



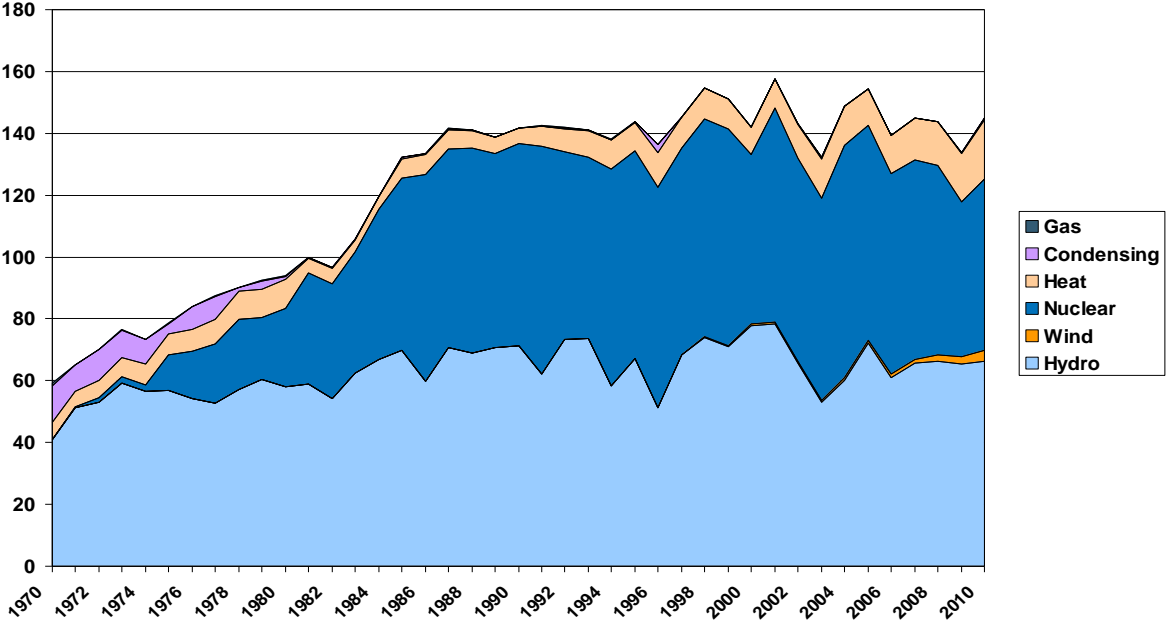
Deploying a Condition-Based Maintenance Strategy in the Hydro Power Business

Presented by Magnus Holmbom



Hydro Power – The backbone of Swedish electricity production

Electricity production in Sweden [TWh]



The Laxede hydro power plant (Lule river)



The Akkats hydro power plant (Lule river)

Vattenfall Hydro Power

The Third Largest Hydro Power Producer In Europe

Vattenfall Hydro Power - Nordic

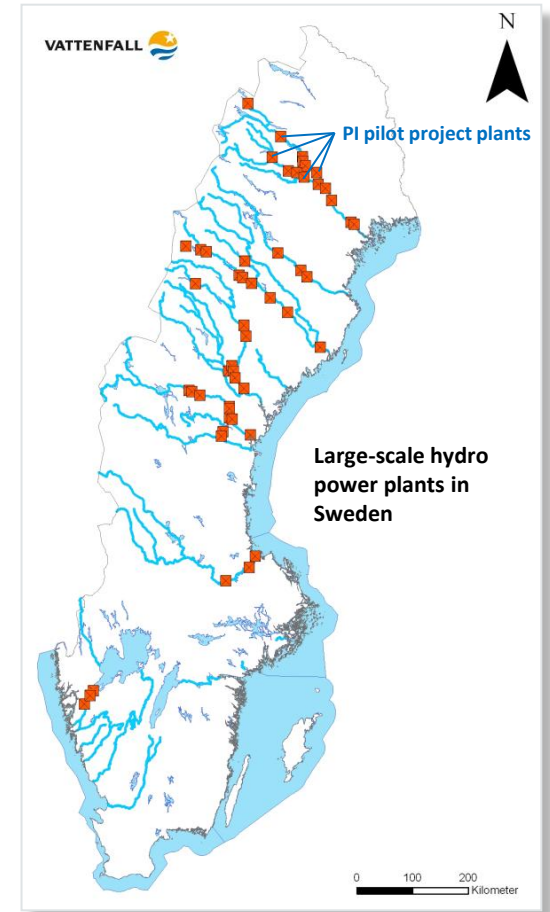
| | |
|---------------------|----------|
| Number of employees | ~ 520 |
| Annual turnover | ~ 950 M€ |

Assets, production och capacity

| | |
|--------------------------|-------------------|
| Large-scale power plants | 55 (1 in Finland) |
| Small-scale power plants | 50 (9 in Finland) |
| Annual production | 30 - 35 TWh |
| Capacity | 8.300 MW |

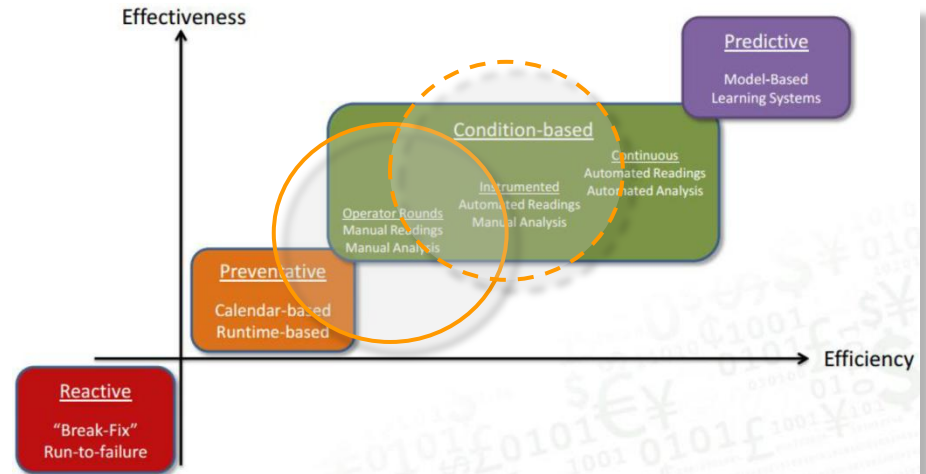
Investments in refurbishment

| | |
|-----------------------------|----------|
| For the period 2013 to 2023 | 1.400 M€ |
|-----------------------------|----------|



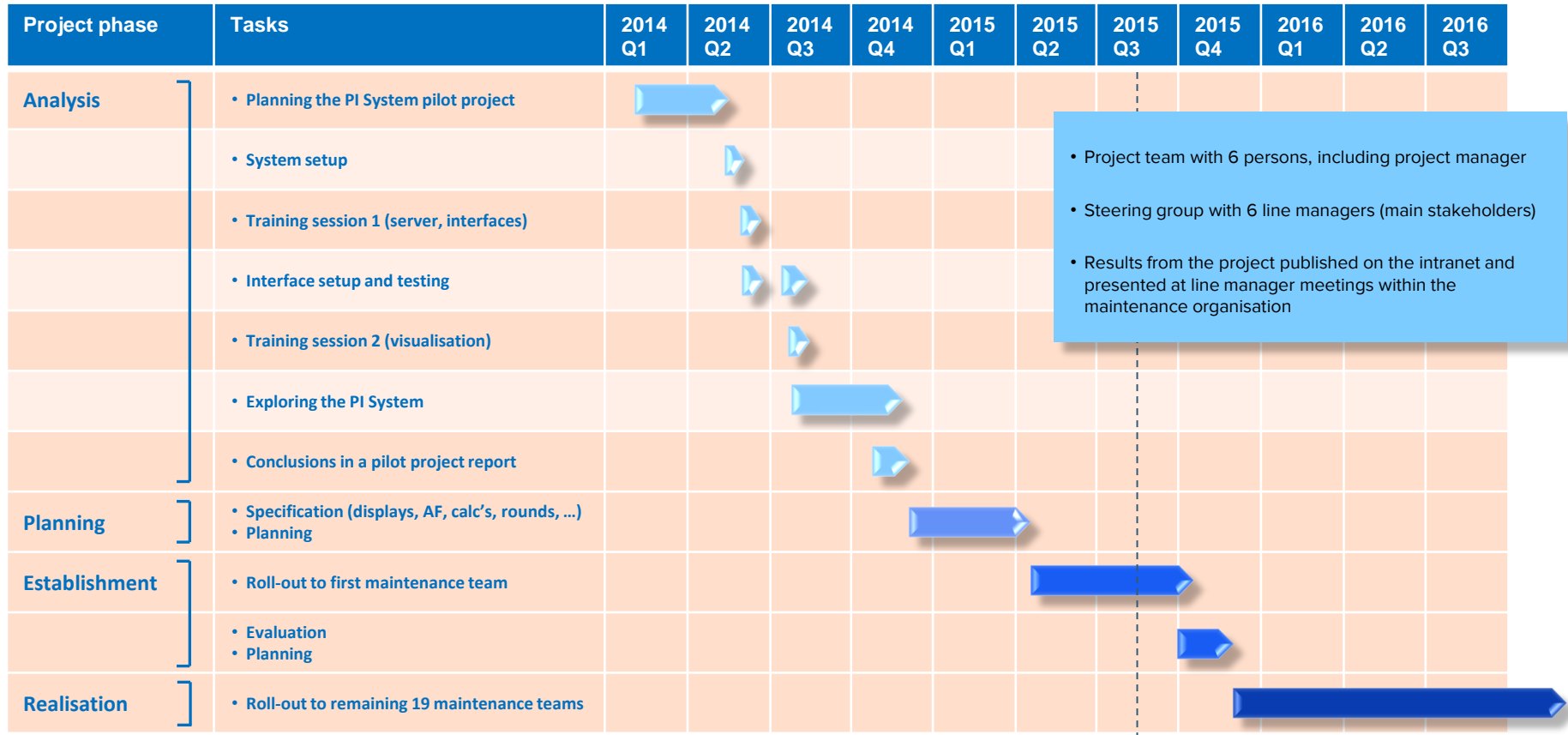
Background

- Need for a new strategy for Condition-Based Maintenance
- Old data historian system not sufficient to support new strategy
- PI System evaluated and used previously in Vattenfall, and decided leading solution
- Management team made a decision to start an analysis phase to evaluate if
 - the PI System could replace the existing system
 - support the new strategy and vision
 - add value by being flexible, able to integrate with other systems, and support a planned "Hydro Information Portal"



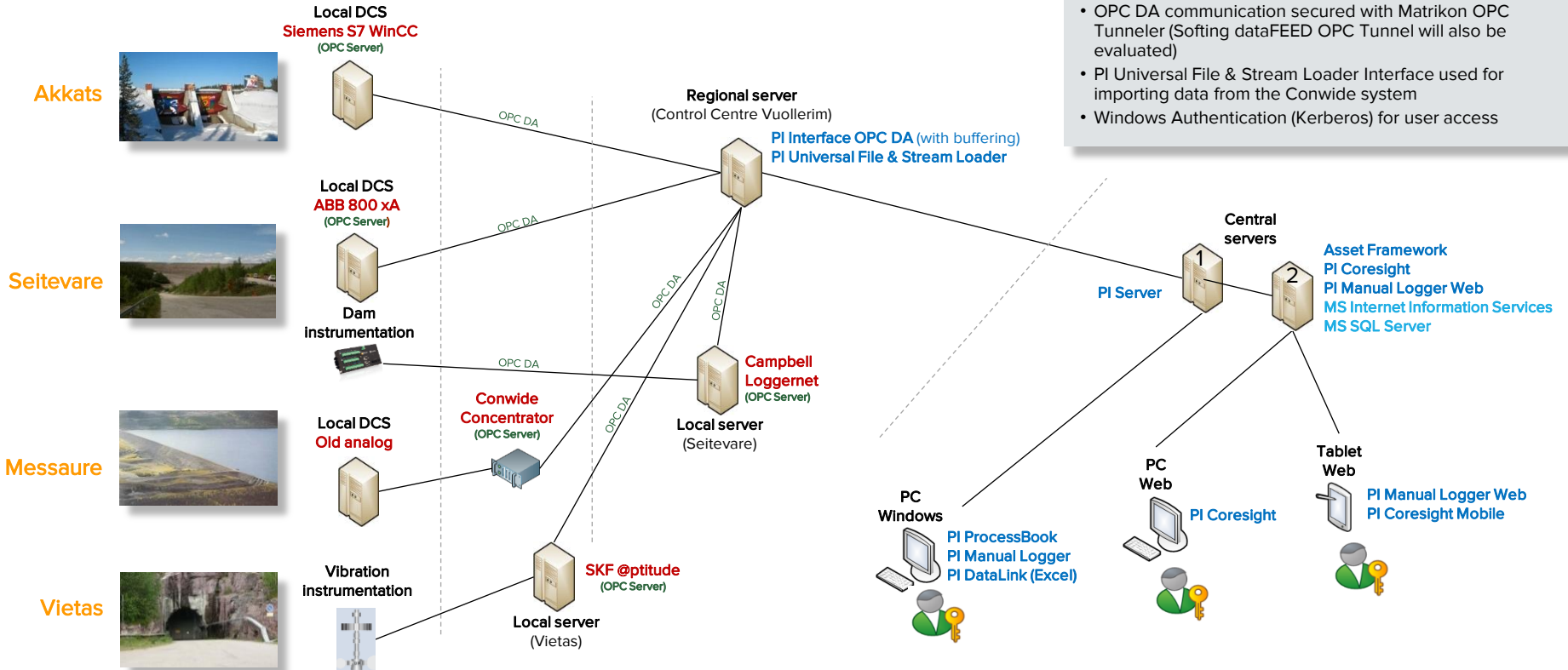
Source: OSIsoft's CBM Guidebook

Our one year journey with the PI System



System setup (pilot)

- Setup was chosen in order to test data capture from modern DCS's, old analog DCS's, dam instrumentation system, and vibration monitoring system
- OPC DA communication secured with Matrikon OPC Tunneler (Softing dataFEED OPC Tunnel will also be evaluated)
- PI Universal File & Stream Loader Interface used for importing data from the Conwide system
- Windows Authentication (Kerberos) for user access



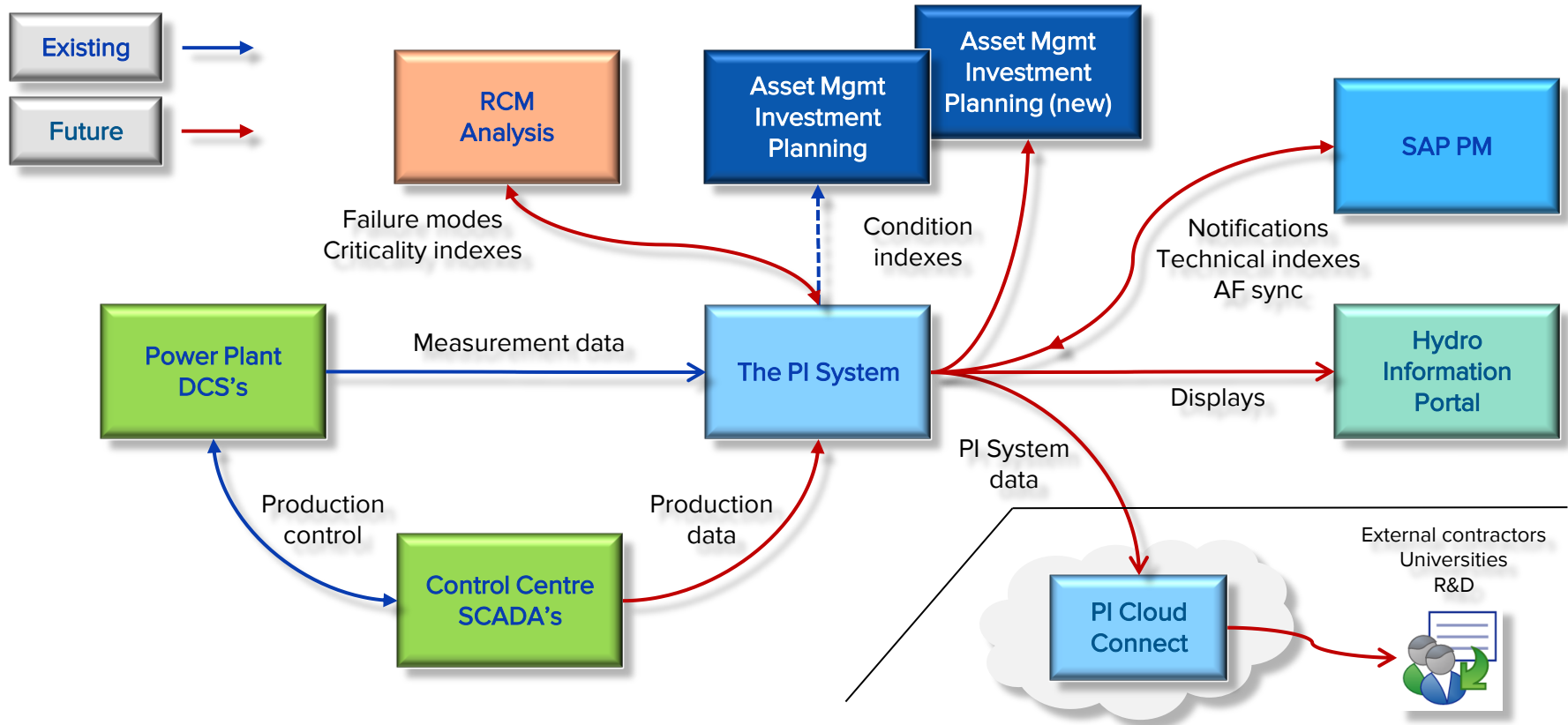
Conclusions from the pilot project

The pilot project verified that the PI System

1. is an **adequate replacement** for the current Conwide system, and fulfills the needs for both plant maintenance and dam safety;
2. provides **added value** with a more stable data capture, a richer analysis functionality, and flexible integration possibilities;
3. provides the prerequisites and **supports the vision and strategy** for our future maintenance development;
4. represents an **important building block** of a planned "Hydro Information Portal", publishing e.g. process data, analyses and KPI's in real-time.



The PI System as part of the IT landscape – Future plan



Trend Analytics

Element template setup

The screenshot displays the 'Magnus - PI System Explorer' interface. The left pane shows a tree view of the system structure, with 'Temperatortrend Template' selected under 'Element Templates'. The right pane shows the configuration for this template, including a table of properties.

Library

- Magnus
 - Categories
 - Analysis Categories
 - Attribute Categories
 - Element Categories
 - Reference Type Categories
 - Table Categories
 - Templates
 - Element Templates
 - Aggregat GXX Template
 - GemensamtTemplate
 - Kraftstation Template
 - Pumpning pumpgrop
 - Tag Alarm
 - Temperatortrend Template
 - Event Frame Templates
 - Model Templates
 - Notification Templates
 - Alarm tagg
 - Alarm tagg2
 - Pumpnin pumpgrop
 - Trend alarm
 - Transfer Templates
 - Enumeration Sets
 - Reference Types
 - Tables
 - Table Connections

Temperatortrend Template

General | Attribute Templates | Ports | Analysis Templates

Filter

| Name | Description | Default Value |
|------------------------|-------------|---------------|
| Drifttid | | 0 |
| Min drifttid för trend | | 0 min |
| Mätvärde | | 0 °C |
| Normvärde | | 0 °C |
| Trend index | | 0 |
| Trend index 1 | | 78 |
| Trend index 2 | | 74 |
| Trend index 3 | | 70 |
| Trend index 4 | | 65 |
| Trend index 5 | | 60 |
| Trendat värde | | 0 °C |
| Trendvillkor uppfyllt | | False |

Create element from template

The screenshot displays the 'Magnus - PI System Explorer' interface. On the left, a tree view shows the hierarchy of elements, with 'Trend NSTL', 'Trend OSTL', and 'Trend TSTL' highlighted by red circles. On the right, the 'Trend OSTL' element is selected, and its properties are shown in a table. The table is also circled in red and contains the following data:

| Name | Value | Category | Unit Of Measure |
|------------------------|---------------------|-------------|-----------------|
| Drifttid | 0 | | <None> |
| Min drifttid för trend | 360 min | | minute |
| Mätvärde | 26,32639 °C | | degree Celsius |
| Normvärde | 66 °C | | degree Celsius |
| Trend index | 4 | Trend index | <None> |
| Trend index 1 | 78 | Trend index | <None> |
| Trend index 2 | 74 | Trend index | <None> |
| Trend index 3 | 70 | Trend index | <None> |
| Trend index 4 | 65 | Trend index | <None> |
| Trend index 5 | 60 | Trend index | <None> |
| Trendat värde | 65,8078058714103 °C | Trend index | degree Celsius |
| Trendvillkor uppfyllt | False | | <None> |

Trend index calculation

Trend NSTL

General Child Elements Attributes Ports Analyses Version

Name: Trendvillkor

Description:

Categories:

Analysis Type: Expression Rollup Event Frame Generation

| Name | Expression | Value | Output Attribute |
|-----------|--|-------|-----------------------|
| Variab1e1 | <code>If('Drifttid'>'Min drifttid för trend') then true else false</code> | False | Trendvillkor uppfyllt |
| Variab1e2 | <code>if('Trendvillkor uppfyllt'= true) then TagAvg('Mätvärde', '-10m', '**') else NoOutput()</code> | - | Trendat värde |
| Variab1e3 | <code>if('Trendat värde'>'Trend index 5' And 'Trendat värde'<'Trend index 4') Then 5 Else if('Trendat värde'>'Trend index 4' And 'Trendat värde'<'Trend index 3') then 4 Else if('Trendat värde'>'Trend index 2') then 3 Else if('Trendat värde'>'Trend index 1') Then 2 Else if('Trendat värde'>'Trend index 1') Then 1 Else NoOutput()</code> | 4 | Trend index |

if('Trendat värde'>'Trend index 5' And 'Trendat värde'<'Trend index 4') Then 5 Else if('Trendat värde'>'Trend index 4' And 'Trendat värde'<'Trend index 3') then 4 Else if('Trendat värde'>'Trend index 2') then 3 Else if('Trendat värde'>'Trend index 1') Then 2 Else if('Trendat värde'>'Trend index 1') Then 1 Else NoOutput()

Trend NSTL

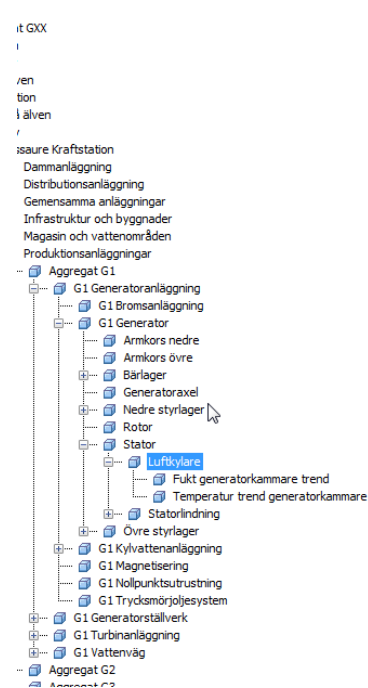
General Child Elements Attributes Ports Analyses Version

Filter

| Name | Value | Category | Unit Of Measure |
|------------------------|---------------------|-------------|-----------------|
| Drifttid | 0 | | <None> |
| Min drifttid för trend | 60 min | | minute |
| Mätvärde | 35,93802 °C | | degree Celsius |
| Normvärde | 0 °C | | degree Celsius |
| Trend index | 4 | Trend index | <None> |
| Trend index 1 | 78 | Trend index | <None> |
| Trend index 2 | 74 | Trend index | <None> |
| Trend index 3 | 63 | Trend index | <None> |
| Trend index 4 | 62 | Trend index | <None> |
| Trend index 5 | 60 | Trend index | <None> |
| Trendat värde | 62,2420280033331 °C | Trend index | degree Celsius |
| Trendvillkor uppfyllt | False | | <None> |

Make analyses easy

Reduce complexity by getting the highest value out of a population



| Name | Value | Description |
|-----------------------------------|----------------|-------------|
| Aggregat idrift | True | |
| Drifttid | 1070,66406 | |
| Kall luft Kylare 1 | 19,18 °C | |
| Kall luft Kylare 2 | 18,21 °C | |
| Kall luft Kylare 3 | 18,35 °C | |
| Kall luft Kylare 4 | 18,4 °C | |
| Kall luft Kylare 5 | 17,25 °C | |
| Kall luft Kylare 6 | 18,03 °C | |
| Kall luft Kylare 7 | 18,17 °C | |
| Kall luft Kylare 8 | 18,07 °C | |
| Kall luft Kylare 9 | 18,35 °C | |
| Kall luft Kylare 10 | 18,07 °C | |
| Kall luft Kylare 11 | 17,62 °C | |
| Kall luft Kylare 12 | 18,85 °C | |
| Kall luft kylare Max | 19,12061 °C | |
| Kall luft kylare Min | 17,2 °C | |
| Kall luft kylare Skillnad Max Min | 1,920613 delta | |
| Luftkylare avkyllning varm luft | 34,64939 °C | |
| Varm luft 1 | 53,77 °C | |
| Varm luft 2 | 53,81 °C | |

Luftkylare

| Name | Expression | Value | Output Attribute |
|-----------|--|-------|---|
| Variable1 | If 'Drifttid' > 30 Then True else False | True | Click to map |
| Variable2 | If Variable1 = True Then Max('Kall luft Kylare 1', 'Kall luft Kylare 2', 'Kall luft Kylare 3', 'Kall luft Kylare 4') | 19,08 | Kall luft kylare Max |
| Variable3 | If Variable1 = True Then Min('Kall luft Kylare 1', 'Kall luft Kylare 2', 'Kall luft Kylare 3', 'Kall luft Kylare 4') | 17,16 | Kall luft kylare Min |
| Variable4 | If Variable1 = True Then 'Varm luft 1' - Variable2 else NoOutput() | 34,69 | Luftkylare avkyllning varm luft |
| Variable5 | If Variable1 = True Then Variable2 - Variable3 else NoOutput() | 1,92 | Kall luft kylare Skillnad Max Min |
| Variable6 | Type an expression | - | Click to map |

Using multiple normal values

Nivå trend Bärlager

General Child Elements Attributes Ports Analyses Version

Filter

| Name | Value | Description |
|-------------------------|----------|-------------|
| Aggregat idrift | True | |
| HH | 10 mm | |
| HL | 7 mm | |
| LH | -7 mm | |
| LL | -5 mm | |
| Mätvärde | 76,12 mm | |
| Normvärde idrift | 75 mm | |
| Normvärde stillastående | 90 mm | |
| Trend index | 5 | |

Left sidebar menu:

- ifstation
- läggning
- ionsanläggning
- smma anläggningar
- struktur och byggnader
- och vattenområden
- onsanläggningar
- regat G1
 - G1 Generatoranläggning
 - G1 Bromsanläggning
 - G1 Generator
 - Armkors nedre
 - Armkors övre
 - Bärlager
 - Nivå trend Bärlager
 - Temperatur trend Bärlager
 - Generatorval

If machine is running then analyses is using 75 mm else it is using 90mm

Nivå trend Bärlager

General Child Elements Attributes Ports Analyses Version

Name: Analysis1

Description:

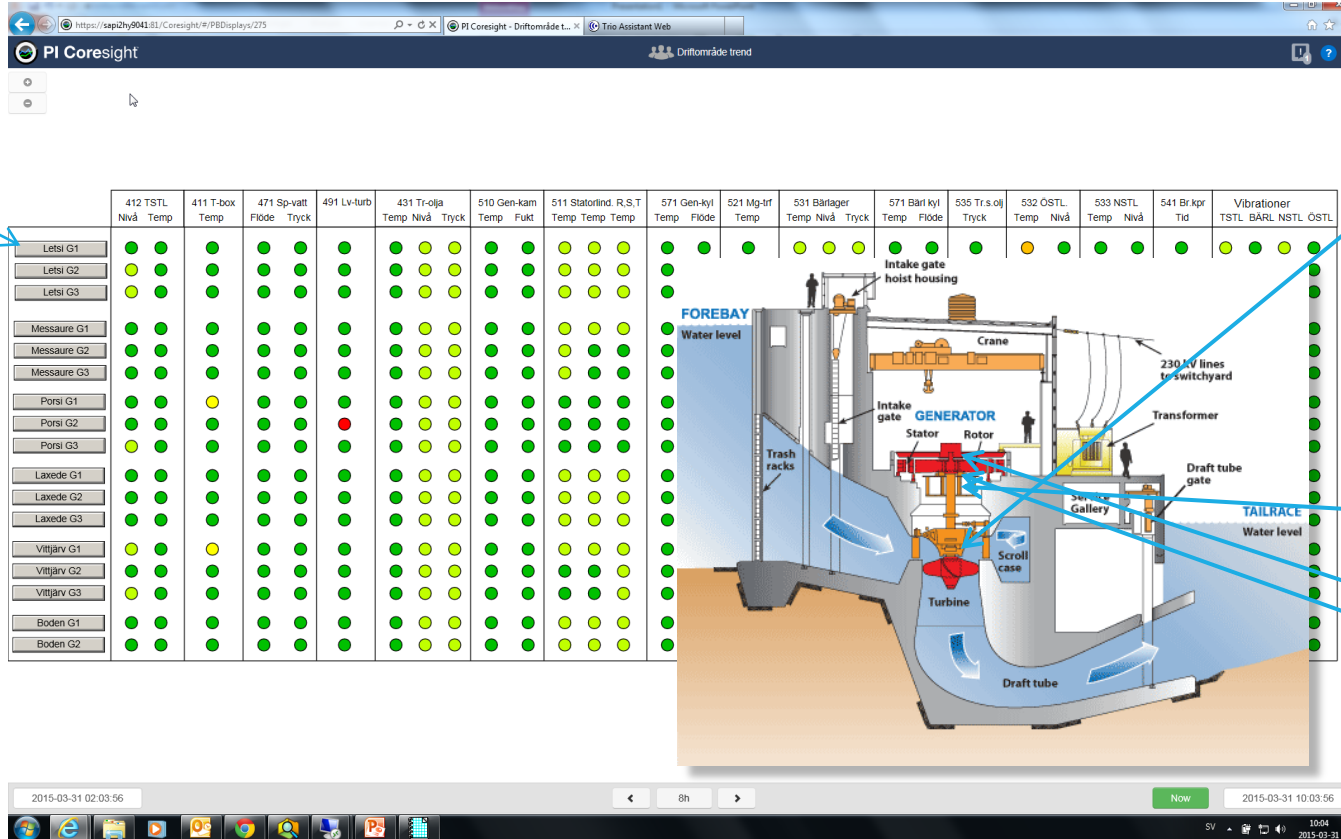
Categories:

Analysis Type: Expression Rollup Event Frame Generation

| Name | Expression | Value | Output Attribute |
|-----------|---|-------|------------------------------|
| Variabel1 | If('Aggregat idrift'=true) Then 'Normvärde idrift' else 'Normvärde stillastående' | 75 mm | Click to map |
| Variabel2 | 'Mätvärde'-Variabel1 | 1,12 | Click to map |
| Variabel3 | If(Variabel2>'LH'and Variabel2<'HL') Then 5 else If(Variabel2>'HL' and Variabel2<'HH') Then 3 else If(Variabel2>'LL'and Variabel2<'LL') | 5 | Trend index |

Add a new expression

Overview of trends



English translation

Turbine

- Turbine guide bearing
- Stuffing
- Barrier water
- Leakage water
- Pressure oil

Generator

- Generator chamber
- Stator winding
- Generator cooling
- Excitation transformer
- Thrust Bearing
- Bearing cooling
- Pressure lubricating oil
- Upper guide bearing
- Lower guide bearing
- Brake compressor
- Vibrations

Individual trends using element relative displays

PI Coresight

PK004 Trendöversikt

Undo Redo

PK004-03 Trendanalys
 PK004-01 Trendanalys
 PK004-02 Trendanalys
 Temperatur trend Bärlager
 Temperatur trend Tätningbox

Assets
 \SAP\ZH9041\Wattenkraft\Luleå älv\Messure Kraftstation\Produktionsanl...

PK004-01 Trendanalys
 PK004-02 Trendanalys
 PK004-03 Trendanalys

Events
 No events for symbols on the display from 2015-09-25 08:44 - 2015-10-16 08:44

Search
 Related Assets/Events (3/0)

Cart
 Drag symbols here for later use

411 TI temp 5
 412 TI temp 4
 412 TI nivå 5
 431 TI temp 4
 431 TI nivå 5
 431 TI Ack nivå 5
 431 TI tryck Pt Created
 471 TI flöde Pt Created
 471 TI tryck Pt Created
 491 TI flöde Pt Created

| Name | Description | Value | Units | Trend | Average | Minimum | Maximum | Range |
|------------------------------|--------------------------------|--------|-------|-------|----------|---------|---------|--------|
| PK004-03 Trendanalys411 temp | Tätningbox trendvärde temp | 2.1303 | °C | | -0.31679 | -4.4747 | 5.9667 | 9.8413 |
| PK004-03 Trendanalys412 temp | Turbinstylager trendvärde temp | 62.309 | °C | | 61.304 | 51.921 | 65.481 | 13.56 |
| PK004-03 Trendanalys431 temp | Objektbälare trendvärde temp | 27.761 | °C | | 27.267 | 24.773 | 28.102 | 3.3289 |

510 TI fukt 4
 510 TI temp 5
 511 TI temp 5
 521 TI temp Pt Created
 531 TI temp 4
 531 TI tryck Pt Created
 532 TI temp 5
 532 TI nivå 5
 533 TI temp 5

| Name | Description | Value | Units | Trend | Average | Minimum | Maximum | Range |
|------------------------------|--------------------------------------|------------|-------|-------|----------------|----------------|----------------|----------------|
| PK004-03 Trendanalys510 temp | Generatorstamare trendvärde temp | 20.22 | °C | | 22.593 | 19.948 | 23.974 | 4.0257 |
| PK004-03 Trendanalys511 temp | Statorledning trendvärde temp | 55.719 | °C | | 60.268 | 51.024 | 67.898 | 16.874 |
| PK004-03 Trendanalys521 temp | Magnetiseringsströmf trendvärde temp | Pt Created | °C | | [-11059] No Go | [-11059] No Go | [-11059] No Go | [-11059] No Go |
| PK004-03 Trendanalys531 temp | Bärlager trendvärde temp | 75.113 | °C | | 75.65 | 73.746 | 77.254 | 3.5082 |
| PK004-03 Trendanalys532 temp | Övre styrlager trendvärde temp | 50.283 | °C | | 49.776 | 45.707 | 50.482 | 4.7753 |
| PK004-03 Trendanalys533 temp | Nedre styrlager trendvärde temp | 48.869 | °C | | 48.541 | 47.607 | 49.475 | 1.868 |

535 TI tryck Pt Created
 571 Gen temp Pt Created
 571 TI BARL flöde Pt Created
 571 TI BARL temp Pt Created
 571 TI Gen flöde Pt Created
 571 TI Gen temp Pt Created

| Name | Description | Value | Units | Trend | Average | Minimum | Maximum | Range |
|-----------------------------------|----------------------------------|------------|-------|-------|----------------|----------------|----------------|----------------|
| PK004-03 Trendanalys571 BARL temp | Bärlagerledning trendvärde temp | Pt Created | °C | | [-11059] No Go | [-11059] No Go | [-11059] No Go | [-11059] No Go |
| PK004-03 Trendanalys571 Gen temp | Generatorledning trendvärde temp | Pt Created | °C | | [-11059] No Go | [-11059] No Go | [-11059] No Go | [-11059] No Go |

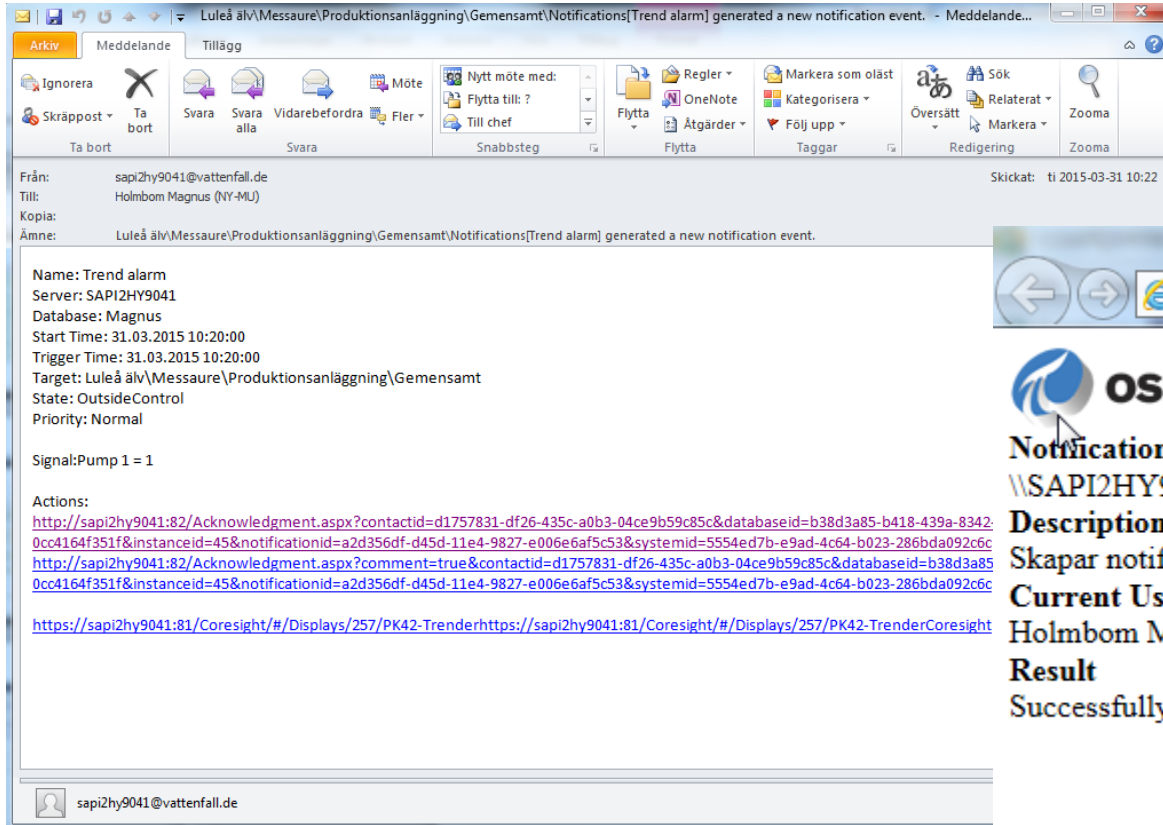
2015-10-02 08:44:56 1h 8h 1d 1w 1mo Now 2015-10-09 08:44:56

Notification setup

The image displays the PI System Explorer interface for configuring a notification. It is divided into three main sections:

- Library:** A tree view on the left showing the project structure. The 'Trend alarm' notification is highlighted under the 'Notification Templates' folder.
- Trend alarm Overview:** A central panel showing the configuration for the 'Trend alarm'.
 - Name:** Trend alarm
 - Description:** (Empty)
 - Status:** (Empty)
 - Categories:** Trend objekt
 - Creation and Startup Options:** Radio buttons for 'Automatically create a notification for ea...', 'Automatically create a notification for ea...', and 'Do not create a notification automatically...'.
 - Trigger:** Target: [Temperaturtrend Template](#); Conditions: [Trend index = Trend index 3](#), [Trend index = Trend index 2](#), [Trend index = Trend index 1](#).
 - Message:** [0 item\(s\) of custom content available to subscribers](#); [0 customized delivery format\(s\) configured for Email](#).
 - Subscriptions:** [1 subscription\(s\) to this notification](#).
- Notifications:** A panel on the right showing a tree of notifications.
 - Disabled (6)**
 - Running (3)**
 - Trend alarm (Trend OSTL)** (Selected)
 - Trend alarm1 (Trend NSTL)
 - Trend alarm2 (Trend TSTL)
- Trend alarm Overview (Detailed):** A detailed view of the 'Trend alarm' notification.
 - Name:** Trend alarm
 - Description:** Trendalarm for alla trendobjekt
 - Status:** Running
 - Template:** Trend alarm
 - Categories:** Trend objekt
 - Trigger:** Target: [Trend OSTL](#); Conditions: [Trend index = Trend index 3](#), [Trend index = Trend index 2](#), [Trend index = Trend index 1](#).
 - Message:** [0 item\(s\) of custom content available to subscribers](#); [0 customized delivery format\(s\) configured for Email](#).
 - Subscriptions:** [1 subscription\(s\) to this notification](#).

Delivery of notification



The screenshot shows an Outlook window with the following details:

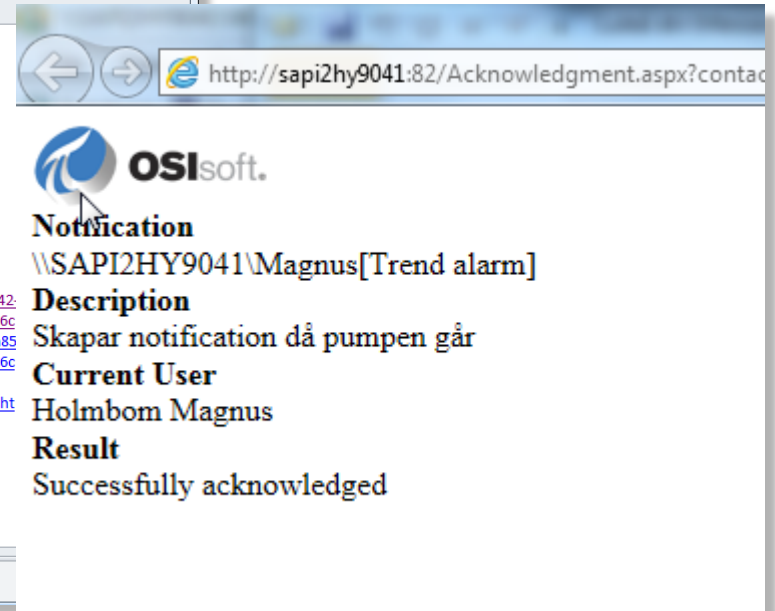
- From:** sapi2hy9041@vattenfall.de
- To:** Holmbom Magnus (NY-MU)
- Subject:** Luleå älv\Messaure\Produktionsanläggning\Gemensamt\Notifications[Trend alarm] generated a new notification event.

The email body contains the following information:

Name: Trend alarm
Server: SAPI2HY9041
Database: Magnus
Start Time: 31.03.2015 10:20:00
Trigger Time: 31.03.2015 10:20:00
Target: Luleå älv\Messaure\Produktionsanläggning\Gemensamt
State: OutsideControl
Priority: Normal

Signal: Pump 1 = 1

Actions:
<http://sapi2hy9041:82/Acknowledgment.aspx?contactid=d1757831-df26-435c-a0b3-04ce9b59c85c&databaseid=b38d3a85-b418-439a-8342-0cc4164f351f&instanceid=45¬ificationid=a2d356df-d45d-11e4-9827-e006e6af5c53&systemid=5554ed7b-e9ad-4c64-b023-286bda092c6c>
<http://sapi2hy9041:82/Acknowledgment.aspx?comment=true&contactid=d1757831-df26-435c-a0b3-04ce9b59c85c&databaseid=b38d3a85-0cc4164f351f&instanceid=45¬ificationid=a2d356df-d45d-11e4-9827-e006e6af5c53&systemid=5554ed7b-e9ad-4c64-b023-286bda092c6c>
<https://sapi2hy9041:81/Coresight/#/Displays/257/PK42-Trenderhttps://sapi2hy9041:81/Coresight/#/Displays/257/PK42-TrenderCoresight>



The screenshot shows a web browser window with the URL: <http://sapi2hy9041:82/Acknowledgment.aspx?contactid=d1757831-df26-435c-a0b3-04ce9b59c85c&databaseid=b38d3a85-b418-439a-8342-0cc4164f351f&instanceid=45¬ificationid=a2d356df-d45d-11e4-9827-e006e6af5c53&systemid=5554ed7b-e9ad-4c64-b023-286bda092c6c>

The page content includes:

- OSIsoft.** logo
- Notification**
- \\SAPI2HY9041\Magnus[Trend alarm]**
- Description**
- Skapar notification då pumpen går**
- Current User**
- Holmbom Magnus**
- Result**
- Successfully acknowledged**

Create notification in SAP PM

Skapa UH-meddel.: Felanmälan (AU)

Medd.status: ÖMED | NEW

Order: []

Innehåll

Arende: B-NORM | N10 | Normal driftäge "Vid start"

2015.03.31 15:08:56 Lars Ören (IASG) Tel. 0706111238
Hög temp styrlager, grundorsaksanalys görs tilli veckan

Position

Feluppstakt: BVM-GEN | 050 | Periodiskt eller rondarbete

Skadebild: []

Text: []

Orsakskod: []

Text orsak: []

Uppgift: 1 av 1

Bestidpunkter

Önskad start: 2015.03.31 | 00:00:00 | Prioritet: [] | Planerbar: []

Önskat slut: 2015.05.31 | 00:00:00

Referensobjekt

Systemposition: FX042-01-532 | Övre styrlager

Utrustning: []

Ansvarsområden

Planeringsgrupp: MB2 | 2100 | Driftgrupp Jokkmok

Ansv. prod.grp: PV_IBI | 21XX | PV Internt arbete

Handläggare: []

Meddelande från: IASG | Meddelandedatum: 2015.03.31 | 00:00:00

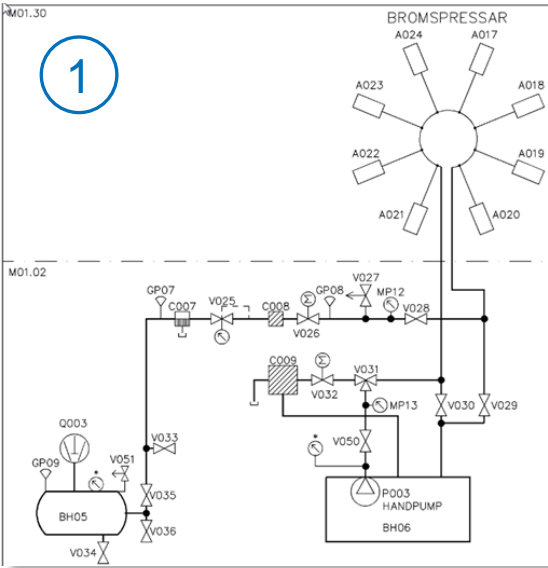
Failure Mode Analysis

Failure Mode Analysis

1. Choose subsystem and use system descriptions and functional descriptions
2. Analysis of current maintenance activities (CMMS)
3. Map all known failure modes to maintenance activities (FMEA)

RCM = Reliability Centered Maintenance
FMECA = Failure Modes, Effects and Criticality Analysis

| Rad | FM | CA | A | Class | Template | Criticality | Status | Last Updated | Updated By | FMECA Name | De |
|-----|------|-----|---|-------|----------|-------------|---------------------|--------------|------------|---|----|
| 1 | 6840 | Nej | | | | 3 R | 2009-04-16 15:31:25 | OLOV | | Fel tryckmätkedja bromssystem | |
| 2 | 6841 | Nej | | | | 3 R | 2009-04-15 12:13:53 | OLOV | | Fel lägesmätkedja bromssystem | |
| 3 | 6839 | Nej | | | | 3 R | 2009-04-15 14:38:33 | OLOV | | Fel tryckmätkedja bromssystem | |
| 4 | 6128 | Nej | | | | 2 R | 2009-04-15 14:04:42 | OLOV | | Säkerhetsventil bromskompressor öppnar ej | |
| 5 | 6838 | Nej | | | | 3 R | 2009-04-15 13:13:30 | OLOV | | Säkerhetsventil bromstavla öppnar ej | |
| 6 | 6833 | Nej | | | | 3 A | 2008-01-25 10:57:44 | OLOV | | Oljebeläggning på bromsbana | |
| 7 | 6830 | Nej | | | | 3 A | 2008-01-25 10:57:34 | OLOV | | Fel reduceringsventil | |
| 8 | 6836 | Nej | | | | 3 A | 2008-01-25 10:57:52 | OLOV | | Utslitna bromsbelägg | |
| 9 | 6842 | Nej | | | | 3 A | 2008-01-25 10:57:31 | OLOV | | Fel i bromskompressor | |
| 10 | 6831 | Nej | | | | 4 A | 2008-01-25 10:57:38 | OLOV | | Kärvande bromspress | |
| 11 | 6835 | Nej | | | | 4 A | 2008-01-25 10:57:48 | OLOV | | Läckage rörsystem/bromspressar | |



BETECKNINGAR

- KOMPR
- PUMP
- AVSTAN
- SAKERH
- REDUCE
- MAGNET
- TREVÄG
- FILTER
- KONDEH
- GIVARE
- MÄTINS
- PROPPA

Operationslistor för

| Rad | FM | CA | A | Class | Template | Criticality | Status | Last Updated | Updated By | FMECA Name | De |
|-----------------------|----|----|---|-------|----------|-------------|--------|--------------|------------|------------|----|
| K001-01-541 | | | | | | | | | | | |
| K001-01-541 | | | | | | | | | | | |
| K001-01-541-C001 | | | | | | | | | | | |
| K001-01-541-C001 | | | | | | | | | | | |
| K001-01-541-C001 | | | | | | | | | | | |
| K001-01-541-Q001 | | | | | | | | | | | |
| K001-01-541-Q001 | | | | | | | | | | | |
| K001-01-541-Q001-BH01 | | | | | | | | | | | |
| K001-01-541-8001 | | | | | | | | | | | |
| K001-01-541-V001 | | | | | | | | | | | |
| K001-01-541-V002 | | | | | | | | | | | |
| K001-02-541 | | | | | | | | | | | |
| K001-02-541 | | | | | | | | | | | |
| K001-02-541 | | | | | | | | | | | |
| K001-02-541 | | | | | | | | | | | |
| K001-02-541-C001 | | | | | | | | | | | |
| K001-02-541-C001 | | | | | | | | | | | |
| K001-02-541-C001 | | | | | | | | | | | |
| K001-02-541-Q001 | | | | | | | | | | | |
| K001-02-541-Q001 | | | | | | | | | | | |
| K001-02-541-Q002 | | | | | | | | | | | |
| K001-02-541-8001 | | | | | | | | | | | |

Failure Mode Analysis, cont.

- Go through all notifications in CMMS. Are there any new failure modes previously unidentified? Fault frequency analysis.
- Which failure modes may be identified with condition monitoring?

Ändra meddelanden: Lista över meddelanden

| Mon... | V | Medd. | Typ | Systemposition | Prioritet | Beskrivning | Order | PG |
|--------|---|----------|-----|-------------------|-----------|--|---------|-----|
| ☉ | | 31153016 | VM | PK003-03-540 | Planerbar | PK003 hamiltonventiler inventering | | MN2 |
| ☉ | | 31235760 | VM | IK1010-02-540 | Akut | IK10 G2 Översyn åtg. kärvande bromspr. | 6034022 | MM6 |
| ☉ | | 31230556 | VM | TK002-01-541 | Akut | TK2 G1 bromstryck lågt | | MS2 |
| ☉ | | 31236006 | VM | IK031-03-541 | Akut | IK31 G3 fel | | MM3 |
| ☉ | | 31236009 | VM | IK035-02-541-Q001 | Akut | G2 Bromsluft ej ok | 6034153 | MM2 |
| ☉ | | 31236007 | VM | PK046-02-540 | Akut | Pk46 AD2 Lång tid stoppsekvens stoppsteg | | MN3 |
| | | | | PK046-02-540 | Akut | AD2 Lång tid stoppsekvens stoppsteg 6 | 6034350 | MN3 |
| | | | | PK044-01-540 | Akut | PK44 G1 Bromstryck | 6035530 | MN2 |
| | | | | IK031-03-541 | Akut | G3 Bromsar ej till stopp. | 6034676 | MM3 |
| | | | | PK002-02-541 | Akut | PK2 G2 krypning | | MN1 |
| | | | | PK002-01-541 | Akut | PK002 G1 Startblock | | MN1 |
| | | | | PK002-02-540 | Planerbar | PK2 G2 krypning | 6034794 | MN1 |
| | | | | NK002-02-540 | Planerbar | NK2 G2 Kärvande bromspress | 6035187 | MV4 |
| | | | | ÅK002-00-541-Q002 | Planerbar | Bromskompressor S-ventil ÅK2 | 6035206 | MS1 |
| | | | | PK002-02-541 | Planerbar | PK2 Krypning | | MN1 |
| | | | | PK002-01-541-GP01 | Akut | PK2 G1 Lågt bromstryck ur funktion | | MN1 |
| | | | | PK002-02-541 | Akut | G2 krypning | | MN1 |
| | | | | IK031-04-541 | Planerbar | G4 kärvande ventil bromsning | 6036964 | MM3 |
| | | | | PK046-03-540 | Planerbar | PK46 G3 BROMSBANAN | 6036566 | MN3 |
| | | | | PK002-02-541 | Planerbar | PK2 G2 krypning | | MN1 |
| | | | | PK052-01-541-Q001 | Planerbar | PK52 G1 bromskompressor | 6040664 | MN1 |
| | | | | IK032-01-541 | Akut | G1 oljedimmsmjörare | | MM3 |
| | | | | IK035-02-540 | Planerbar | Bromskompressor mycket gångtid | 6037213 | MM2 |
| | | | | NK009-01-541 | Planerbar | NK9 Magnetventil bromsutrustning | 6039160 | MV2 |

| FMECA Name | Symptom 1 | Symptom 2 | Condition monitoring |
|---|--------------------|-----------------------|---|
| Fel tryckmätkedja bromsventil | Lång stopptid | Utebliven manöver | Stoptid, Gränslägen bromsar |
| Fel lägesmätkedja bromssystem | Ej frigivning | | Gränslägen bromsar |
| Fel tryckmätkedja bromsventil | Felaktig manöver | | Gränslägen bromsar, signal:Bromsar till |
| Säkerhetsventil bromskompressor öppnar ej | Högt tryck | 5 | Tryck kompressor |
| Säkerhetsventil bromstavla öppnar ej | Högt tryck | | Tryck efter kompressor |
| Oljebeläggning på bromsbana | Lång stopptid | | Stoptid: signal bromsar från |
| Fel reduceringsventil | Avvikande tryck | | Bromstryck |
| Utslitna bromsbelägg | Lång stopptid | | Stoptid: signal bromsar från |
| Fel i bromskompressor | Lågt tryck | Lång gångtid | Tryck kompressor, gångtid kompressor |
| Kärvande bromspress | Lång stopptid | Ej frigivning bromsar | Gränslägen bromsar, signal:Bromsar till |
| Läckage rörsystem/bromspressar | Gångtid kompressor | | Gångtid kompressor, Bromstryck |

- Mätvärdesbehov
- Varvtal aggregat
- Gränslägen bromspressar
- Signal bromsar till/från
- Tryck kompressor
- Tryck efter kompressor
- Bromstryck
- Kompressor driftindikering

Symptoms
Failure modes for break system

Sensor needs

Condition monitoring

4

Failure Mode Analysis, cont.

6. Which measurements are required?
(Process to install new sensors)
7. Define a general analysis model
8. Adapt to local conditions by using parameters (requires deeper local knowledge of each power plant)
9. Classify normal and deviating conditions in 5 levels (technical index)

Asset structure

Fault modes from RCM

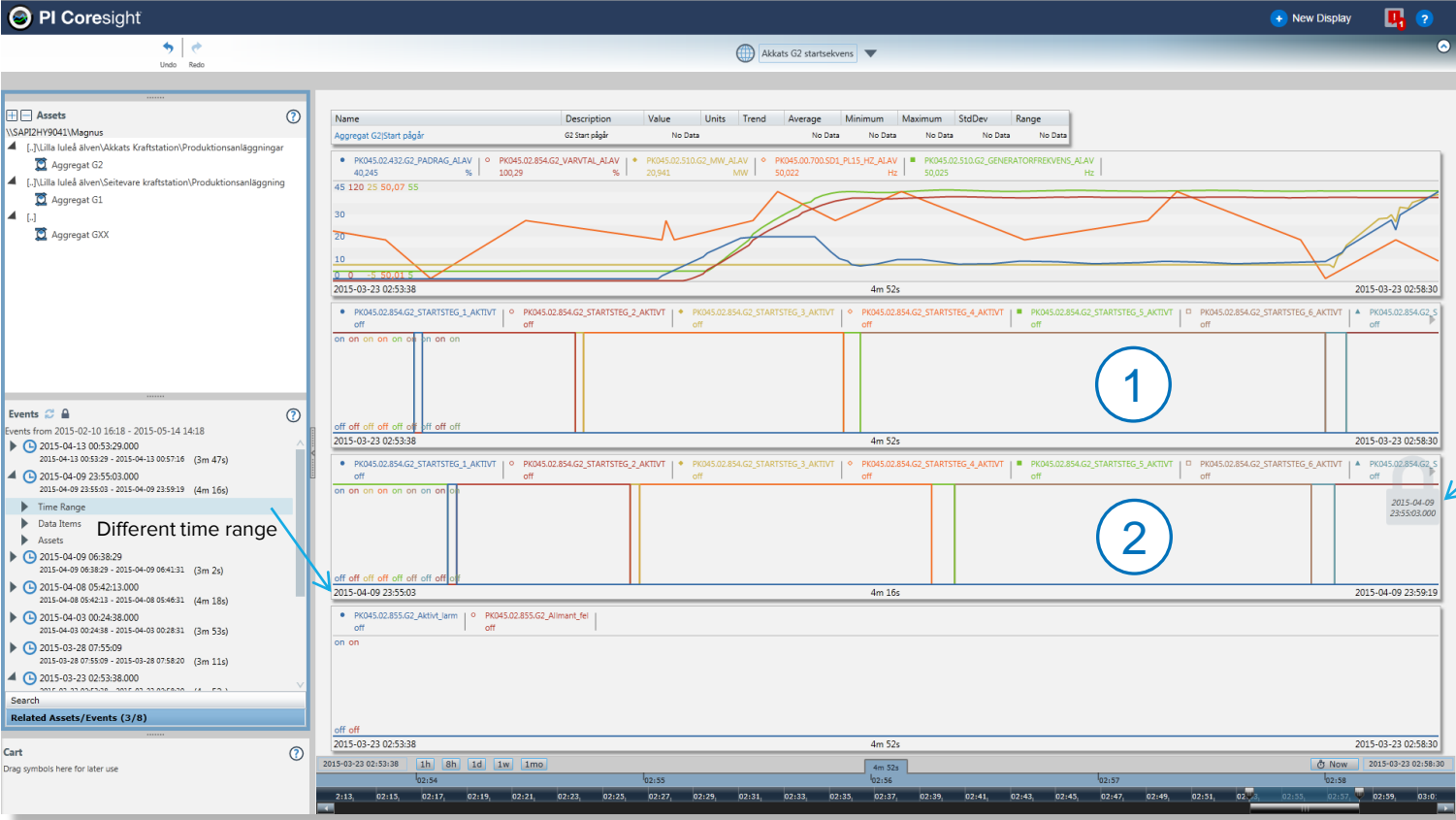
Calculation of technical index ("Analyses" tab)

The screenshot displays the PI System Explorer interface. On the left, the 'Elements' tree shows a hierarchical structure of power plant components. On the right, the 'Analyses' tab is active, showing a table of fault modes and their associated technical index values. Red circles highlight the 'Kärvande bromspress' element in the tree and the 'Kärvande bromspress Tekniskt index' row in the table. Blue arrows point from the labels above to these elements.

| Name | Value | Category | Unit Of Measure |
|------------------------------------|-------|----------|-----------------|
| Bromspress 1 till | on | | <None> |
| Bromspress 1 från | off | | <None> |
| Anliggande bromsar | off | | <None> |
| Tryckvakt tryck efter ventil | off | | <None> |
| Tryckvakt Lågt tryck före ventil | off | | <None> |
| Normtid Bromspress Från - Till | 5 s | | second |
| Normtid Bromspress Till-från | 15 s | | second |
| Norm bromstryck | 4 bar | | bar |
| Kärvande bromspress Tekniskt index | 4 | | <None> |

Calculated index, to be presented in a display and/or used to generate a notification

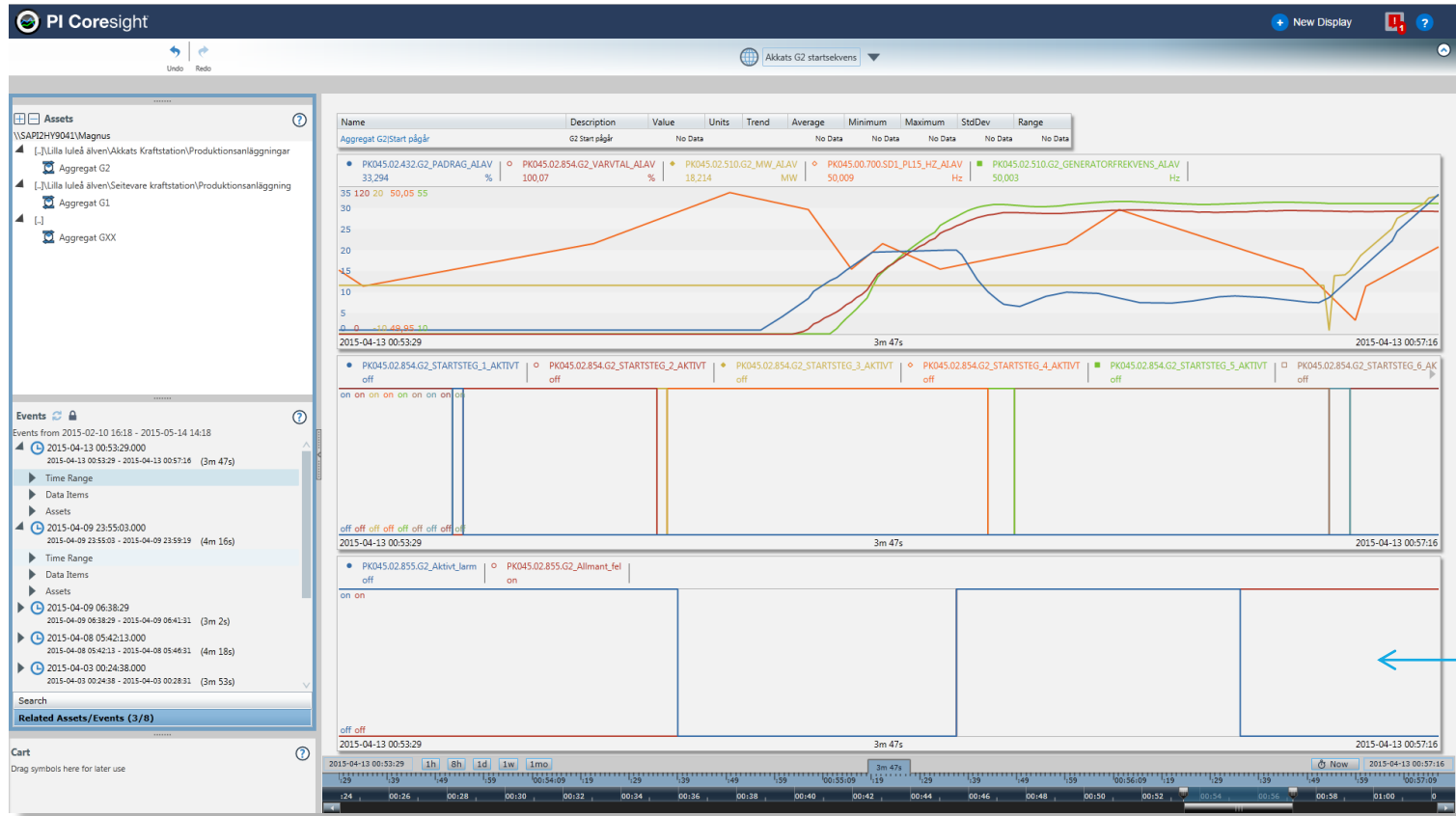
Comparing startup event sequences



Locked

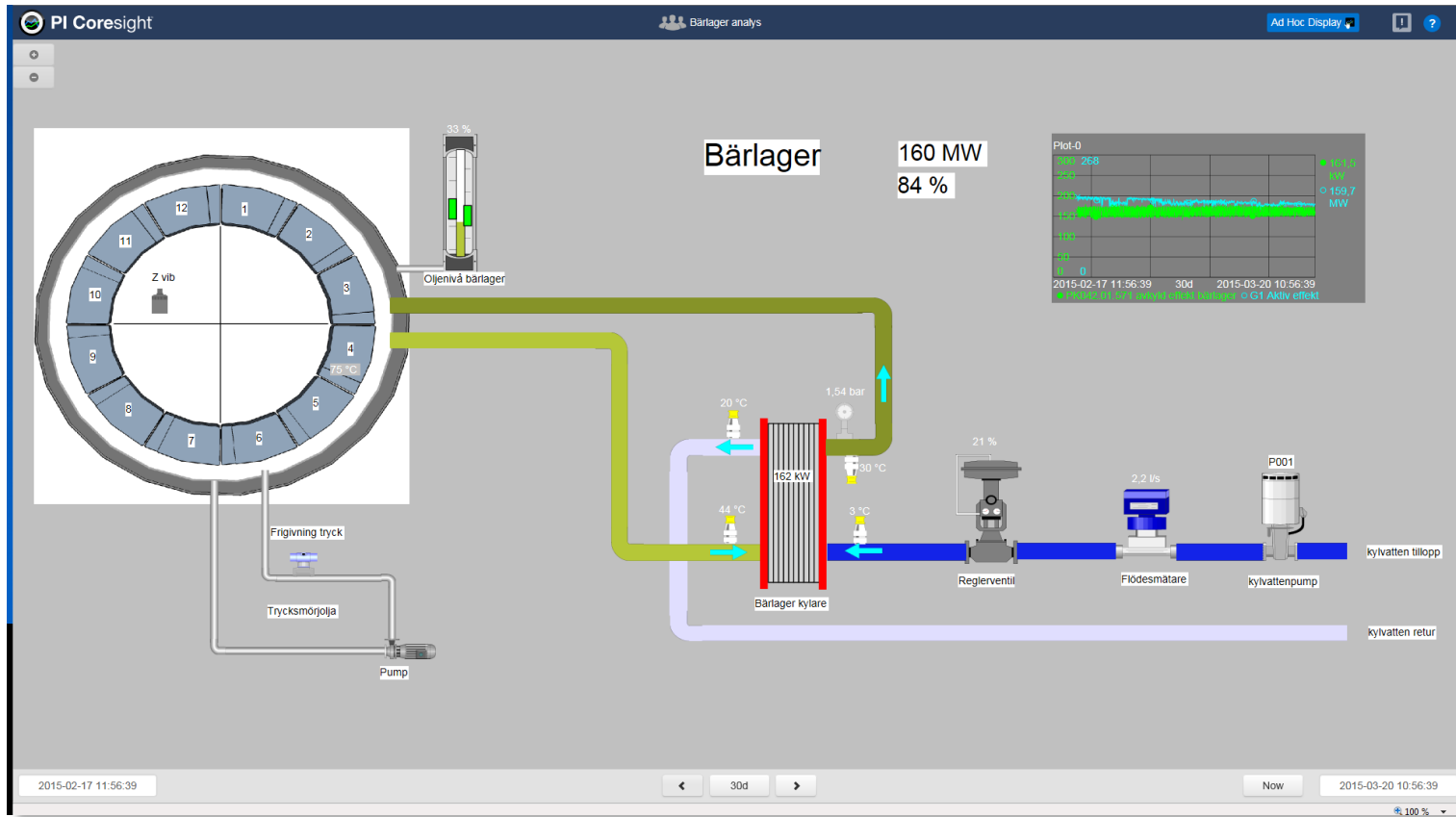
Different time range

Alarm during startup



← Alarm

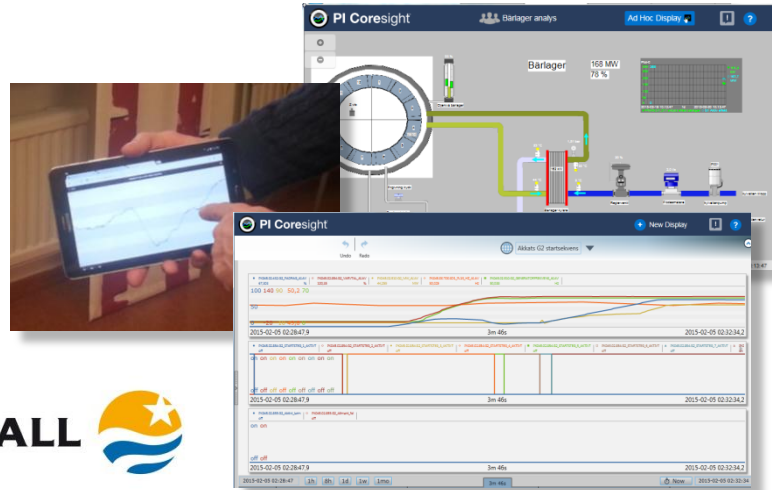
System overview – Thrust Bearing cooling



Deploying a Condition-Based Maintenance Strategy in the Hydro Power Business

“We needed to implement a new strategy and the existing IT solution did not provide the necessary functionality for this. After a thorough evaluation project in 2014, we are now deploying the PI System and use many of the possibilities in the implementation of the new strategy.”

Stina Pettersson
Head Of Maintenance Development
Vattenfall Vattenkraft AB



Business Challenge

- Need for a new strategy and standardised methodology for Condition-Based Maintenance
- Old data historian system is not sufficient

Solution

- Implementing the PI System as data infrastructure, analytical modeling and presentation tool
- Use of Android tablets for on-site manual rounding with PI Manual Logger and visualization of PI System data through PI Coresight displays

Results and Benefits

- Improved common continuous monitoring of the hydro power plants
- Reduced costs for unplanned maintenance (~1.5% of total maintenance costs)
- Increased accuracy in asset condition assessment

Magnus Holmbom

- magnus.holmbom@vattenfall.com
- Maintenance Development Engineer
- Vattenfall Vattenkraft AB



Questions

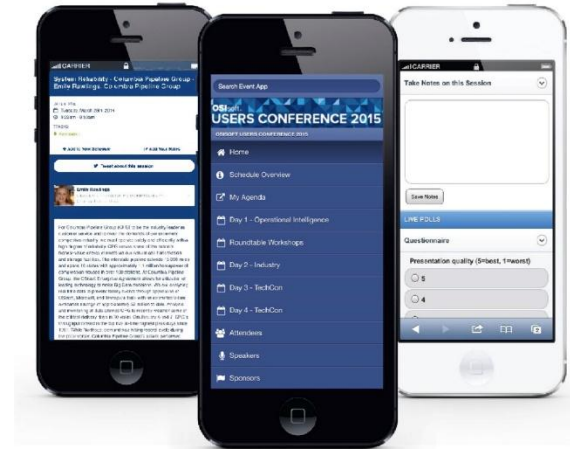
Please wait for the **microphone** before asking your questions



State your **name & company**

Please don't forget to...

Complete the Online Survey for this session



<http://eventmobi.com/emeauc15/>

THANK YOU

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