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BERLIN, GERMANY • SEPT 26-29, 2016



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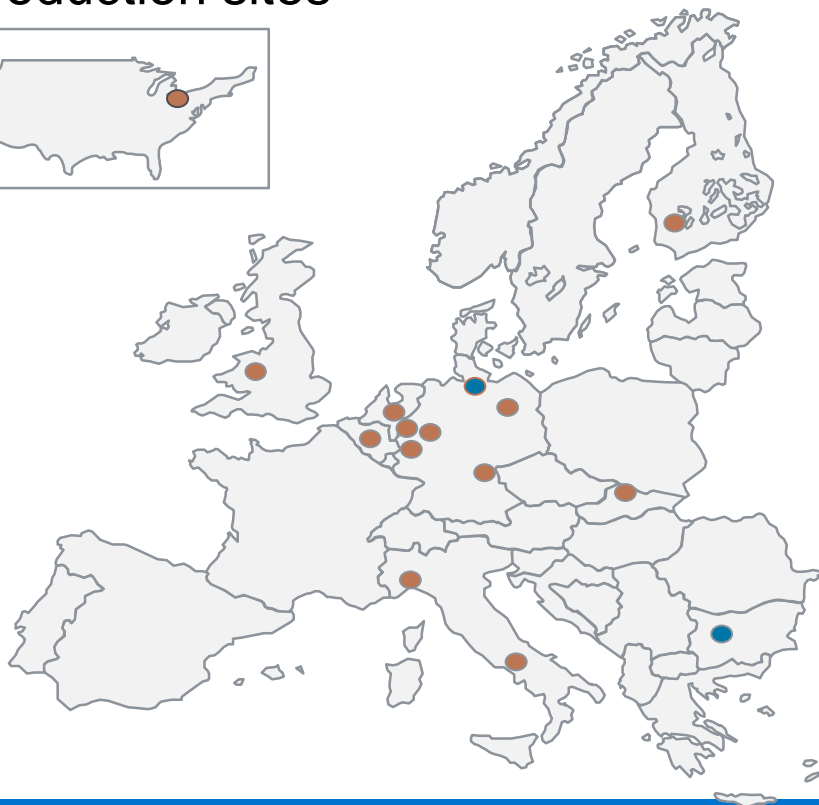
How the PI System Can Support an Energy Management System in a Copper Company

Presented by **Thorsten Stölcken**
Philipp Kohne



- » About Aurubis AG
- » Energy Management Systems (EnMS) and how they are made
- » Measurement monitoring using PI AF
- » Visualization
- » Conclusion

Production sites



BU Primary Copper:

- » Hamburg DE
- » Pirdop BG

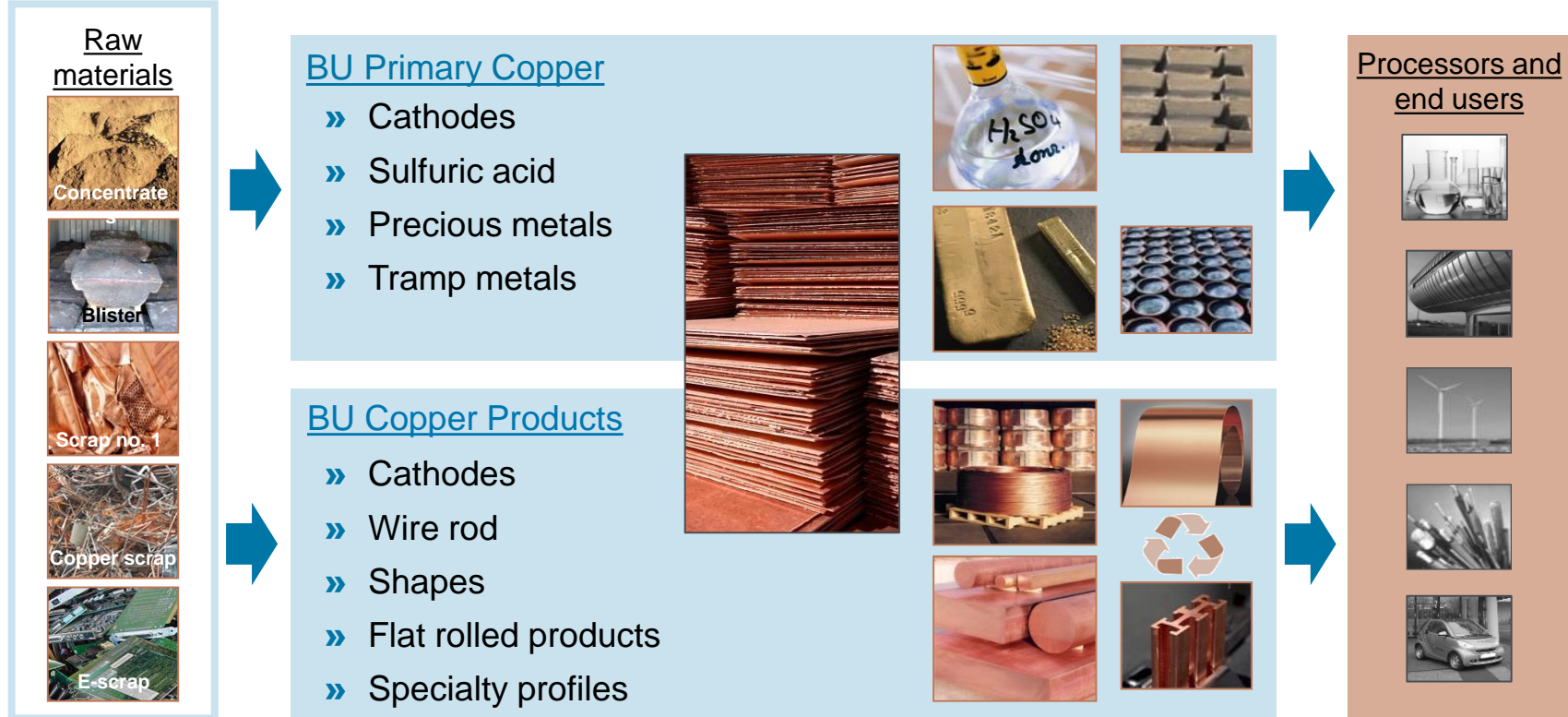
BU Copper Products:

- | | | | |
|---------------|----|--------------|----|
| » Avellino | IT | » Mortara | IT |
| » Buffalo | US | » Olen | BE |
| » Dolný Kubín | SK | » Pori | FI |
| » Emmerich | DE | » Röthenbach | DE |
| » Fehrbellin | DE | » Smethwick | GB |
| » Hamburg | DE | » Stolberg | DE |
| » Lünen | DE | » Zutphen | NL |

- » Aurubis has a service and sales network in more than 20 countries (Europe, Asia and North America)

Aurubis' strengths include productivity, efficiency, environmental protection and processing expertise

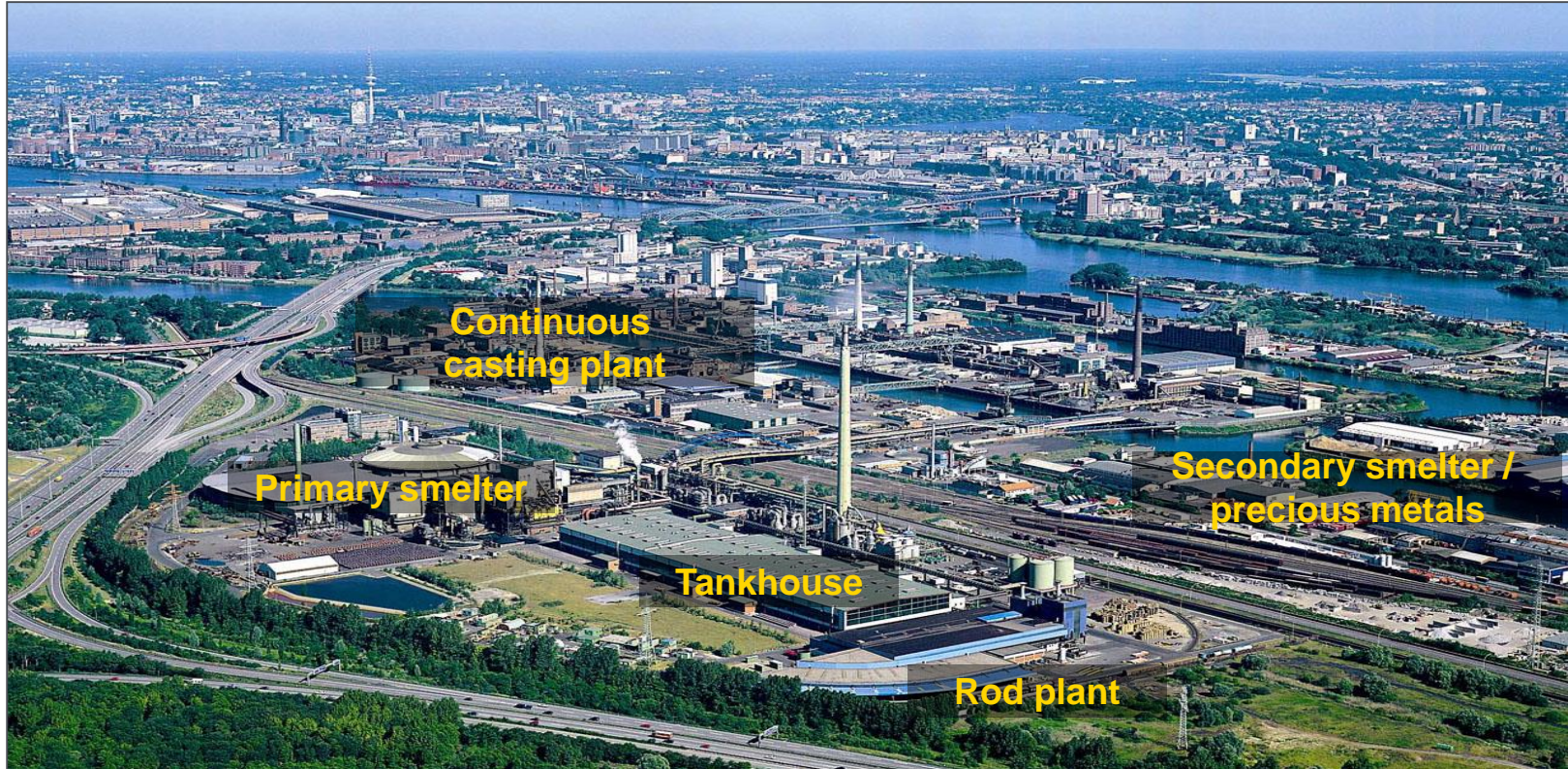
Aurubis: an integrated copper producer



Processed Cu concentrate:	2.3 million t/a
Processed Cu scrap:	0.7 million t/a
Cathode output:	1.1 million t/a
Rod output:	0.7 million t/a
Shape output:	0.2 million t/a
Employees:	6,300 total 2,300 in Hamburg

- » About Aurubis AG
- » Energy Management Systems (EnMS) and how they are made
- » Measurement monitoring using PI AF
- » Visualization
- » Conclusion

Aurubis' main production plant in Hamburg – a downtown copper smelter



- » Electricity: 650,000 MWh/a – 90 MW peak
- » Natural gas: 550,000 MWh/a – 115 MW peak
- » Steam: 400,000 t/a
- » Oxygen, compressed air, cooling water, coal, HFO ...

Energy costs:
More than € 50 million (\$ 55 million) per year

Why implement an Energy Management System (EnMS) in accordance with ISO 50001?

Energy is becoming an increasingly important issue for companies:

- » Energy costs are an important factor, especially additional costs are rising
- » Environmental protection is needed, sustainability in focus

An Energy Management System in accordance with ISO 50001 provides a systematic approach in detecting ways to increase energy efficiency and lower energy costs. The certificate documents this for the public and authorities.

The PI System is a very good tool to support this and, as such, is necessary to have.

It is not the Energy Management System.

And:

Only implemented energy efficiency projects or changes in behavior save energy!

Aspects considered for the development of an EnMS in accordance with ISO 50001, part 1

An EnMS is a management system that requires strong support from the management:

- » The company has to give an commitment to efficient energy usage and energy targets.
- » Sufficient employees and money have to be provided.
- » A responsible person has to be appointed who directly reports to the management.
- » All production units, the purchasing dept., the engineering dept., etc. have to be included.
- » Energy performance indicators have to be developed and checked.
- » Processes should be transparent and documented.
- » Energy optimization projects have to be implemented.
- » The system has to be certified by an external certifier such as TÜV, Norske Veritas ...

The PI System cannot help in these areas.

Aspects considered for the development of an EnMS in accordance with ISO 50001, part 2

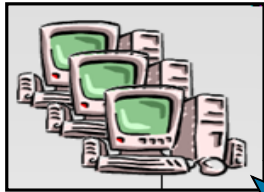
But here the PI System can help perfectly:

- » Energy flows should be transparent.
- » Energy flows have to be analyzed.
- » Possibilities for energy optimization have to be identified; implemented projects have to be monitored.
- » A data storage system has to be installed. All data has to be comprehensible; data validation is very important.
- » Incorrect measurements have to be detected and replaced.
- » Energy reports have to be issued regularly, as well as an annual management review.

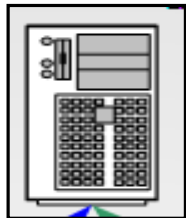


=> See how it is made =>

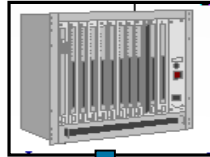
See all results on all desktop PCs



Energy report analyses



SAP



All measurements of more than 50 PLC connected via OPC (by using a buffer) to the PI Data Archive



All metering data stored in PI Data Archive; specific calculations in PI System tags and PI AF



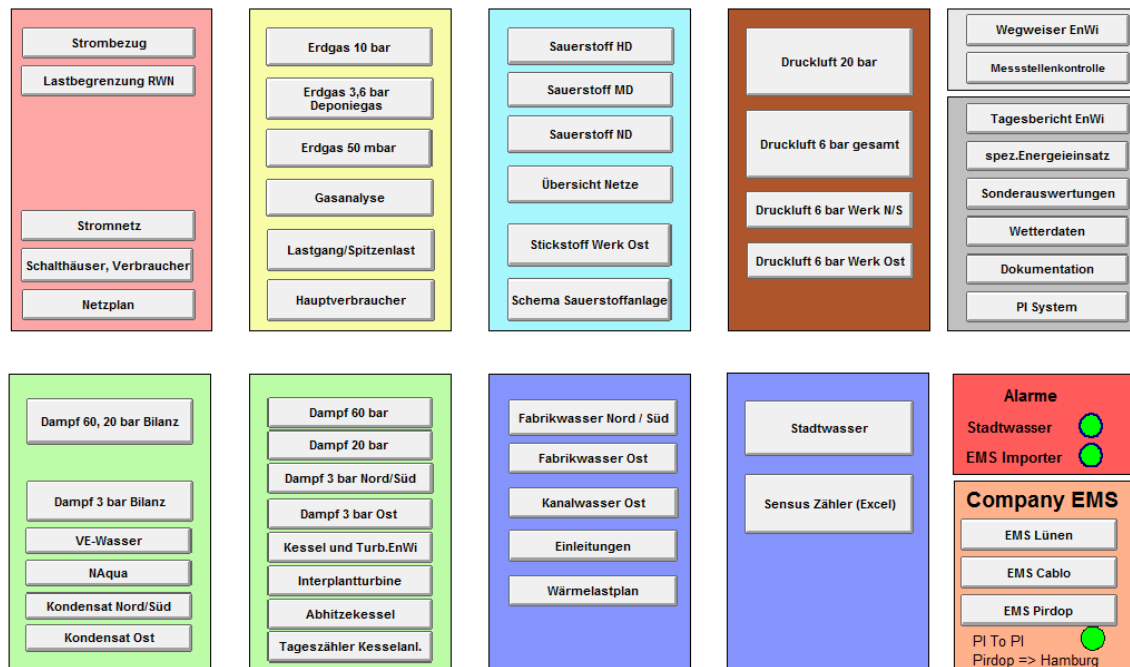
The EMS server is used for energy accounting, related to SAP cost accounting positions, and archives the results in an SQL database; SAP interface via XML

The system was built in cooperation with **Plantsoft**

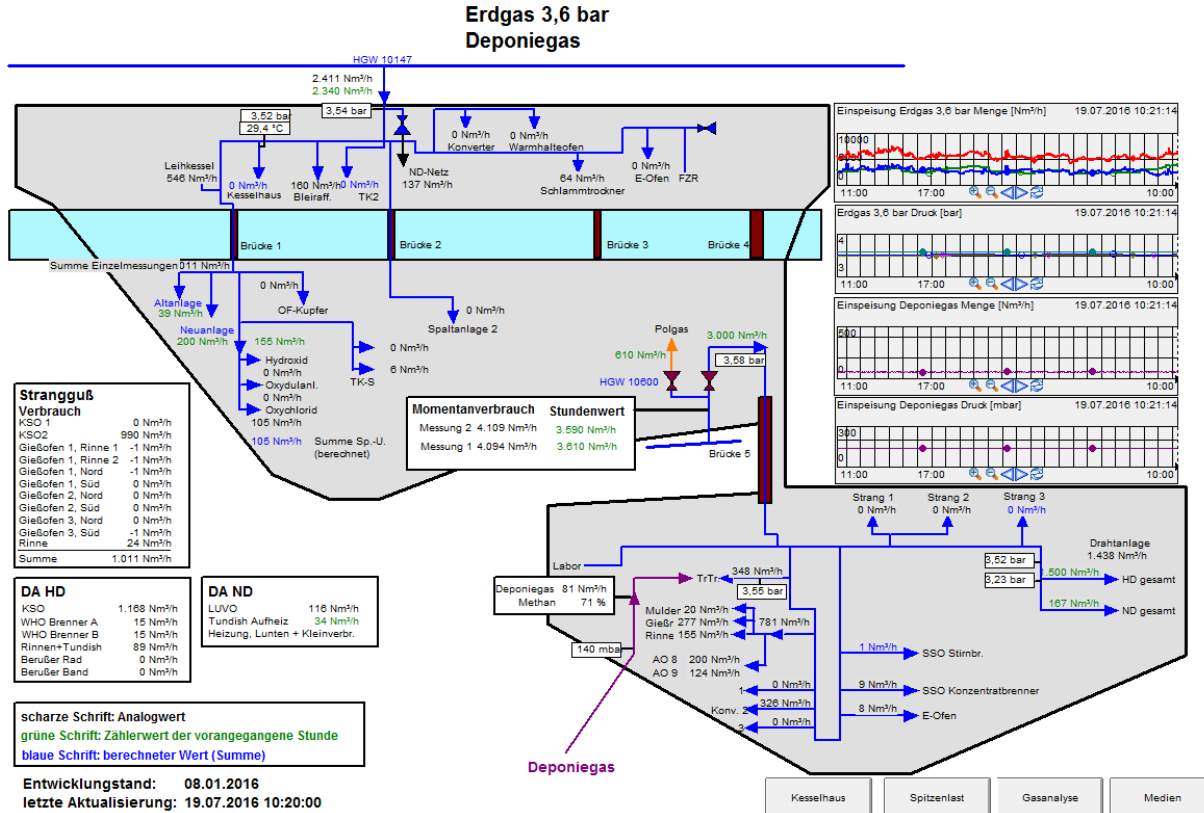
Startup screen of the monitoring system using PI ProcessBook

EMS Hamburg

Energiemanagement



Overview of our network; natural gas as an example



More detailed information below this overview by clicking the button

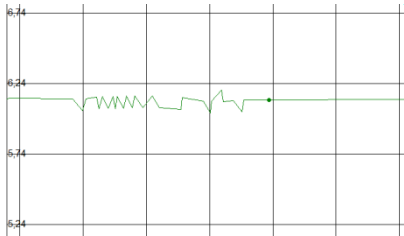
Costs: **€ 1 million**, mostly for metering devices;
 2 employees working for Energy Management

Benefits:

- » Energy balances
- » Monthly energy calculation to costs centers
- » Optimized operation mode
- » Energy efficiency projects and controlling
- » Forecasts for energy
- » Delivery of all data and reports to the board, authorities ...
- » Direct savings: **€ 0.5 – € 1 million/a**
- » Savings as a result of saving projects: **€ 0.5 million/a**
- » According to German law, you have to pay less tax if you run a 50001 system:
some xx € million/a

- » About Aurubis AG
- » Energy Management Systems (EnMS) and how they are made
- » **Measurement monitoring using PI AF**
- » Visualization
- » Conclusion

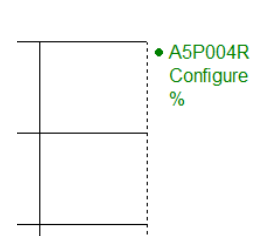
- » Data of energy measurements in the PI System is the basic data for
 - Energy KPIs
 - Energy optimization projects and controlling
 - Basis for cost center calculation
- » Reliable data is a core demand of the certification (50001)



Same value



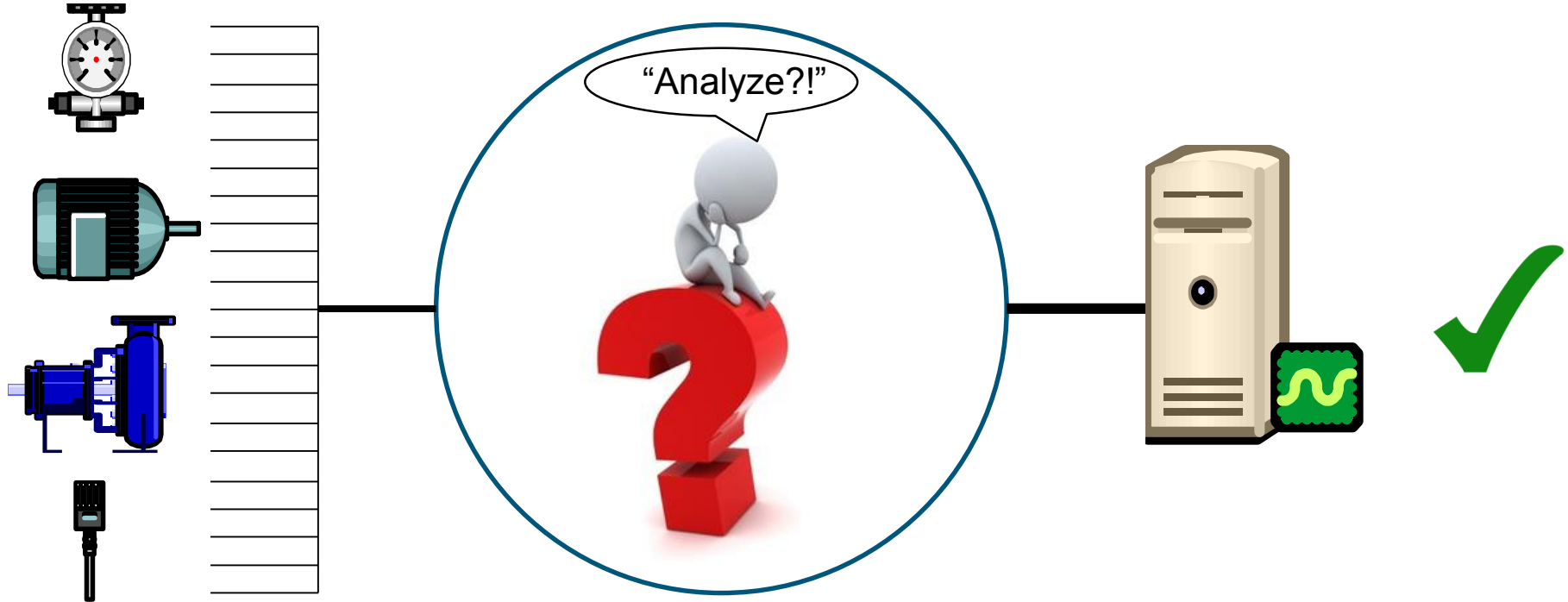
Peak value



Configure, no data ...

Challenge:

How to monitor more than 3,000 measurements?



- » Provide an overview of all available measuring devices.
 - previously: check all PI ProcessBook Display Files you work with
 - e.g. flow, pressure or temperature measurements
- » Link and compare statistical data from other data sources to create a detailed analysis
- » Create a structure to analyze all measurements
 - Get an automatic system

- » Implement analyses that are working in the background
 - Use generally applicable algorithms
- » Systematically detect sensor failure
- » Store the results
- » User-friendly interface
 - The client should be able to find and analyze measurement failures easily

The use of PI Asset Framework (PI AF)

→ Structure of assets in elements

Database Query Date Back Check In Refresh New Element New Attribute

Elements

- Elements
 - Auswertung_EnWi
 - Druck
 - Durchflussmesser
 - Annubarsonde
 - Blende
 - Coriols
 - ESF506R
 - F4F128A
 - F4F228A
 - F8F154A
 - Drehkolbenzähler
 - A7F128Z_CTP
 - D7F023Z11
 - D7F024Z11
 - Elektromagnetisch
 - Flügelradzähler
 - A1F201Z11
 - A1F201Z12
 - A6F108
 - A6F111A
 - B2F403FI_OUT
 - D6F003Z12
 - D6F003Z14
 - F1F229Z11
 - F1F229Z12
 - F1F230Z1
 - G7F111A
 - H2F360Z1
 - Magnetisch-induktiv
 - No Data
 - NULL
 - Schwebekörper
 - Segmentblende
 - Thermisch
 - Turbinenrad
 - Ultraschall-Laufzeit
 - FSF951A**
 - FSF952A
 - Vortex

FSF951A

General Child Elements Attributes Ports Analyses Version

Filter

Name	Value	Description
Category: Ausgabewerte		
Category: Description		
Description	Kanalwassereinsp.RWO	
Größe	Clamp on	
Kostenstelle	0	
Medium	Kanalwasser	
MediumID	14	
Messbereich	0-2000m³	
Messgenauigkeit	0,02	
Messprinzip	Ultraschall-Laufzeit	
MessstelleId	2280	
Parameter	PI	
Point Source	H	
Tag Name	FSF951A	
Value Engineering Unit	m³/h	Einheit (UOM)
Category: Value		
End Value	2000	measuring range end value
Span	2000	
Value	617,3583984375	
Value for EventFrame	617,3583984375	
Zero	0	measuring range zero point

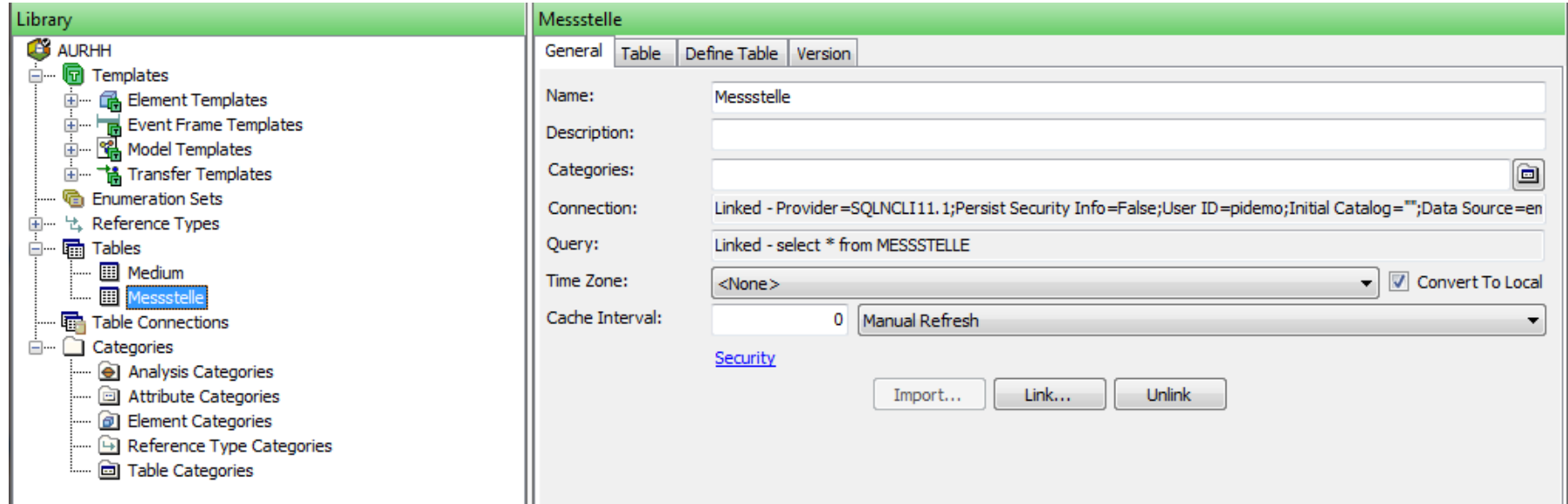
Structure of elements

Store information in Attributes

From EMS-SQL-Database

From PI Data Archive

How to link other relational database to get more information

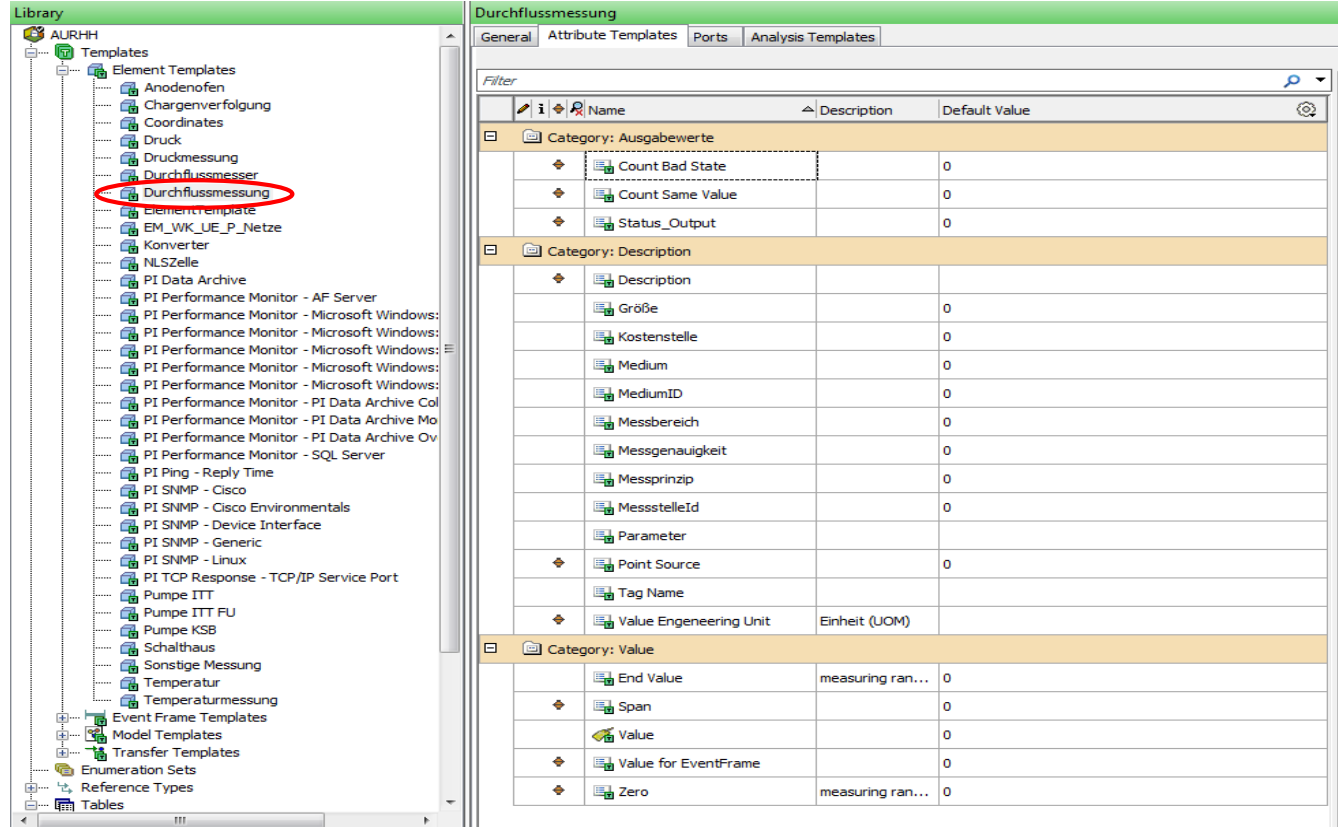


The screenshot displays the Aurubis software interface, divided into two main sections: 'Library' on the left and 'Messstelle' configuration on the right.

Library Panel:

- AURHH
 - Templates
 - Element Templates
 - Event Frame Templates
 - Model Templates
 - Transfer Templates
 - Enumeration Sets
 - Reference Types
 - Tables
 - Medium
 - Messstelle**
 - Table Connections
 - Categories
 - Analysis Categories
 - Attribute Categories
 - Element Categories
 - Reference Type Categories
 - Table Categories

The use of templates to create a large number of same type measurements



The screenshot displays the AURHH software interface. On the left, a tree view under 'Library' shows 'Templates' expanded, with 'Element Templates' containing 'Durchflussmessung' highlighted by a red circle. The main window shows the 'Durchflussmessung' configuration page with tabs for 'General', 'Attribute Templates', 'Ports', and 'Analysis Templates'. The 'General' tab is active, showing a table of attributes categorized into 'Ausgabewerte', 'Description', and 'Value'.

Category	Name	Description	Default Value
Category: Ausgabewerte	Count Bad State		0
	Count Same Value		0
	Status_Output		0
Category: Description	Description		
	Größe		0
	Kostenstelle		0
	Medium		0
	MediumID		0
	Messbereich		0
	Messgenauigkeit		0
	Messprinzip		0
	MessstelleId		0
	Parameter		
	Point Source		0
	Tag Name		
Category: Value	Value Engineering Unit	Einheit (UOM)	
	End Value	measuring ran...	0
	Span		0
	Value		0
	Value for EventFrame		0
	Zero	measuring ran...	0

Generation of analysis to detect a failure of a measurement

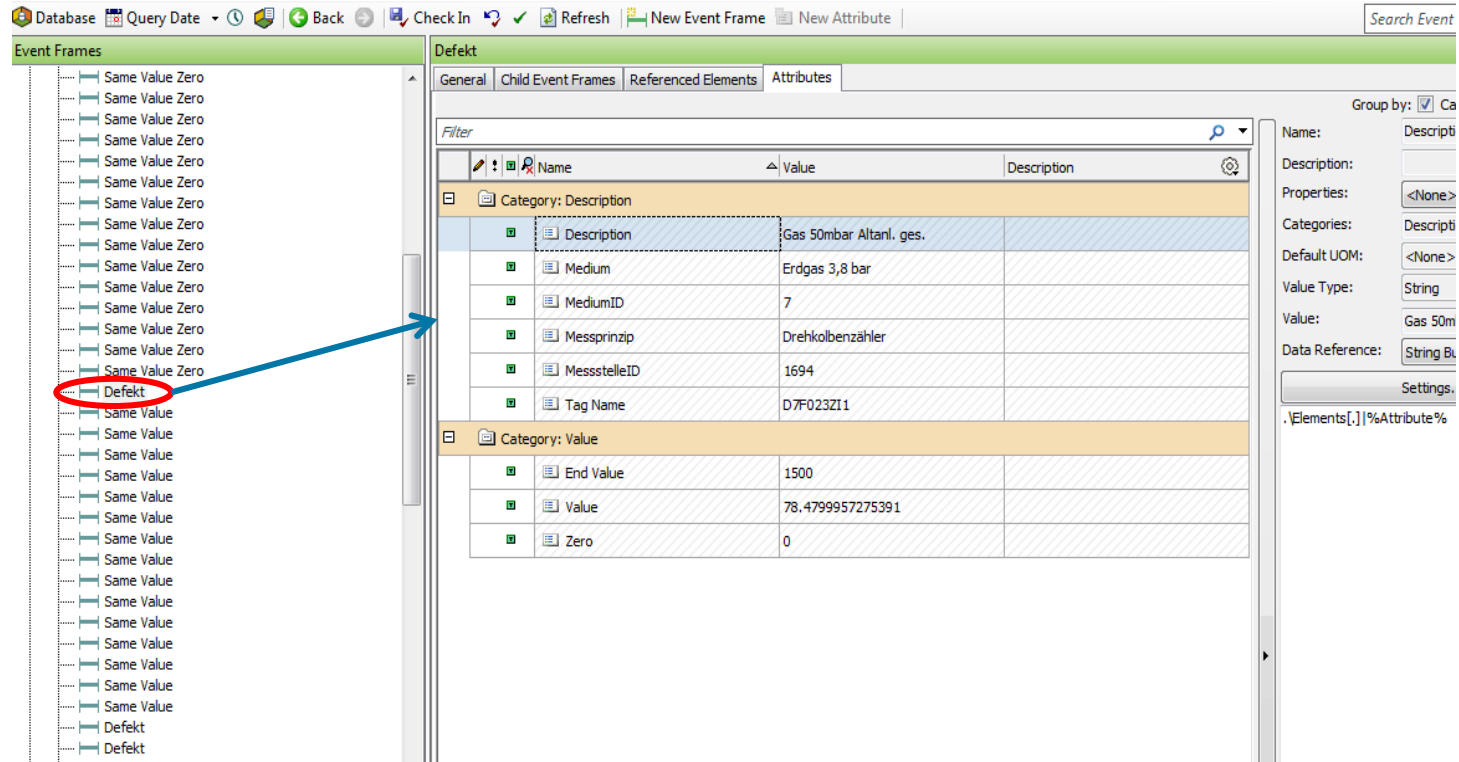
The screenshot displays the OSIsoft InRoads software interface. On the left, a tree view shows the project structure, with 'F5F951A' selected under 'Ultraschall-Laufzeit'. The main window is titled 'F5F951A' and has tabs for 'General', 'Child Elements', 'Attributes', 'Ports', 'Analyses', and 'Version'. The 'Analyses' tab is active, showing a table of analysis elements. A red circle highlights the 'Defekt' analysis. A blue arrow points from a box labeled 'Analyses' to this circle. Another blue arrow points from a box labeled 'StartTrigger' to the 'Expression' field in the 'Event Frame Template' section. The 'Expression' field contains the following text:

```
TimeLT('Value', '*-1h', '*', 'Zero'-0.2*'End Value') > 30 or TimeGT('Value', '*-1h', '*', 1.2*'End Value') > 30
```

The 'Event Frame Template' is set to 'Messungsanalyse'. On the right, the 'Name' field is 'Defekt', the 'Description' is empty, and the 'Categories' dropdown is set to 'Messungsanalysen (Event Frames)'. The 'Analysis Type' is set to 'Event Frame Generation'.

Analyses

StartTrigger



The screenshot displays the 'Event Frames' window in the Aurubis software. On the left, a list of event frames is shown, with 'Defekt' highlighted and circled in red. A blue arrow points from this list to the main 'Defekt' frame details on the right. The 'Defekt' frame is currently selected, and its details are shown in the 'General' tab. The details include a table of attributes and a right-hand panel with various settings.

Category	Attribute	Value	Description
Category: Description	Description	Gas 50mbar Altanl. ges.	
	Medium	Erdgas 3,8 bar	
	MediumID	7	
	Messprinzip	Drehkolbenzähler	
	MessstelleID	1694	
	Tag Name	D7F023Z1	
Category: Value	End Value	1500	
	Value	78.4799957275391	
	Zero	0	

Right-hand panel settings:

- Group by: ☒ Ca
- Name: Description
- Description:
- Properties: <None>
- Categories: Descripti
- Default UOM: <None>
- Value Type: String
- Value: Gas 50m
- Data Reference: String B
- Settings: .Elements[%Attribute%

The Event Frame stores start and end time of each event

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» PI System Explorer is not adapted for a general user

Database Query Date Back Check In Refresh New Event Frame

Event Frames		Durchflussmessung					
		Filter					
		Name	[9.13:35:01]	Duration	Start Time	End Time	Primary Element
		Same Value Zero		77 Hours	25.07.2016 05:35:00		G7F111A
		Same Value Zero		77 Hours	25.07.2016 05:35:00		55F312A
		Same Value Zero		101 Hours	24.07.2016 05:35:00		D8F022A
		Same Value Zero		96 Hours	24.07.2016 05:35:00	28.07.2016 05:35:00	F6F120R
		Same Value Zero		125 Hours	23.07.2016 05:35:00		A4F504
		Same Value Zero		192 Hours	20.07.2016 05:35:00	28.07.2016 05:35:00	F8F11302A
		Same Value Zero		221 Hours	19.07.2016 05:35:00		G7F509A
		Same Value Zero		221 Hours	19.07.2016 05:35:00		D6F005Z11
		Same Value Zero		221 Hours	19.07.2016 05:35:00		A6F422A

» A new interface has to be created

End-user friendly interface

→ Excel and the add-in 'PowerPivot'

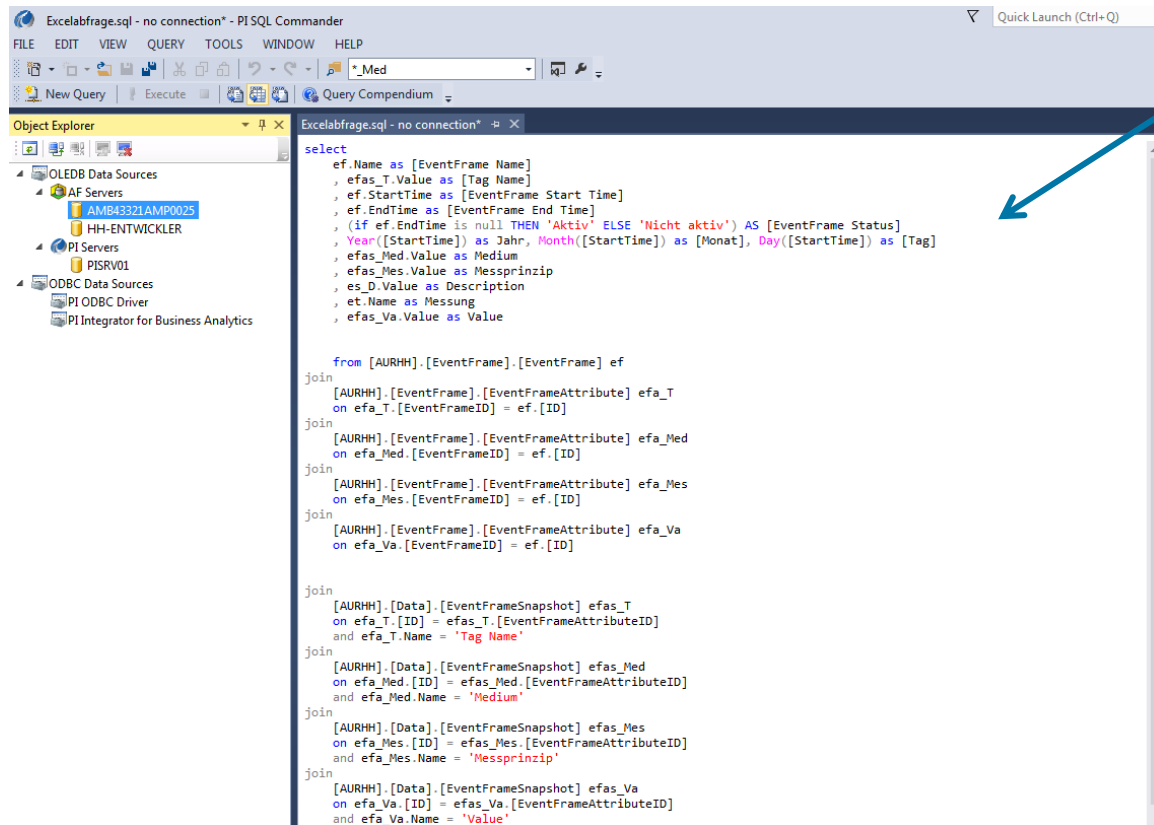
A		B		C		D		E		F		G		H		I		J		K		
1	Aktualisieren	Trend																				
2																						
3																						
4	Jahr	EventFrame Status	EventFrame Name	Tag Name	EventFrame Start Time	EventFrame End Time	Description	Medium	Messprinzip	Value	Anzahl											
6	2016	Aktiv	Same Value Zero	30F012Z	19.07.2016 05:35	(Leer)	Erdgas 3,8bar R/VN E-Ofen	Erdgas 3,8 bar	Turbinenrad	0	6											
7		Nicht aktiv	Same Value Zero	A1F201Z	19.07.2016 05:35	(Leer)	Wasser 301-001HZ Hauptlabor	Stadtwasser m. Siel	Flügelradzähler	0	6											
9			Same Value Zero	A7F214A	19.07.2016 05:35	(Leer)	DL 6bar CIS	Druckluft 6 bar, trocke	Annubarsonde	0	2											
11	Monat	Messung	Same Value Zero	B1F001A	19.07.2016 05:35	(Leer)	Gas 50mbar Bemusterung Probenahme	Erdgas 0,05 bar	Blende	1.2982474565506	5											
12	7	Durchflussmessu...	Same Value Zero	B1F202Z	19.07.2016 05:35	(Leer)	Gas 50mbar Edelprobe Aufheizstation	Erdgas 0,05 bar	Turbinenrad	0	5											
13			Same Value Zero	D6F003Z	19.07.2016 05:35	(Leer)	W/S OF-Cu 203-051 HZ	Stadtwasser o. Siel	Flügelradzähler	0	5											
14		4	Druckmessung	Same Value Zero	D6F003Z	19.07.2016 05:35	(Leer)	W/S OF-Cu 203-051 HZ	Stadtwasser o. Siel	Flügelradzähler	0	5										
15	5	Temperaturmess...	Same Value Zero	D6F005Z	19.07.2016 05:35	(Leer)	Gas 3,8bar OF-Cu ges.	Erdgas 3,8 bar	Turbinenrad	0	6											
16	6		Same Value Zero	F1F205A	19.07.2016 05:35	(Leer)	HD-O2 TK2, Lanze 1	Sauerstoff 99% HD	Vortex	0	5											
17			Same Value Zero	F1F223Z	19.07.2016 05:35	(Leer)	W/S 105-002 HZ, TK2, Probenahme	Stadtwasser o. Siel	Flügelradzähler	0	6											
18			Same Value Zero	F1F230Z	19.07.2016 05:35	(Leer)	W/S 105-003, TK2, Sozialwasser	Stadtwasser m. Siel	Flügelradzähler	0	6											
19		EventFrame Name	Same Value Zero	F1F236Z	19.07.2016 05:35	(Leer)	Gas 50mbar TK2, Heizstrahler	Erdgas 0,05 bar	Turbinenrad	0	6											
20	Tag	Same Value Z...	Same Value Zero	G7F509A	19.07.2016 05:35	(Leer)	HD-O2 NMA Summe	Sauerstoff 99% HD	Blende	0	6											
21			Same Value Zero	G7F608A	19.07.2016 05:35	(Leer)	Luft Netz NMA - EI	Druckluft 6 bar, trocke	Blende	0	2											
22		19	12095	Same Value Zero	H6F225A	19.07.2016 05:35	(Leer)	Gas 3,8bar SpU. Oxydul	Erdgas 3,8 bar	Vortex	0	2										
23	1	Defekt	Same Value Zero	F1F223Z	19.07.2016 05:35	(Leer)	W/S 105-002 NZ, TK2, Probenahme	Stadtwasser o. Siel	Flügelradzähler	0	6											
24	2	Defekt 2139F...	Same Value Zero	B1F019A	19.07.2016 05:35	(Leer)	HD-O2 Probenahme	Sauerstoff 99% HD	Vortex	0	7											
27	3	Defekt ASE20...	Same Value Zero	55F204A	19.07.2016 05:35	(Leer)	Gas 3,8bar Anheiz Str.2 ges.	Erdgas 3,8 bar	Blende	0	5											
28	4	Defekt F4F128A	Same Value Zero	55F311A	19.07.2016 05:35	(Leer)	Gas 3,8bar Anheiz Str.3 Br.1	Erdgas 3,8 bar	Turbinenrad	0	5											
29	5	Defekt F4F228A	Same Value Zero	55F312A	19.07.2016 05:35	(Leer)	Gas 3,8bar Anheiz Str.3 Br.2	Erdgas 3,8 bar	Turbinenrad	0	5											
30	6		Same Value Zero	55F313A	19.07.2016 05:35	(Leer)	Gas 3,8bar Anheiz Str.3 Br.3	Erdgas 3,8 bar	Turbinenrad	0	5											
31	7		Same Value Zero	55F105A	19.07.2016 05:35	(Leer)	Gas 3,8bar Anheiz Str.1 ges.	Erdgas 3,8 bar	Blende	0	5											
32	8		Same Value Zero	2139F622A	19.07.2016 05:35	(Leer)	TKS,Erdgas Konverteraufheizbrenner	Erdgas 3,8 bar	Turbinenrad	0	7											
33	9		Same Value Zero	B1F205Z	19.07.2016 05:35	(Leer)	Gas 50mbar Edelprobe Heizstrahler	Erdgas 0,05 bar	Turbinenrad	0	6											
34	10		Same Value Zero	F8F010A	19.07.2016 05:35	(Leer)	DL 20bar Nm³/h Schwanenhals	Druckluft 20 bar	Blende	0	6											
35	11		Same Value Zero	G7F814A	19.07.2016 05:35	(Leer)	Dampf 3bar NMA	Dampf 3 bar	Blende	0	5											
36	12		Same Value Zero	A1F100Z	19.07.2016 05:35	(Leer)	Erdgas 50mbar F-E Versuchsanlage	Erdgas 0,05 bar	Turbinenrad	1.96800005435944	3											
37	13		Same Value Zero	F6F120R	19.07.2016 05:35	(Leer)	O2-MD R/Wo Konverter 1	Sauerstoff 95% MD	Vortex	0	4											
38	14		Same Value Zero	A6F421Z	19.07.2016 05:35	(Leer)	Gas 3,8bar, Kessel 4, Br.2 Zaehler	Erdgas 3,8 bar	Turbinenrad	0	1											
39	15		Same Value Zero	A7F215A	19.07.2016 05:35	(Leer)	HD-O2 Spiess-Urania	Sauerstoff 99% HD	Vortex	0	2											
40	16		Same Value Zero	A6F411Z	19.07.2016 05:35	(Leer)	Gas 3,8bar, Kessel 4, Br.1 Zaehler	Erdgas 3,8 bar	Turbinenrad	0	1											
41																						
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44																						
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The data source is the integrated database of PI AF

The data source is the integrated database of PI AF

How to get the data from PI AF database

→ Data link with PI OLEDB Enterprise



The screenshot shows the SQL Commander interface with a query titled 'Excelabfrage.sql - no connection* - PI SQL Commander'. The query is a complex SELECT statement joining various tables from the PI AF database to retrieve event frame data. The Object Explorer on the left shows the database structure, including OLEDB Data Sources, AF Servers, and PI Servers. A blue arrow points from the 'SQL-Query' label to the query text.

```
select
  ef.Name as [EventFrame Name]
  , efas_T.Value as [Tag Name]
  , ef.StartTime as [EventFrame Start Time]
  , ef.EndTime as [EventFrame End Time]
  , (if ef.EndTime is null THEN 'Aktiv' ELSE 'Nicht aktiv') AS [EventFrame Status]
  , Year([StartTime]) as Jahr, Month([StartTime]) as [Monat], Day([StartTime]) as [Tag]
  , efas_Med.Value as Medium
  , efas_Mes.Value as Messprinzip
  , es_D.Value as Description
  , et.Name as Messung
  , efas_Va.Value as Value

from [AURHH].[EventFrame].[EventFrame] ef

join
[AURHH].[EventFrame].[EventFrameAttribute] efa_T
on efa_T.[EventFrameID] = ef.[ID]

join
[AURHH].[EventFrame].[EventFrameAttribute] efa_Med
on efa_Med.[EventFrameID] = ef.[ID]

join
[AURHH].[EventFrame].[EventFrameAttribute] efa_Mes
on efa_Mes.[EventFrameID] = ef.[ID]

join
[AURHH].[EventFrame].[EventFrameAttribute] efa_Va
on efa_Va.[EventFrameID] = ef.[ID]

join
[AURHH].[Data].[EventFrameSnapshot] efas_T
on efa_T.[ID] = efas_T.[EventFrameAttributeID]
and efa_T.Name = 'Tag Name'

join
[AURHH].[Data].[EventFrameSnapshot] efas_Med
on efa_Med.[ID] = efas_Med.[EventFrameAttributeID]
and efa_Med.Name = 'Medium'

join
[AURHH].[Data].[EventFrameSnapshot] efas_Mes
on efa_Mes.[ID] = efas_Mes.[EventFrameAttributeID]
and efa_Mes.Name = 'Messprinzip'

join
[AURHH].[Data].[EventFrameSnapshot] efas_Va
on efa_Va.[ID] = efas_Va.[EventFrameAttributeID]
and efa_Va.Name = 'Value'
```

SQL-Query

- » About Aurubis AG
- » Energy Management Systems (EnMS) and how they are made
- » Measurement monitoring using PI AF
- » Visualization
- » Conclusion

- » All measurements can be tested fast
- » Existing information from other databases can be used
- » A systematic and automatic system to detect failures
- » One view to monitor 3,000 measurements

How the PI System can support an Energy Management System in a copper company?

COMPANY and GOAL

Aurubis is the leading integrated copper group and the world's largest copper recycler, and wanted to **monitor all measurements systematically.**



CHALLENGE

Monitor and analyze all energy measurements of an Energy Management System

- » More than 3,000 measurements
- » 50 PLCs
- » More than 20 types of energy

SOLUTION

Use of PI AF

- » Interconnection of PI System and EnMS SQL database
- » Universal template and algorithm in PI AF
- » End user interface in MS Excel

RESULTS

System is part of the EnMS

- » Failure detection faster and systematic
- » Less downtime
- » Analysis and calculations more reliable



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감사합니다

谢谢

Danke

Merci

Gracias

Thank You

ありがとう

Спасибо

Obrigado



Questions

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

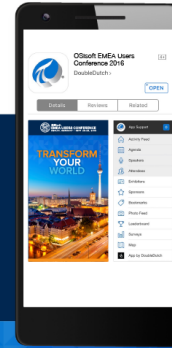


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