



PI and PI AF Systems: A dynamic solution for maintenance management

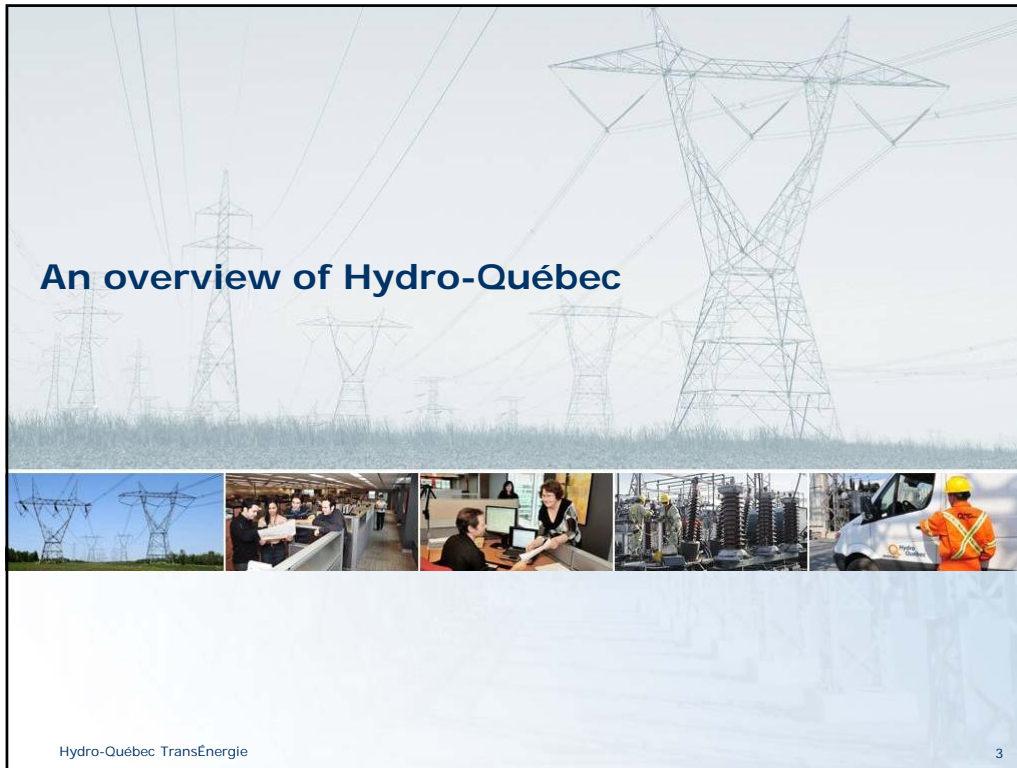
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Engineer – Reliability

October 24, 2012



Contents

- An overview of Hydro-Québec
- The IMAGINE project
- The OSIsoft PI System
- Conclusions



Snapshot

- Hydro-Québec is among the largest power generator in North America
 - 98% renewable energy
- Hydro-Québec is among the largest power transmission companies in North America
- Hydro-Québec is the largest electric utility in Canada

Hydro-Québec TransÉnergie

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This slide has a blue header with the word 'Snapshot'. The background is a light blue with a faint, repeating pattern of power line towers. The content consists of three bullet points with circular markers. The footer includes the company name 'Hydro-Québec TransÉnergie' and the page number '4'.

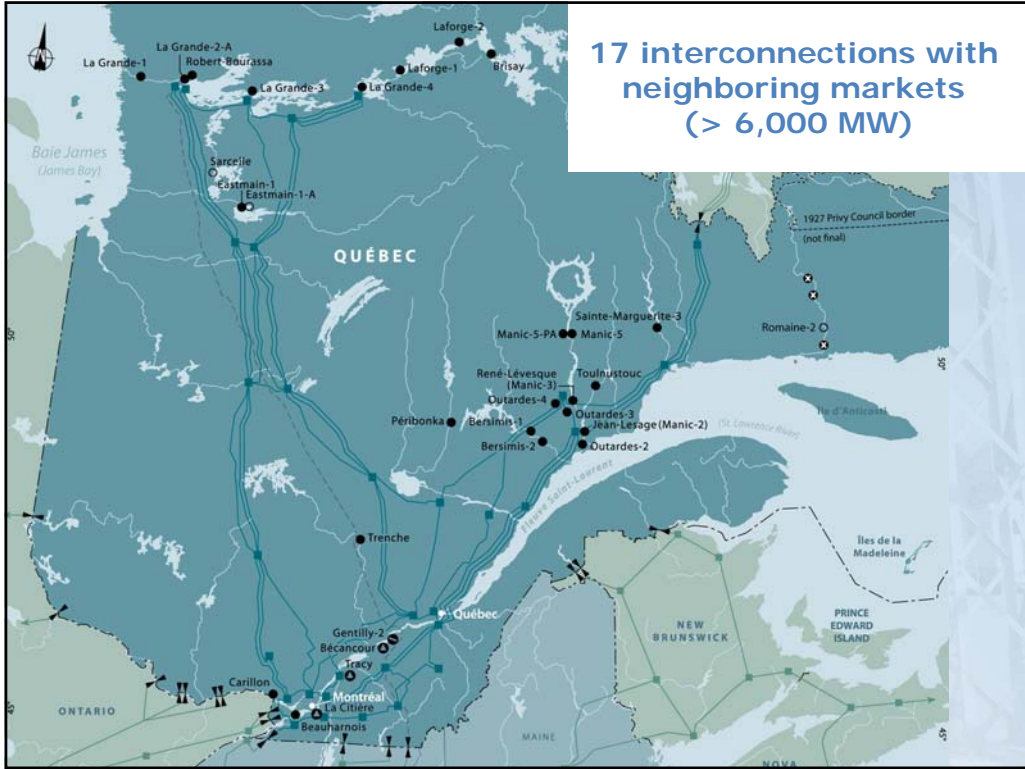
Corporate Structure



Hydro-Québec TransÉnergie



- Transmission assets: \$17.6 B (2011)
- 33,630 km of power transmission lines
 - Including 11,422 km of 735 kV lines
- 514 transmission substations
- Annual investment: \$1,3 B (2011)



The IMAGINE Project

Automated maintenance and remote monitoring data management

Hydro-Québec TransÉnergie

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Background: Major Challenges



- Network: reliable and available
- Exports: growth in sales
- Data: high-quality, value-added and just-in-time
- Decisions: appropriate, timely
- Manpower: massive retirement and renewal of expertise
- Digital technology: use to full potential

IMAGINE: Why?

- Implement new technologies at Hydro-Québec TransÉnergie
 - Remote monitoring and maintenance
 - Remote diagnostics
- Real-time monitoring of equipment
 - Awareness of its condition and performance
 - Transition from scheduled maintenance to condition-based maintenance (based on condition and risk)
 - To maximize system availability



IMAGINE: How?

- Implementation of 2 remote maintenance centres
 - Redundancy
 - Secure centres
- Implementation of 2 remote maintenance laboratories
 - For testing of new equipment
- Connection of several substations
 - Implementation of digital technology
- Addition of new types of jobs
 - Remote maintenance expert technicians

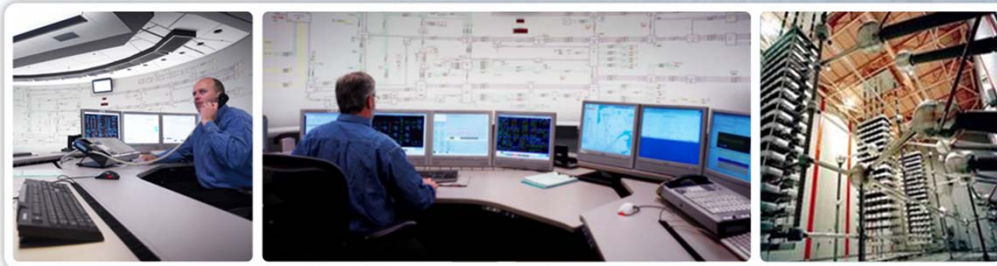
IMAGINE: Phased implementation

- Phase 1: Monitoring of strategic transformers
 - Installation of gas and temperature sensors
 - Connection of protection relays
 - Objectives of this phase
 - Develop a monitoring process
 - Set up the infrastructure and organization needed to ensure real-time monitoring of transformer condition
- Upcoming phases
 - Monitoring of breakers, voltage transformers, relays, etc.



Role of the remote maintenance technician

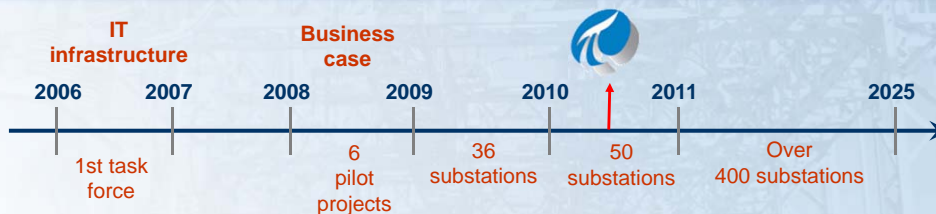
- Monitor the condition of equipment
- React to alerts from equipment
- Consult the data
- Make a diagnosis and characterize the data
- Submit the problem to the unit responsible
- Provide real-time technical support during testing and checking



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IMAGINE: From past to future



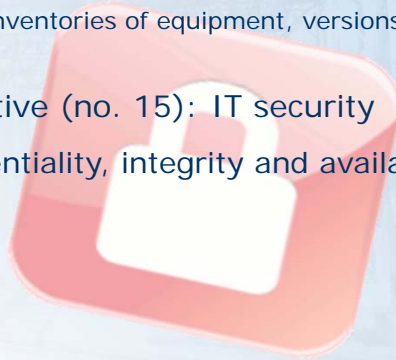
- Use remote monitoring for all growth and asset sustainment projects
 - More than 500 substations over a 15-year timeframe (2009–2025)
 - Objective: 30 to 40 substations a year
 - Connect equipment to a secure IP network
 - Servers and LANs in all substations
 - Replacement of 40,000 relays with digital relays
 - Monitoring of 240 strategic transformers by 2014
 - Monitoring of ancillary equipment

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Security: Strict rules

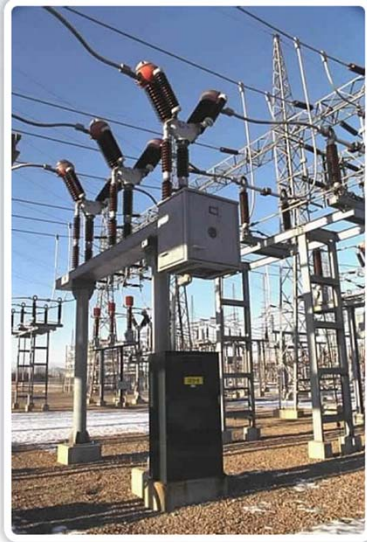
- NERC CIP standards (Critical Infrastructure Protection)
 - Management of system security (access, versions, traceability)
 - Cyber security perimeter (substations, RMCs)
 - Management of critical cyber-asset security
 - Management and inventories of equipment, versions, access
- Hydro-Québec directive (no. 15): IT security
 - Protect the confidentiality, integrity and availability of data



The PI System



Hydro-Québec TransÉnergie is...

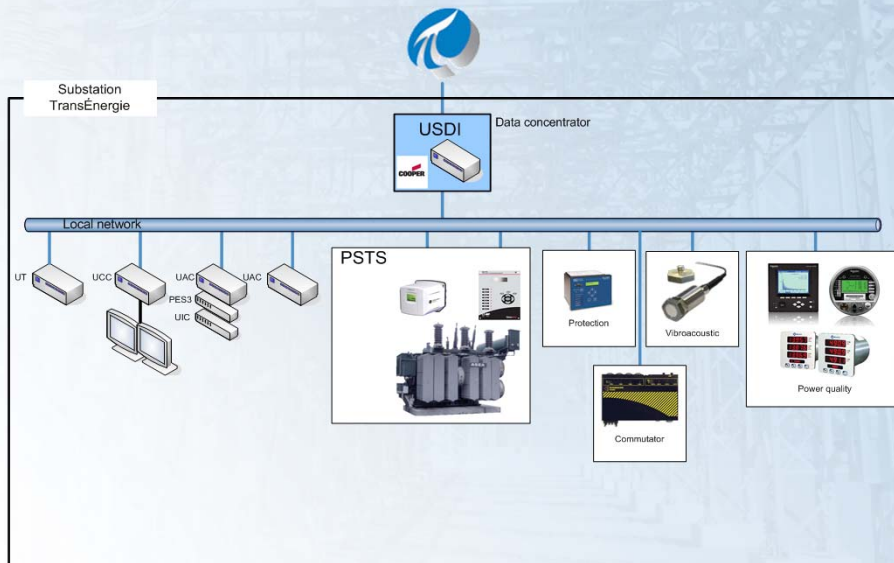


- 514 substations
- 2,200 power transformers
- 8,000 circuit breakers
- More than 40,000 control and protection relays
- On average
 - ~100 sensors per substation
 - ~2,000 PI points per substation
- Potentially more than one million PI points

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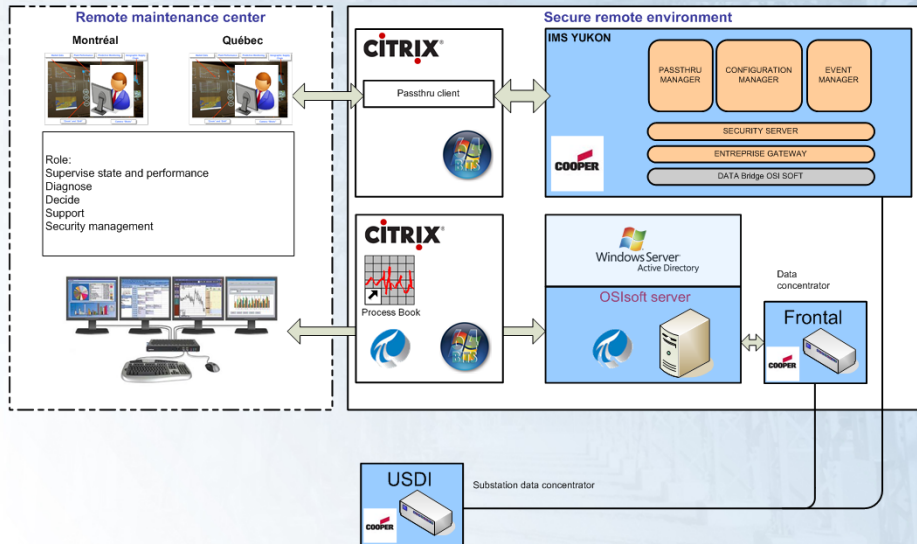
PI points: In a substation



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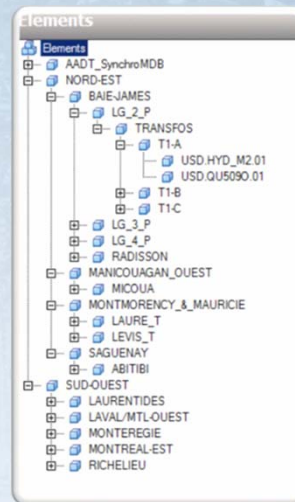
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PI points: From substation to user



PI AF: Asset management

- Recreates equipment tree structure
 - Substations
 - Equipment
 - Sensors
- Pools data from existing systems
 - Equipment specifications
 - Maintenance data
 - Laboratory data
- Manages notifications
 - Sends automated e-mails

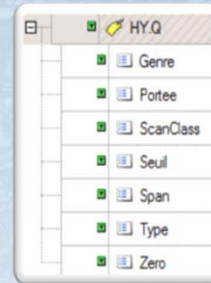


PI AF: Asset management (continued)

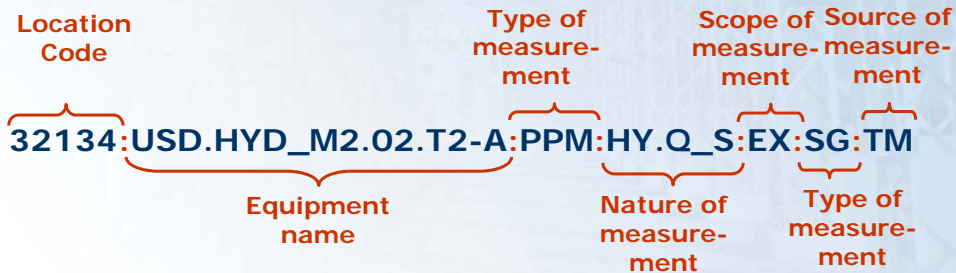
- Maximizes use of templates
 - Components
 - Notifications
- Enables use of plugins (AF SDK) to:
 - refine attributes
 - PI points, table lookup
 - Custom Data Reference to combine attributes
 - optimize notifications
 - Generation of notification templates
 - Generation of notifications

PI points: Generation process

- Script developed in PowerShell
 - Allows automatic addition of points
 - Uses PI APS
 - Uses PI OLEDB/PI OLEDB Enterprise
 - Validates that the source point is properly configured (e-mail)
 - Validates that the PI point added follows the nomenclature (e-mail)

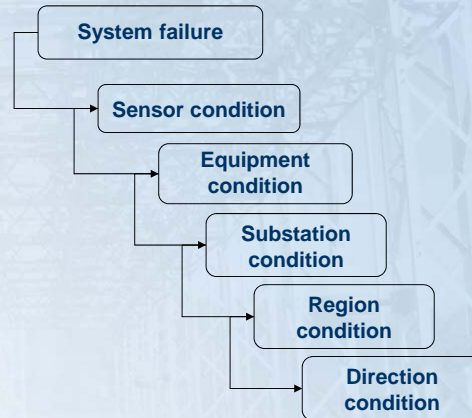


- Example of PI point nomenclature (7 segments)

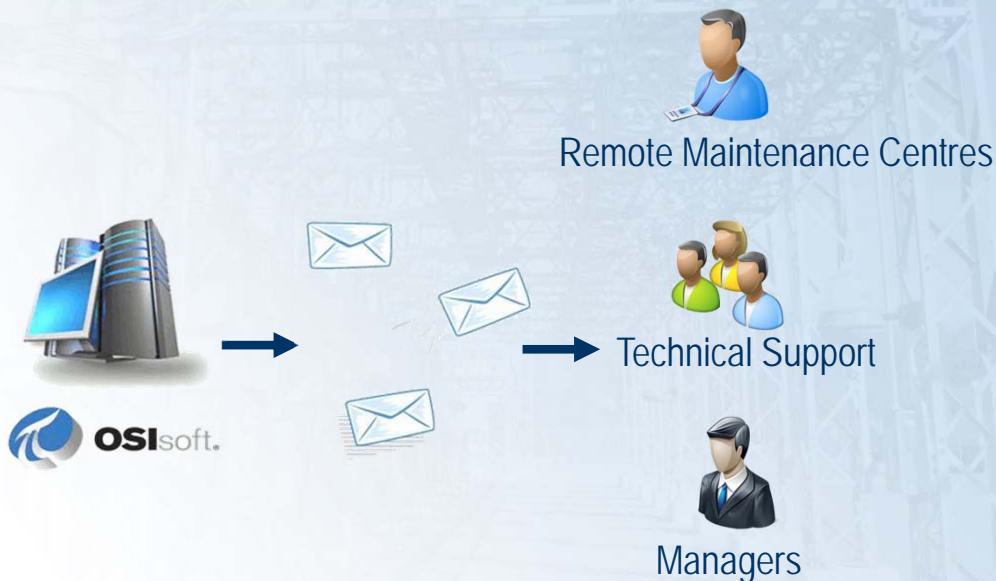


PI ACE: Calculations

- Generation of alert points using PI ACE
- Use of contexts contained in PI AF through MDB to AF synchronization
 - Different calculation module for each level
 - Each level has its own PI alarm point
- Use of PI ACE Manager to apply calculations to different contexts
- Reuse of these alert points in various applications



PI Notifications: Alerts



PI Notifications: Alerts (continued)

Sample e-mail

À : Di Gaetano, Nicolas
Cc :
Objet : LG_4_P:T2-B seuil de gaz dépassé et/ou tendance gaz dissous dépassée.

Equipment identification

POSTE
LG_4_P

EQUIPEMENT
T2-B

DATE
8/8/2012 9:17:00 AM Eastern Daylight Time (GMT-04:00:00)

Measurements at the time the thresholds were exceeded

MESURES ACTUELLES

- Mesure de gaz actuelle: 10 ppm
- Tendance de gaz horaire: 2 ppm/hr
- Tendance de gaz journalière: 1 ppm/jour
- Tendance de gaz hebdomadaire: 0 ppm/semaine
- Tendance de gaz mensuelle: 2 ppm/mois

Thresholds

SEUILS

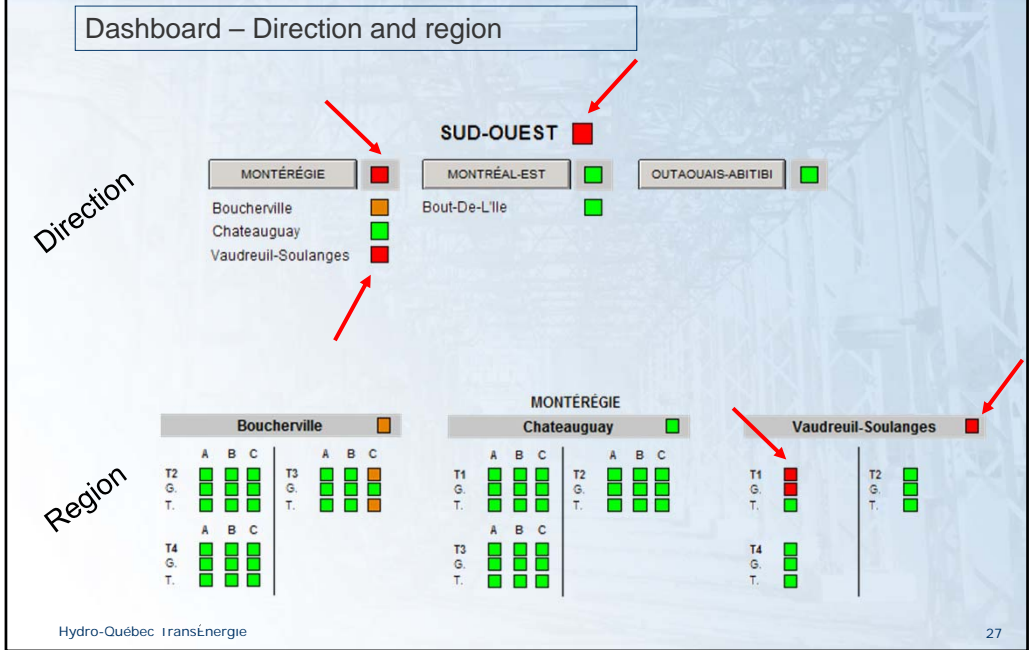
- Les seuils de tendances sont applicables lorsque la mesure de gaz est d'au moins 10 ppm
- Seuil de gaz horaire: 1 ppm/hr
- Seuil de gaz journalier: 2 ppm/jr
- Seuil de gaz hebdomadaire: 3 ppm/sem
- Seuil de gaz mensuel: 4 ppm/mois

PI Processbook: Displays

- Dashboards indicating real-time condition of equipment
 - Indicator lights
 - Numerical values
 - Graphs
- Dashboard by hierarchical level
 - Use of Element Relative Display to change context
 - No need to keep numerous PI Processbook pages

PI Processbook: Displays (continued)

Dashboard – Direction and region



PI Processbook: Displays (continued)

Dashboard - Transformer

Search

Elements of Interest

Filter: []

- SUD-OUEST.MONTEREGIE
- BOU_VIL
- CHATE
- VAU_SOU
- TRANSFOS
- T1**
- T2
- T4

Direction: SUD-OUEST Âge: 3

Région: VAU_SOU Âge apparent: 4.35

Poste: VAU_SOU Cote: 3

Type: Poste(s) satellite(s) Probabilité: 1

Équipement: 1UX0020 Ans avant probabilité 9: 63.66

No expl.: T1 Âge apparent potentiel: 2.35

Responsable: 10162ELE Probabilité potentielle: 1

LISTE INDICATEURS			INFORMATIONS SUR L'ÉQUIPEMENT	
Indicateurs	Cote	Pondération	Fabricant	MEGATRAN ELECTR
Antécédents Familiaux	0	5	Date fabrication	01/01/2007
Papier	0	5	Date Mise en Service	01/04/2009
Gas Dissous	0	5	Année Remise à Neuf	No Data
CPC	0	3	Tension Primaire (kV)	120.00
Traversées	1	3	Tension Secondaire (kV)	26.40
Eau	0	5	Puissance 1 (MVA)	28.00
Huile	0	4	Puissance 2 (MVA)	37.00
Accessoires	0	3	Puissance 3 (MVA)	47.00
Fuites Huile	0	3	CPC Fabricant	ABB
			CPC Modèle	UZFRN

ÉTAT DU TRANSFORMATEUR

État: [Green Box]

État du transformateur: [Graph showing Normal state]

LEGENDE

- Communication normale
- Alertissement en vigueur
- Donnée non définie

BOUONS DE NAVIGATION

- BONDE GAZ
- BONDE TEMPÉRATURE
- PAGE MONTRÉGIE
- PAGE SUD-OUEST
- ACCUEIL

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PI Processbook: Displays (continued)

Dashboard – Gas sensor

Search

Elements of Interest

Group by: Template

Filter

Name
SUD-OUEST/MONTEREGIE
BOU_VIL
CHATE
VAU_SOU
TRANSFOS
T1
USD.HYD_M2.01
USD.QU5095.01
T2
USD.HYD_M2.02
USD.QU5095.02
T4
USD.HYD_M2.03
USD.QU5095.03

Alarme générale	■	Poste:	VAU_SOU	Fabricant:	GE
Alarme non acquittée	■	Transfo:	T1	Équipement:	1UX0020
Panne système hydran	■	Sonde:	USD.HYD_M2.01	Modèle:	Hydran
Panne communication	■	Local:	35167	No. modèle:	M2
État sonde	■	Date essai EVA:	3/3/2011 10:00:00 AM		

GAZ DISSOUS		HUMIDITÉ		BATTERIE	
Gaz 1er niveau	■	Humidité 1er niveau	■	Voltage (V)	3.35
Gaz 2e niveau	■	Humidité 2e niveau	■	Pile faible	■
Gaz (ppm)	10.00	Taux humidité (ppm)	0.00	Pile très faible	■
Gaz EVA (formule GE)	55.95	Taux humidité EVA	9.00		

Tendances		Tendance	
Heure (ppm/heure)	0.00	Semaine (ppm/semaine)	0.00
Jour (ppm/jour)	1.00		
Semaine (ppm/semaine)	0.00		
Mois (ppm/mois)	0.00		

Taux d'humidité et gaz dissous

● 0.0000
● 10.000
● 36.800

PLAQUE CHAUFFANTE	
Haute température	■
Très haute température	■
Basse température	■
Très basse température	■
Température (°C)	36.80
Pourcentage utilisation (%)	9.00
Réglage (°C)	35.10

REPLACEMENT SONDE

Maintenant ■

Bientôt ■

LÉGENDE

■ Communication normale

■ Avertissement en vigueur

■ Donnée non définie

BOUTONS DE NAVIGATION

PAGE TRANSFO

EDGE TEMPÉRATURE

PAGE MONTRÉGIE

PAGE SUD-OUEST

Conclusions



Advantages

- Transformers
 - Avoiding major failures (May 2011)
- Equipment
 - Awareness about equipment condition as it ages
- Sensors
 - Detection of malfunctioning equipment
 - Avoiding unavailability and captive power
- Settings
 - Improvements on many pieces of equipment



Next steps

- Continue to connect as many pieces of equipment as possible
- Optimize the expert system
- Evolve toward predictive maintenance
- Incorporate PI WebParts / PI Coresight



Thank you for your attention!

Questions ?

