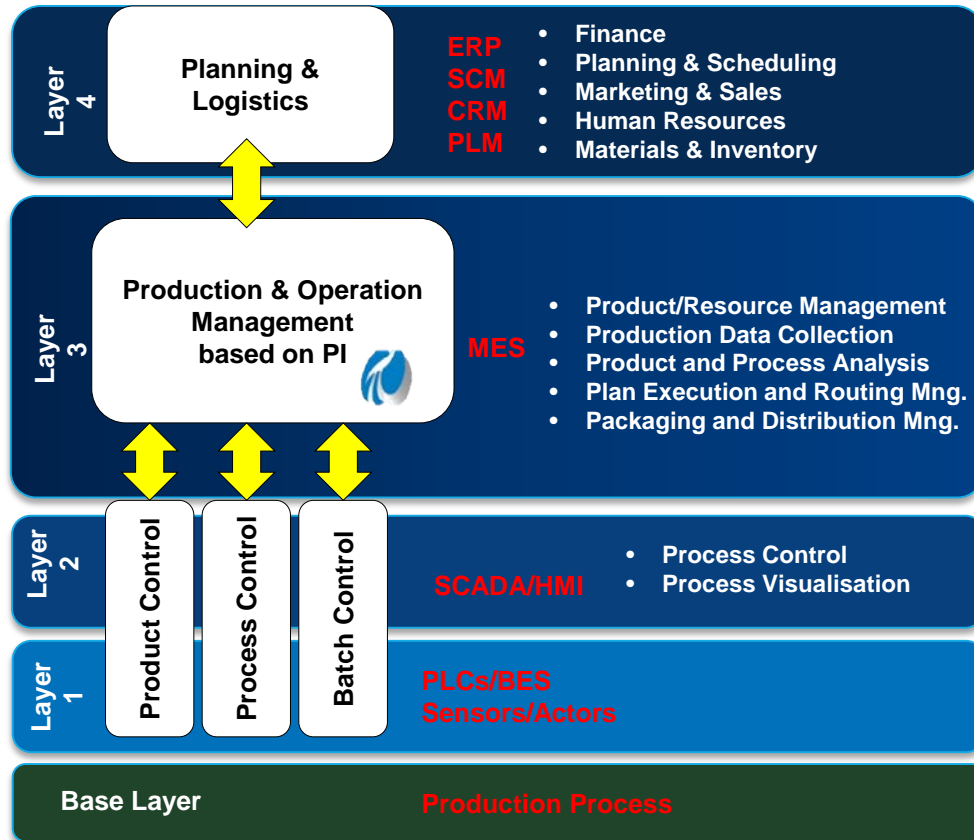
Operational Optimization

- Plan vs Actual Analytics with Future Data
- NG and Fuel Demand gas forecasting
- Peak Electrical forecasting
- Normal mode of control loops
- APC monitoring
- PI AF and Sigmafine (PI AF) used for yield accounting & Material Movement



Integration

MES Standardization in MOL Group level



Separate group and local level responsibility

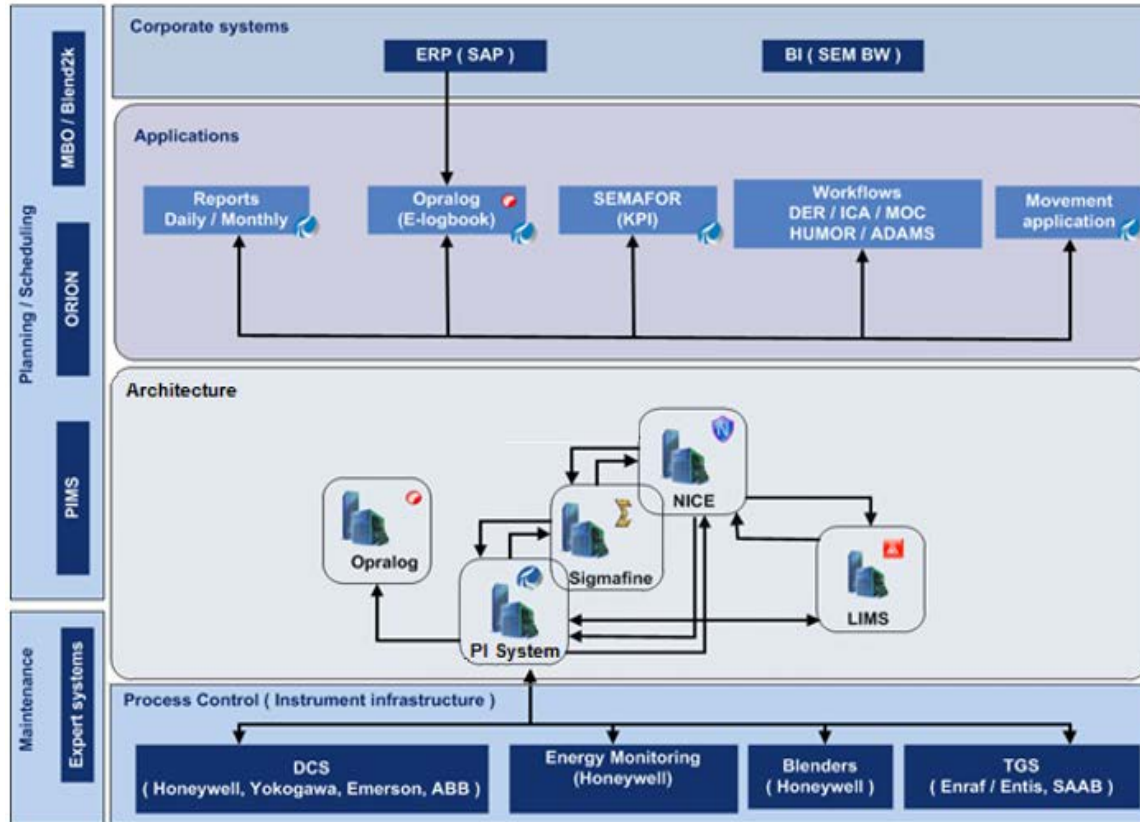
Determine standardization goals according to common principles

Establish unified software architecture based on PI system

Ensure equivalent PI system structure in MOL Group refineries

Create efficient contract management system with vendors (PI System as an Infrastructure)

Danube Refinery MES portfolio



Software components

PI System – **(PI AF is key)**

Sigmafine(PI) (Reconciliation)

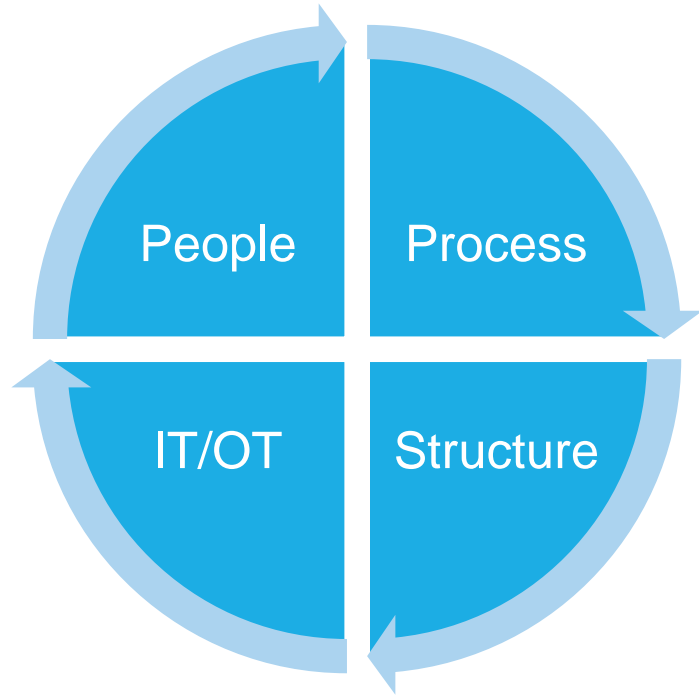
LIMS (Laboratory)

Opralog (E-logbook)

SEMAFOR (KPI system)

NICE (Natural Info –center)

MES integration efforts - A Change Management Effort



Main objectives

Shape the strategy via four domains

Merge Business and IS project goals

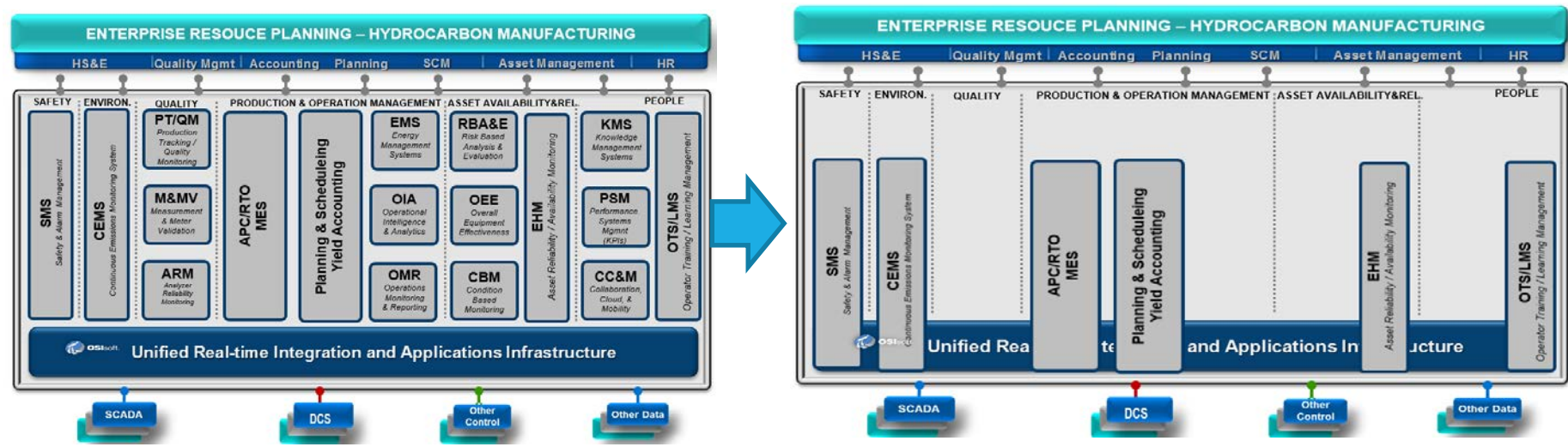
Share ideas and resources

Create long term plan

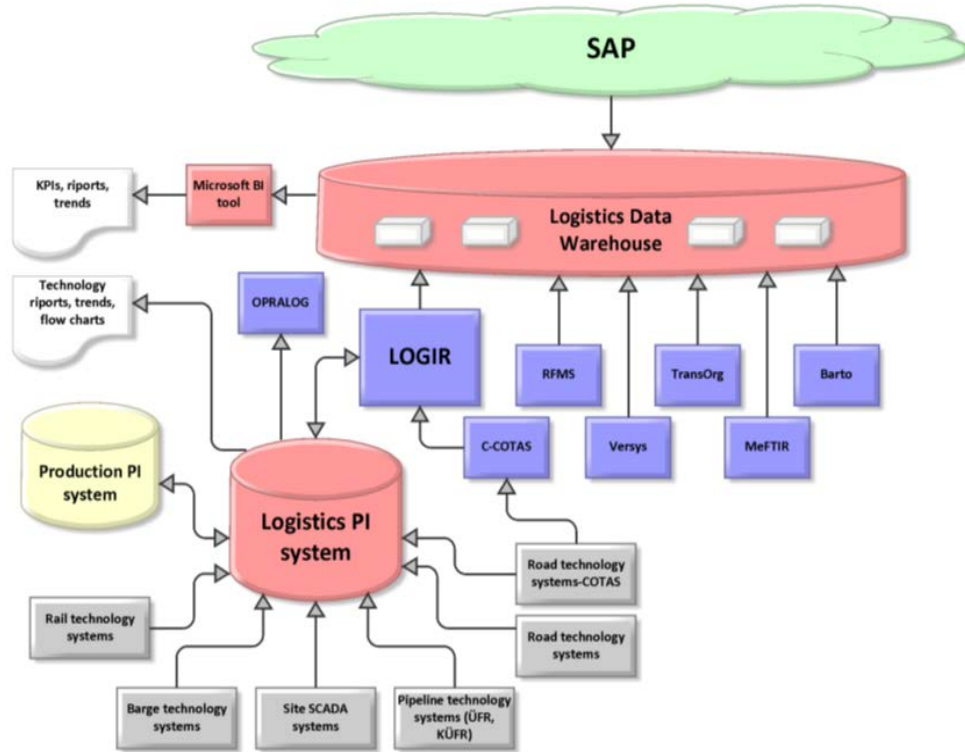
Involve the following areas:

Downstream, SCM, HSE, Logistic

Production (Refinery & Petchem) ○ & Logistic standardization ○



MOL Logistics - Fuels Value Chain Integration



Project initiations

Visualizing and monitoring logistics outside of SCADA

Supporting preventive maintenance and asset reliability

Ensuring KPI measurement across the fuels value chain

Notification of events

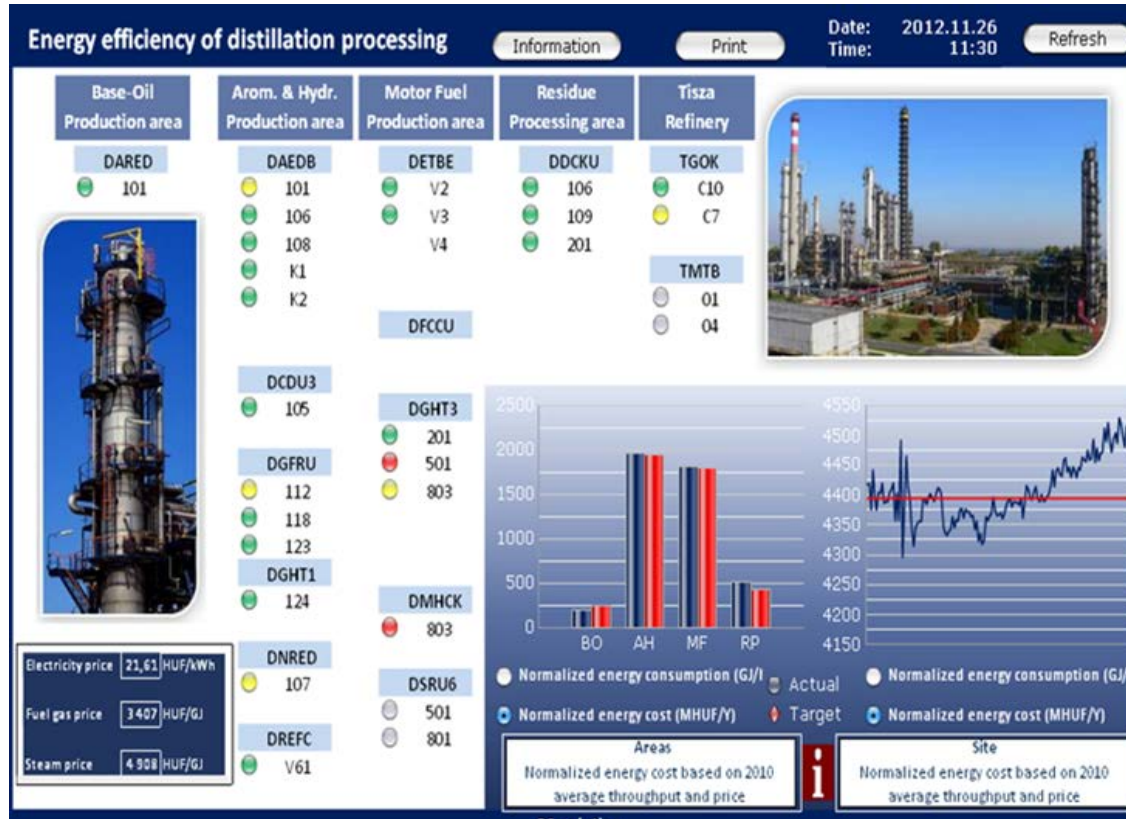
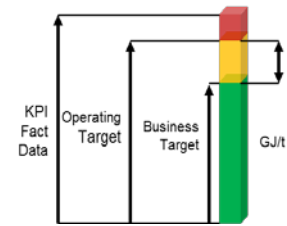
Holistic Inventory management and Optimization including MBDT*

* MBST = Make-Buy-Sell-Trade Decision support



Business Value Leveraging the PI System & PI AF

1- Energy Monitoring & Reporting



Benefits

Continuous monitoring of the parameters

Normalized, unified, and quality information leveraging PI AF

Easy maintenance and Governance of the PI AF templates

Structured format

Increased production as a result of improved energy and environmental constraint visibility and forecasting

Templates of the Energy KPI System

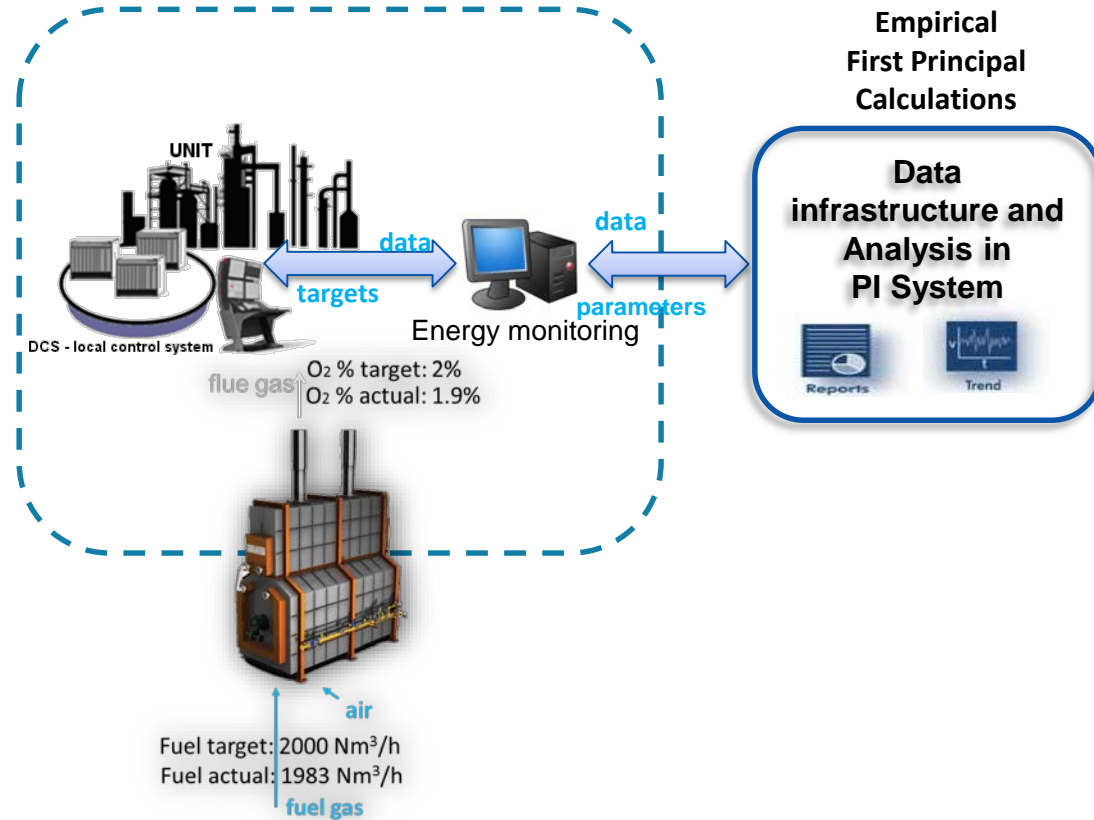
- The structure of the Energy KPI System is based on element templates
- The parent and child elements are linked to each other
- The templates include the basic energy calculation

The screenshot displays the Energy KPI System interface. On the left, a hierarchical tree shows the structure of the system, starting with 'Energy KPI System' and branching into various units and processes. The 'DAV2 Futoanyag Fogyasztas' element is highlighted. On the right, a table provides detailed data for this element, organized into categories: Auxiliary Calculations, Consumption Data, Data for Aggregation, Feed, and General Attributes.

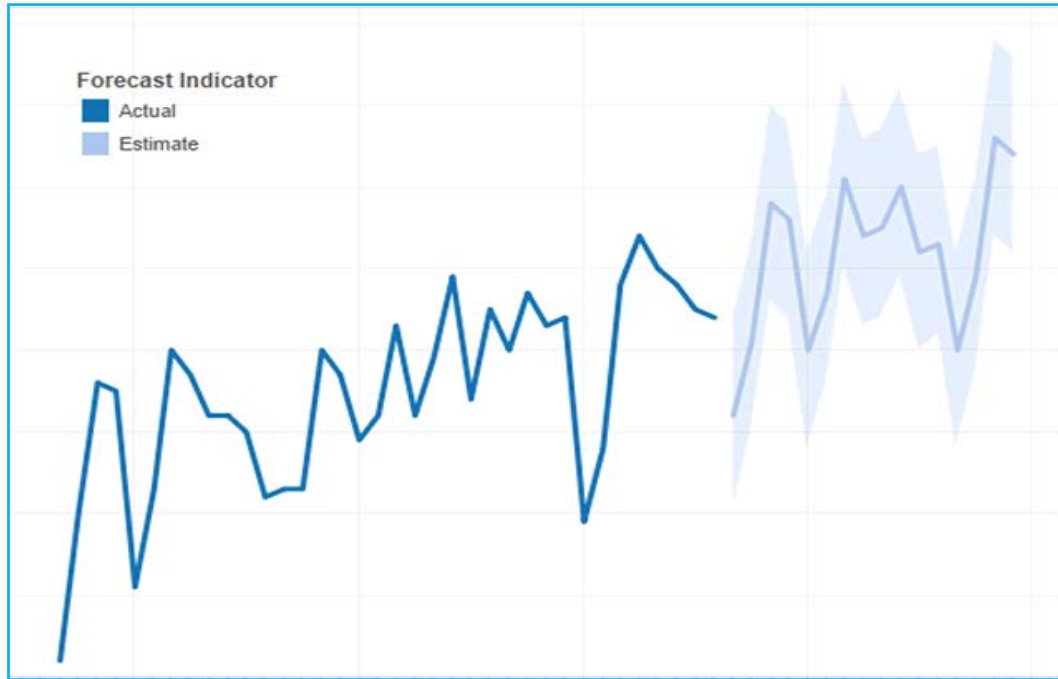
Name	Value
Category: Auxiliary Calculations	
Cumulated KPI Actual Value Evaluate	2
Cumulated KPI Actual Value Evaluate H Limit	0.1
Cumulated KPI Actual Value Evaluate HH Limit	0.2
KPI Engineering Units	GJ/t
Specific Divider Engineering Units	/t
Specific Divider Limit	0.1
Time Cumulated Engineering Units	GJ
Category: Consumption Data	
Energy Cons COR	249.04598999023438
Energy Cons RAW	240.35787963867188
Energy Cons Target BP	219.09304809570313
Energy Cons Target OT	240.04478454589844
Energy Cons Target RP	229.64166259765625
Category: Data for Aggregation	
AGG Coefficient	1
AGG Energy Cons COR	249.045989990234 GJ/h
AGG Energy Cons RAW	240.357879638672 GJ/h
AGG Energy Cons Target OT	240.044784545898 GJ/h
Category: Feed	
Unit Feed BP	324.341033935547 t/h
Unit Feed COR	349.790649414063 t/h
Unit Feed RAW	350.962982177734 t/h
Unit Feed RP	337.708343505859 t/h
Category: General Attributes	
Block ID	DOESTB
Block Name	Desztillácó
Element Name	DAV2 Futoanyag Fogyasztas
Energy Type	FUEL
Unit ID	DAV2
Unit Name	Atm. és Vákuumdeszt. 2.
Usage Type	CONS

#2 Energy Monitoring & Management System (EMMS)

- On-line, open loop, model based (PI AF Based) EMMS system
- Calculates targets for assets, unit, and plant
- Detects excess energy consumption, and advises corrective interventions to the operators.
- The EMMS system helps to evaluate the operation of the units.



Energy Demand Forecasting with Future Data



Improve energy trading by

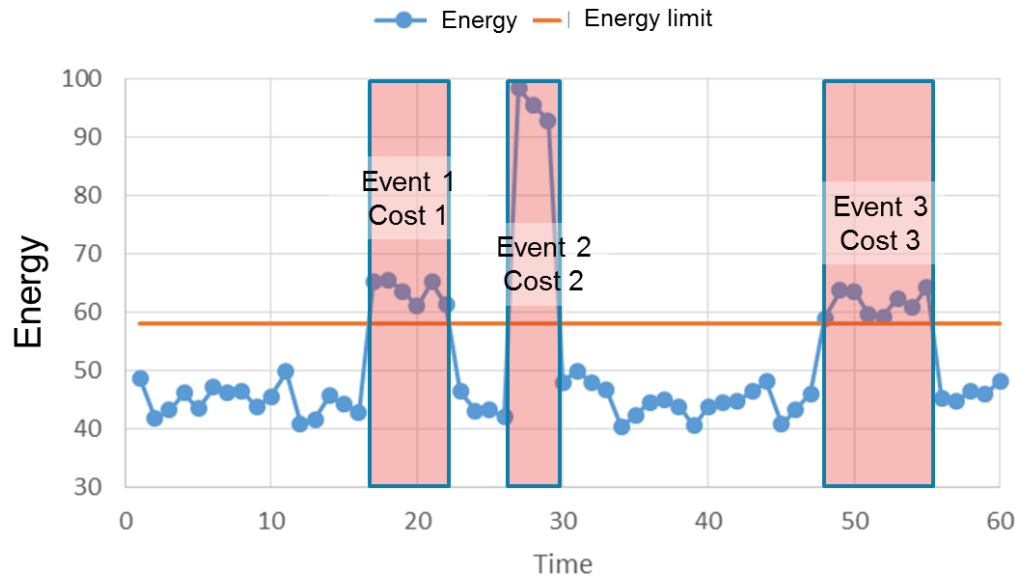
Collect real-time data

Train energy consumption models

Predict energy consumption based on production plan

Monitor and update models

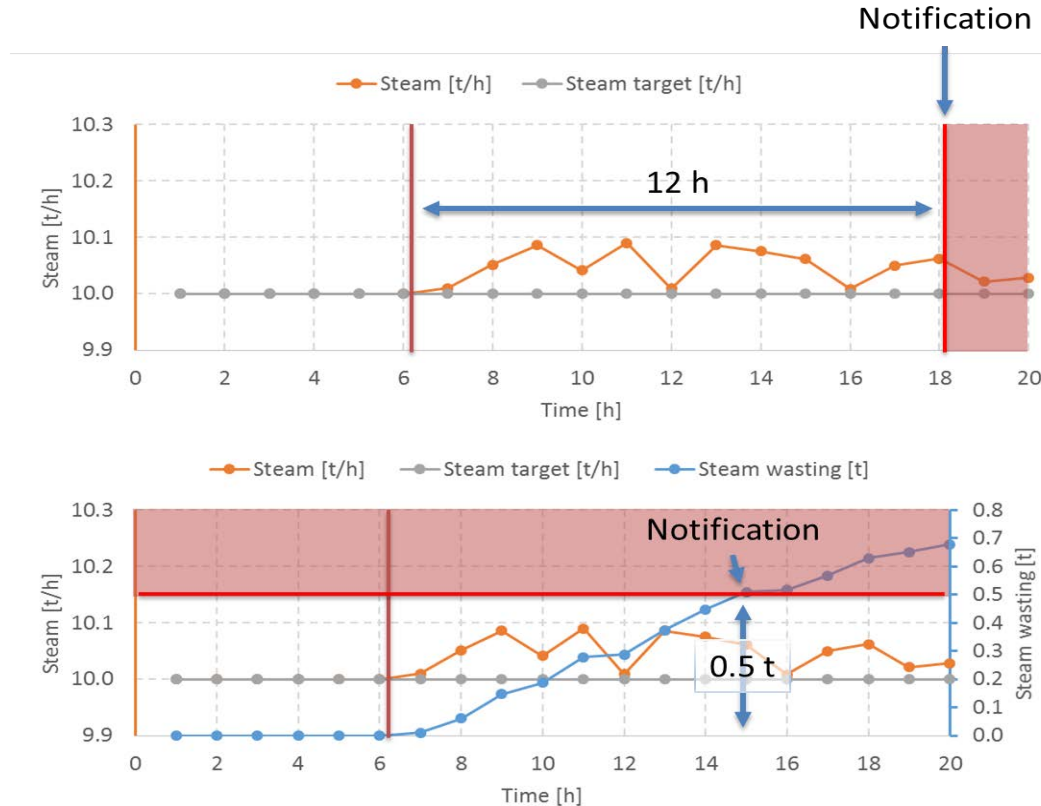
PI Event Frames - Over consumption events



Library	
Assets	
Templates	
Element Templates	
Event Frame Templates	
BazsolajBatch	
BazsolajBatchTartaly	
BazsolajBatchTartalyISOPeb	
BazsolajBatchTartalyKODForm	
BazsolajBatchTartalyModFin	
BazsolajBatchTartalyOkfAag	
BazsolajBatchTartalyOkfAagFin	
BazsolajBatchTartalyOkfRaf	
BazsolajBatchTartalyPomAag	
BazsolajBatchUzem	
BazsolajBatchUzemOKOH	
BazsolajBatchUzemOKOH1	
BazsolajBatchUzemOKOH2	
BazsolajBatchUzemOKOP	
BazsolajBatchUzemOKOPAM	
Coke Drum change	
Coke drum preheating	
Energy KPI System Deviation (Tier6)	
Kamraciklus	
Operating mode	
Operation	
Phase	
PhaseStep	
Procedure	
shift	
Tank Overheat	
TechnologyDataSheet Exceedence	
Template66	
UnitProcedure	
Model Templates	
Notification Templates	
Transfer Templates	
Enumeration Sets	
Reference Types	
Tables	
Table Connections	
Categories	
Analysis Categories	

Energy KPI System Deviation (Tier6)	
General	Attribute Templates
Filter	
1. Name	Description
Category: General Attributes	
Asset ID	Készletk azonosító
Asset Name	Készletk neve
Asset Type	Készletk típusa
Block ID	Üzemcsoport azonosítója
Block Name	Üzemcsoport neve
Energy Type	Energia típus
KOI ID	
KOI Name	
Unit ID	Üzem azonosítója
Unit Name	Üzem neve
Usage Type	Felhasználás fajta
Utility Type	Segídeenergia típus
Category: Operational Parameter	
Energy relevant	Energia szükséglet
Limitation	Figyelembe vett határérték
Category: Time Aggregated Data	
Deviation Increment Total	KOI által okozott TS szintű eltérés (dőben integrálva)
KOI Cost Increment	KOI eltérés költséghez való hozzájárulása
KOI Cost Increment Ratio	KOI eltérés költséghez való hozzájárulása
TS Deviation Cost Total	TS Utlérés költsége (dőben integrálva)
TS Deviation Total	TS Utlérés (dőben integrálva)

PI Notifications - EMMS Notifications triggers



Types of Notification:

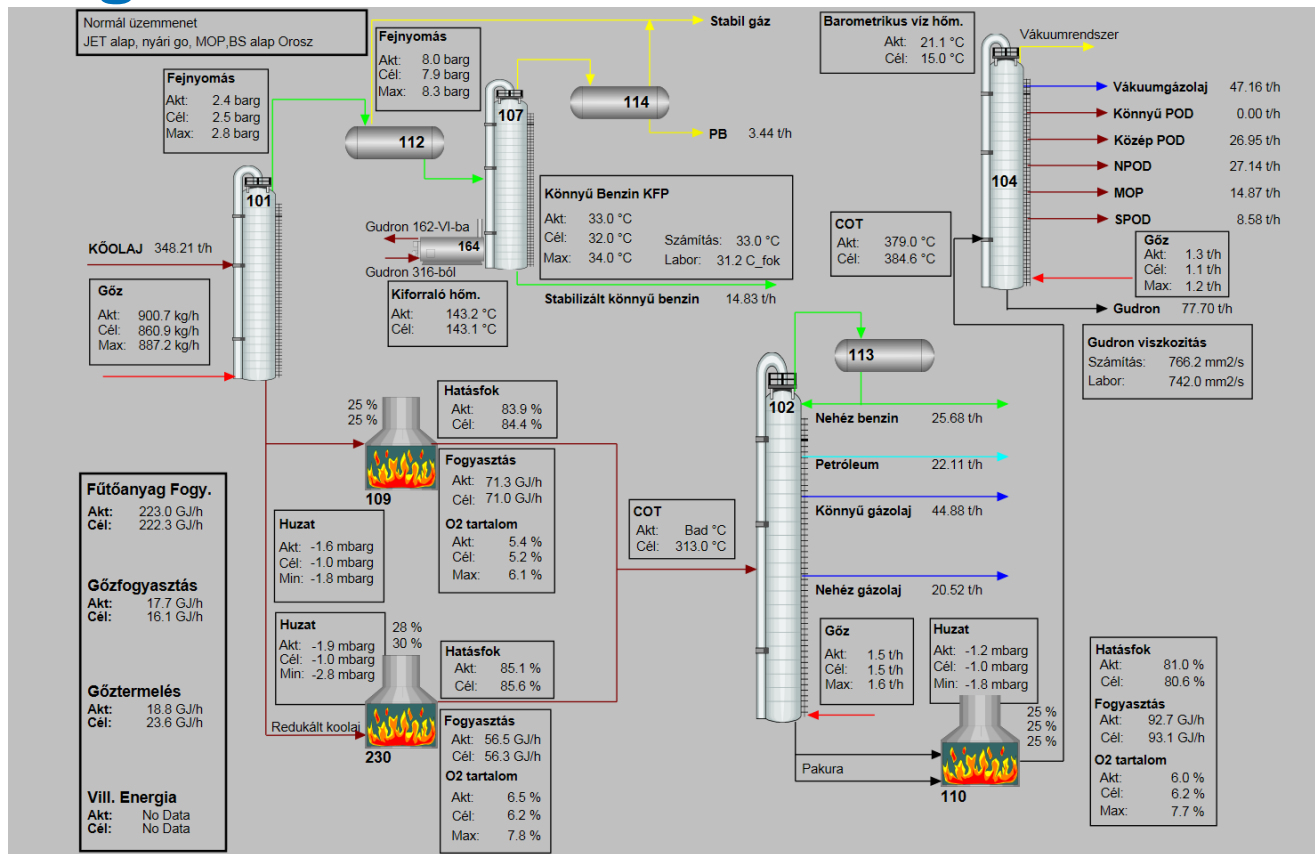
1. Period time of the event
2. Cost of the event

PI Coresight screens based on AF template

- PI ProcessBook (PI PB) graphics linked to AF templates
- The AF structure was converted easily into PI PB display
- The display is published in PI Coresight

		Kiegyenlített értékek			Nyers értékek		
DAV1 Uzem			Üzleti terv	Gördülő terv	Tényleg	EMR cél	Tényleg
	Betöltődés	t	2753.91	2733.33	2742.03		2752.03
	Energia	GJ/t	0.96	0.96	0.93	0.90	0.99
DAV1 Elektromos Fogyasztás		kWh/t	8.80	8.80	8.92	9.10	8.90
DAV1 Fűtőanyag Fogyasztás		GJ/t	0.81	0.81	0.86	0.78	0.83
DAV1 Gáz Fogyasztás		GJ/t	0.13	0.13	0.13	0.12	0.13
DAV1 Gáz Fűtési célú felhasználás		GJ/mo	1300.00	1300.00	2377.00	470.90	470.86
DAV1 Gáz Tényleg		GJ/t	0.06	0.06	0.06	0.06	0.06
		Kiegyenlített értékek			Nyers értékek		
DAV2 Uzem			Üzleti terv	Gördülő terv	Tényleg	EMR cél	Tényleg
	Betöltődés	t	7789.03	8106.00	8376.47		8423.64
	Energia	GJ/t	0.72	0.73	1.26	0.74	0.75
DAV2 Elektromos Fogyasztás		kWh/t	7.80	7.00	6.57	6.44	6.66
DAV2 Fűtőanyag Fogyasztás		GJ/t	0.68	0.68	0.70	0.68	0.68
DAV2 Gáz Fogyasztás		GJ/t	0.06	0.06	0.06	0.06	0.06
DAV2 Gáz Fűtési célú felhasználás		GJ/mo	1400.00	1400.00	3913.46	1673.39	1673.76
DAV2 Gáz Tényleg		GJ/t	0.06	0.07	0.06	0.06	0.06
		Kiegyenlített értékek			Nyers értékek		
DAV3 Uzem			Üzleti terv	Gördülő terv	Tényleg	EMR cél	Tényleg
	Betöltődés	t	9973.75	10480.83	10020.62		9940.81
	Energia	GJ/t	0.68	0.68	0.67	0.69	0.65
DAV3 Elektromos Fogyasztás		kWh/t	8.00	8.00	6.71	7.66	6.68
DAV3 Fűtőanyag Fogyasztás		GJ/t	0.68	0.68	0.68	0.72	0.67
DAV3 Gáz Fogyasztás		GJ/t	0.07	0.07	0.06	0.07	0.06
DAV3 Gáz Fűtési célú felhasználás		GJ/mo	2300.00	2300.00	2476.93	2736.63	2737.84
DAV3 Gáz Tényleg		GJ/t	0.15	0.15	0.13	0.17	0.14

PI Coresight screens



3 – Energy Intensity Index (EII) and Solomon Index

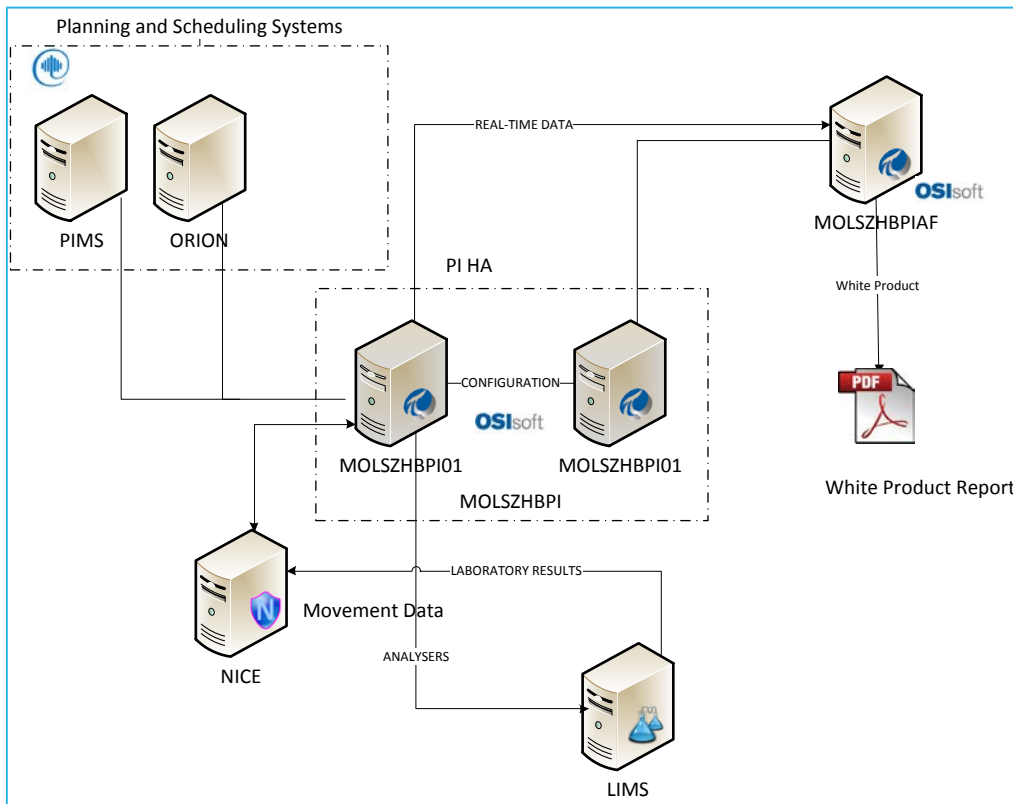
The screenshot displays the PI System Explorer application. The left sidebar shows a tree view of elements, with 'DAV1 Uzem' selected under 'Solomon Szamitasok'. The main window shows the 'Attributes' tab for 'DAV1 Uzem'. The table lists various attributes categorized into 'Consumption Data' and 'General Attributes'.

Name	Value	Description	Configuration Item	Unit of Measure
Category: Consumption Data				
Standard sum energy	Pt Created	Összes energia standard	False	<None>
Calculation Formula	Analysis Calc	Képlet	False	<None>
Description	DAV1 EII Standard összes energia	Leírás	False	<None>
Engineering Units	GJ/d	Mértékegység	False	<None>
PI Tag	DAV1_EII_STANDARD_UNIT_ENERGY_CONS	PI Tag	False	<None>
Category: General Attributes				
Atm.Res.Dens	907		True	<None>
Operating Mode	27		True	<None>
Unit ID	DAV1	Üzem azonosítója	True	<None>

New PI AF structure & workflow to calculate key SOLOMON indicators:

- Energy Intensity Index (EII)
- Utilized Equivalent Distillation Capacity (UEDC)
- Complexity-Weighted Barrel

4 – White Product (Yield) Analytics & Reporting



Report content

Future data from Business Plan

Future Scheduling data

Calculated movement data from PI AF
Analyses Rules

Forecast data used in PvA analytics

Integrated \$/loss from deviation from
PvA summed over periods of time

5 - Improving Asset Integrity with Advanced Corrosion Analytics

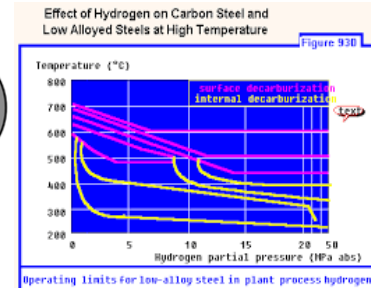
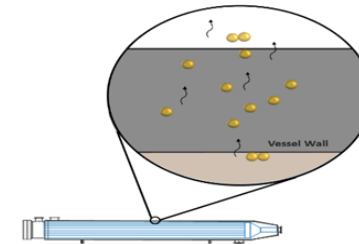
The screenshot shows the PI System Explorer interface. The main table displays the following data:

Category	Name	Value
Current	Current	214.10000610351563
Desc	Desc	Ide kell a hosszú leírás.
Gasolin flow	Gasolin flow	82.83045
Density	Density	801.9
Gasolin molar flow kmol/h	Gasolin molar flow kmol/h	0.28879018023142428
Molar weight g/mol	Molar weight g/mol	230
H2 flow	H2 flow	11238.164436340332
H2 molar flow kmol/h	H2 molar flow kmol/h	1348.57973236084
HTHA limit F	HTHA limit F	605.81629193204753
Kivencia H2	Kivencia H2	86.3660355
Make up H2	Make up H2	254.211136
Molar weight g/mol	Molar weight g/mol	1
Partial pressure	Partial pressure	20.002323679218641
Partial pressure psi	Partial pressure psi	290.03369334867028
Pressure	Pressure	19.0066071
Rec H2	Rec H2	11070.3193
Suruseg kg/Nm3	Suruseg kg/Nm3	0.12
H2 Limit	H2 Limit	270
HTHA	HTHA	318.7868288511375
Is operating	Is operating	1
LO Limit	LO Limit	-1000000000
Name	Name	DBK5RTI2017.DACA.PV
Naplo_AZON	Naplo_AZON	BK5_TK
Type	Type	
Yesterday Out of limit time	Yesterday Out of limit time	0 h

- High Temperature Hydrogen Attack (HTHA)
- f^x (metallurgy, temperature, hydrogen partial pressure(PP), length of exposure)

Developed PI AF template that:

- Determine partial pressure
 - Attribute of pipe class
 - Temperature and length of exposure limits
 - Total time above Temp and PP
 - Alerts/notification/event frame
- Tested and rolled out in 6 units < 1 week
 - Expanding to all plants in 2015.



#6 - Natural Gas Consumption Predictive Analytics



BackGround

- Huge saving possibilities in the decrease of contracted natural gas daily maximum amount across the 6 production units in multiple countries.
- High penalty on daily amount exceedance
- Alerting system was needed

Approach

- Built PI AF demand forecasting model (first principle)
- PI AF was used aggregate, normalize, and perform data validation
- Used to project NG demand across multiple time horizons
- Developed analysis rules with notifications

Solution

- Demand prediction calculations in PI Analysis
- Alerts based on demand vs contracted peak to enable proactive action
- Detailed information on PI Coresight display (about consumption, prediction, contacts of decision makers)
- E-mail alerting system in Notifications

The screenshot shows the PI Coresight interface. On the left is a tree view of elements, including APC, ARGUS, Control loops DR, Danube Refinery, Energy Consumption Predictions, MOLHU NatGas Cons, Energy KPI System, EzittEgyTeszt, Flare Monitoring, IOW, Siofok, System, Tanks, Technology DataSheet, Tisza Refinery, Zala Refinery, and Element Search 1. On the right is a table with tabs for General, Child Elements, Attributes, Ports, Analyses, and Version. The table displays analysis results for various categories.

Category	Name	Value
<None>	CoreSight Link	http://molzhbpicore/Coresight/#/PBD...
Auxiliary Calculations		
Consumption Calculations		
	Cumulated Daily Consumption	18723164 MJ
	Current Consumption	1991855,5 MJ/h
	Predicted Daily Consumption	49276016 MJ
Exceedance Calculations		
	Alert State	4
	HI Limit Exceedance	0 MJ
Limits		
	HI Alert	59500000 MJ
	HHI Alert	61000000 MJ
	LO Alert	0 MJ
	LOLO Alert	0 MJ

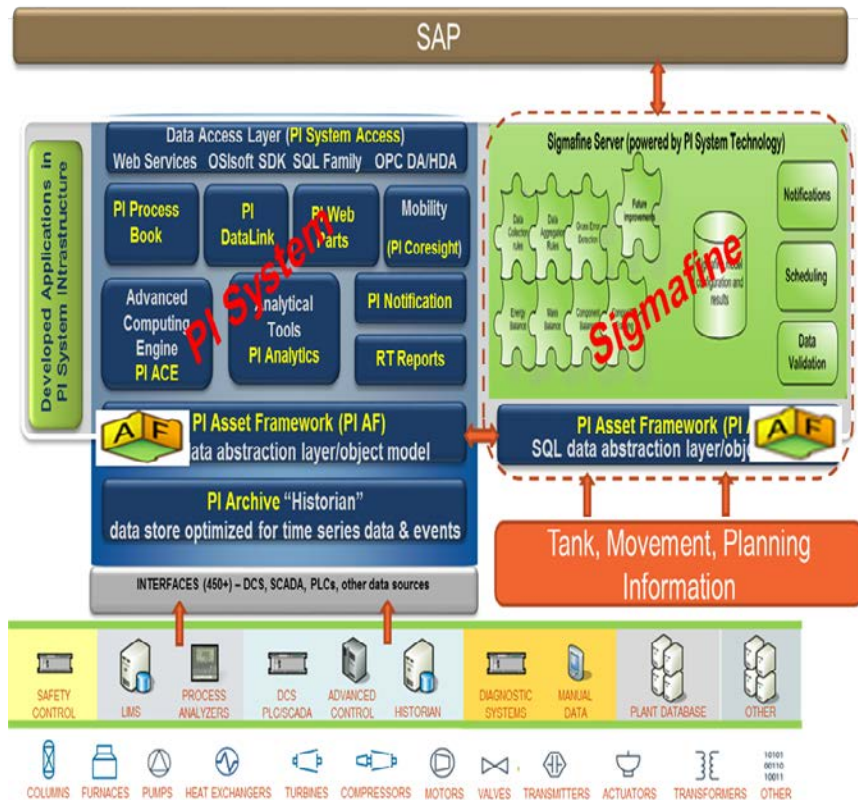
The screenshot shows the PI Coresight interface with a table of analysis rules. The table has columns for Name, Configuration, Schedule, Output(s), and Backfilling. Below the table is a section for expressions.

Name	Configuration	Schedule	Output(s)	Backfilling
fe0 Auxiliary Calculations	RemainingDayRatio := In...	Frequency=120...	RemainingDayPart; RefD...	
fe0 CumulatedDailyConsumption	CumulatedDailyConsump...	Frequency=120...	Cumulated Daily Consum...	✓
fe0 CurrentConsumption	CurrentConsumption := T...	Frequency=120...	Current Consumption	✓
fe0 PredictedDailyConsumption	SecondsToNextGasDayTu...	Frequency=120...	Predicted Daily Consump...	✓

Name	Expression
SecondsToNextGasDayTurn	<code>Int(Bod('*'-6h')+'*+30h'-'**')</code>
PredictedDailyConsumption	<code>*Cumulated Daily Consumption'+*Current Consumption'*SecondsToNextGasDayTurn/3600</code>

[Add a new expression](#)

7- Yield and Production Accounting



Benefits

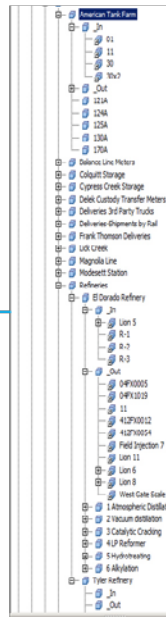
Deep integration at the PI AF Level

Integrated approach to meter and data accuracy – PI AF and Sigamfine

Enables a hierarchical material balance approach

Brings in movement capabilities into the "PI/Sigamfine" system

Improved data quality, yield accounting, & operational performance





Business Intelligence Solutions in PI AF Quality and Energy Management Applications in MOL production

Presented by László SZABÓ



EMEA USERS' CONFERENCE, 2015

l.szabo@mol.hu

deteriorating process control

wide specification range

narrowing specification range

dilating specification range

— LCL — UCL — Process



Methodology

PI SQC provides an excellent capability to highlight issues

Using dynamic limits increased the robustness and value

Used on 14 units and 41 critical quality specifications – expanding

PI AF & PI Analytics used extensively
parameter including write back

Quality parameters & associated information are displayed in Coresight

9 – eFlare – Flaring Management System

Increasing Efficiency and Process Safety with PI Notifications in MOL

Presented by Tibor Komárczki

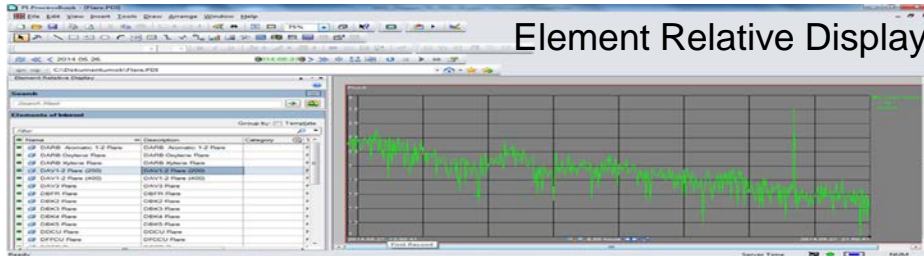
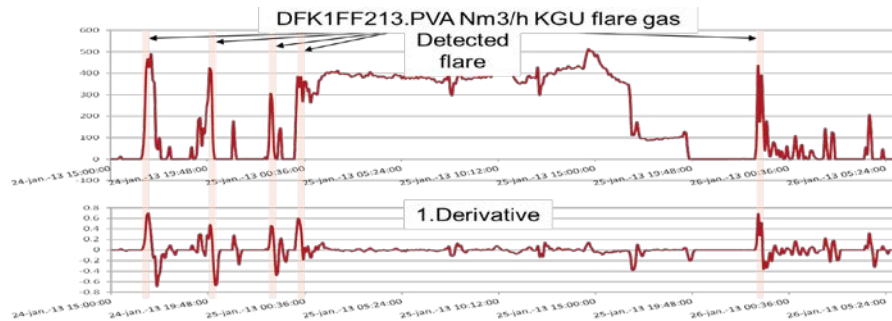
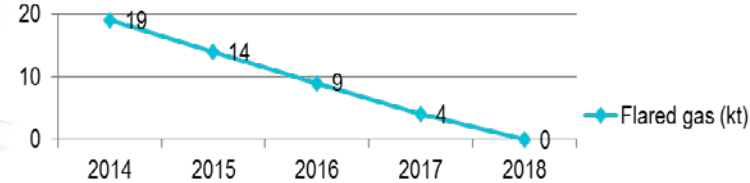


EMA USERS CONFERENCE 2014

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22 kt baseline in 2013

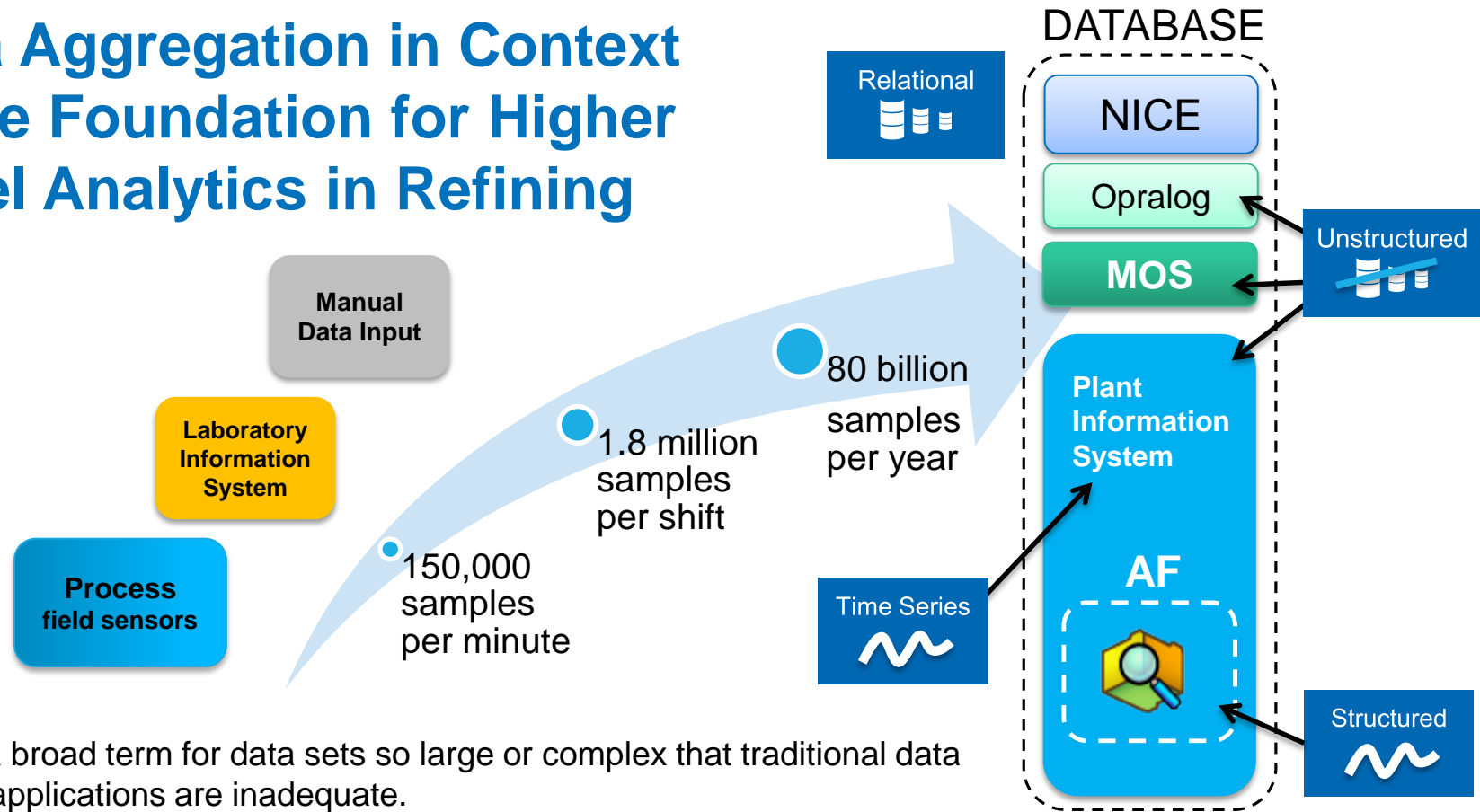
MOL roadmap for Danube Refinery



- Goal is to reduce the amount of flaring from improved data and information
- Critical to be able to take a “systems approach” to understand sources and root causes of flaring
- “what gets measured gets managed”
- PI AF/EF based
- Calculations, analytics, and events are integral to the system
- Integrated with workflow
- Displays information in context to stakeholders

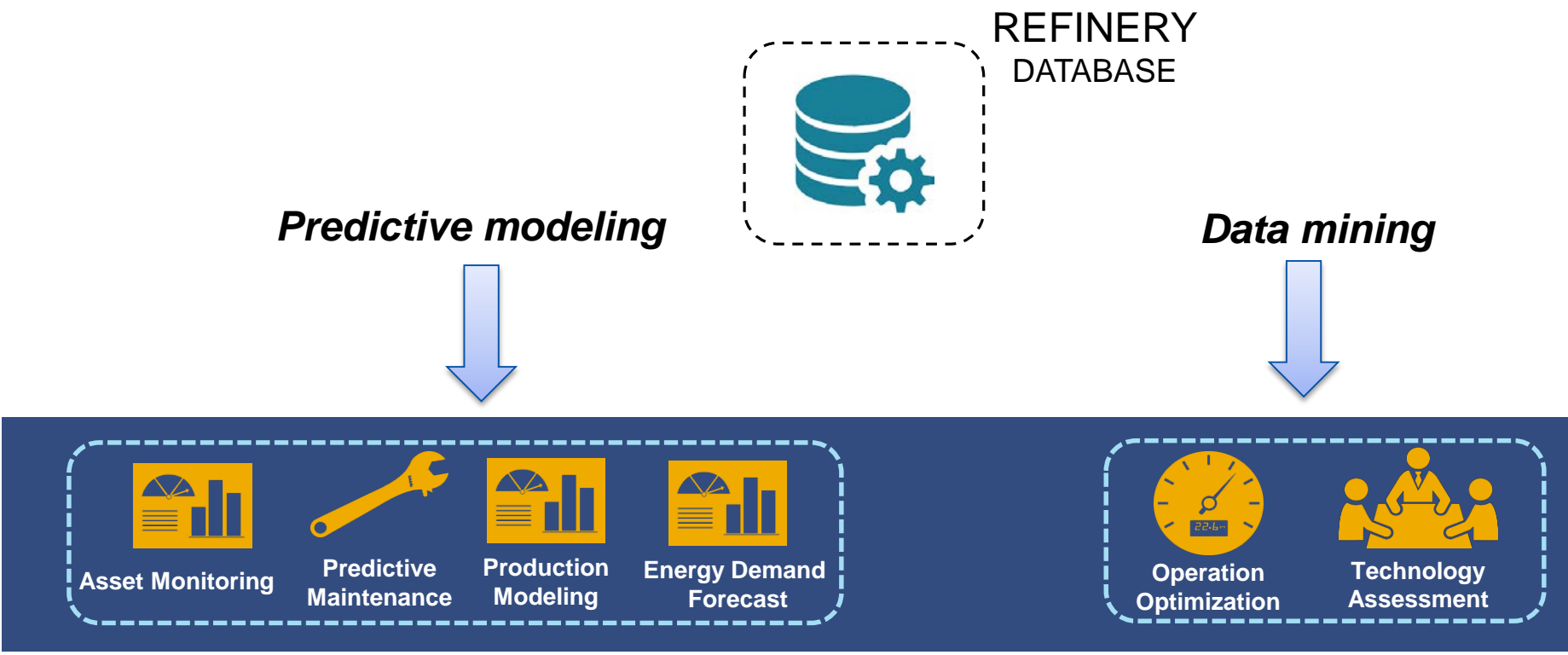


PI AF and Real-Time Data Aggregation in Context is the Foundation for Higher Level Analytics in Refining



Big data is a broad term for data sets so large or complex that traditional data processing applications are inadequate.

Advanced Analytic Possibilities



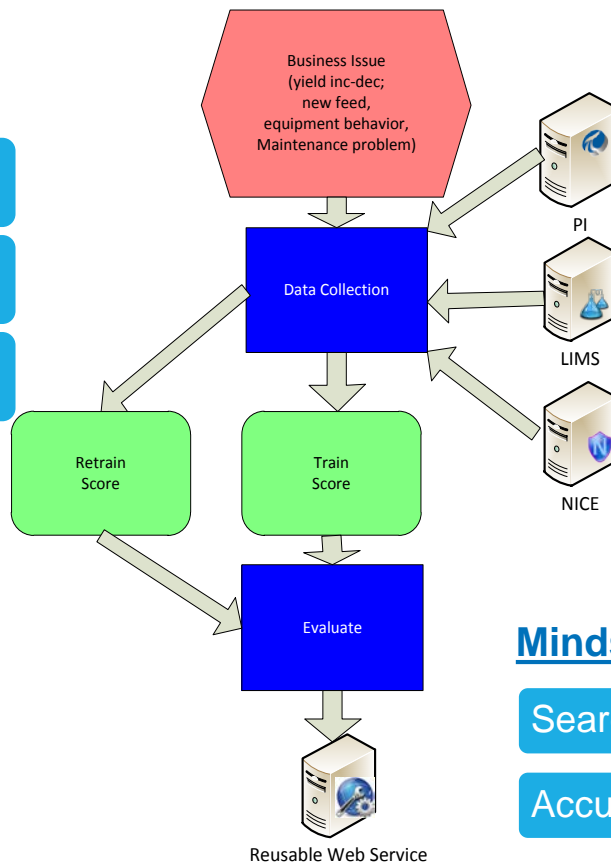
Azure Machine Learning

Business impact

Increase efficiency

Identifying development opportunities

Specific development proposal



Better understanding operation & processes

Identifying efficiency gains /losses reduction opportunities

Understanding operation optimum

Mindset changes

Searching possibilities

Accurate business reasons



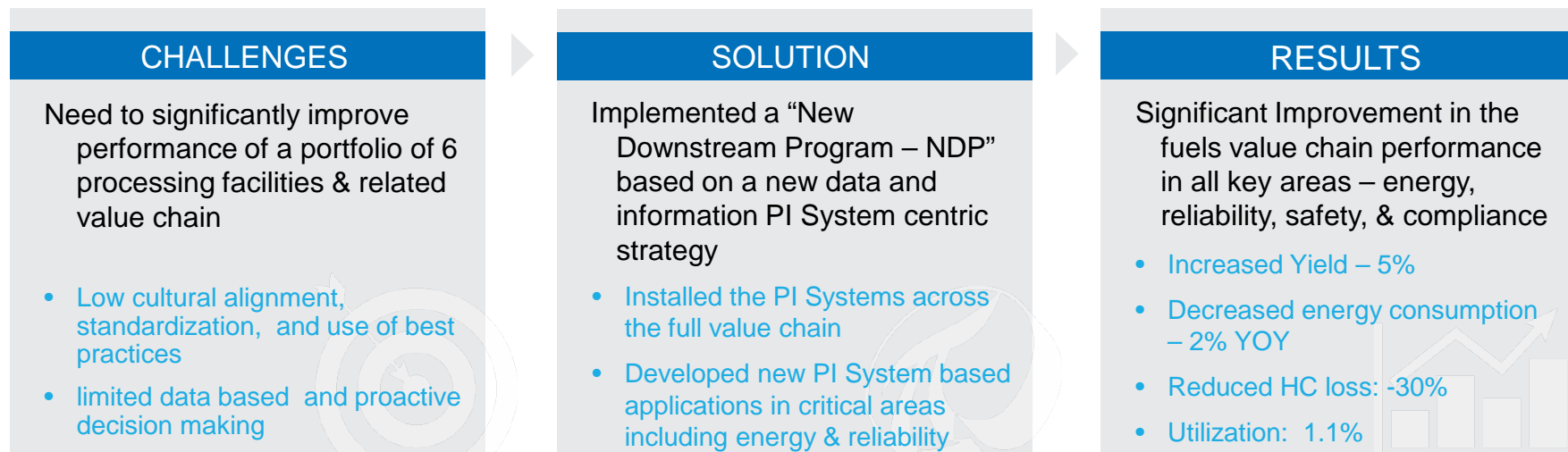
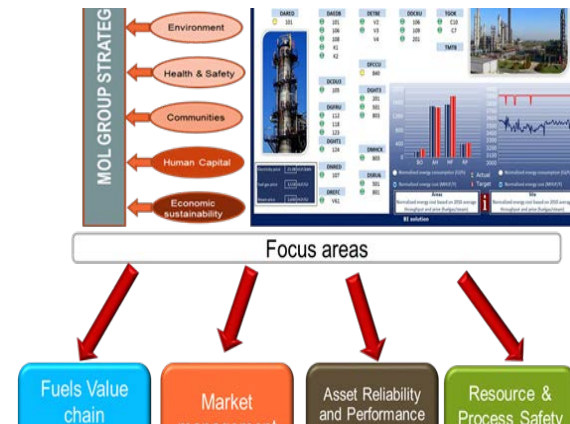
Conclusion

\$500M-550M EBITDA improvement

MOL (Global Integrated O&G Company – Hungary)

*"Installing the **PI System infrastructure across our fuels value chain** was fundamental to our New Downstream Program and the **significant performance and sustainability improvement** we have seen."*

Tibor Komróczki Head of Process Information & Automation





감사합니다

谢谢

Danke

Merci

Gracias

Thank You

ありがとう

Спасибо

Obrigado

Köszönöm!

Děkuji

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