

IEEE PES GM 2010

WG Smart Distribution

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**Improving the potential of
distribution IEDs for the sake of
Smart Distribution applications**

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Smart Distribution Applications

- Applications:
 - Volt & VAR Control,
 - Fault Location,
 - Feeder Restoration
 - *FLISR (Fault Location, Isolation, and Service Restoration)*
 - Remote Equipment Predictive Maintenance,
 - Remote Power Quality Monitoring, ...
 - Feeder Reconfiguration (*future application*)
 - *For system optimization (minimize losses...)*

Distribution IEDs

Grid

- Major Equipment Controls (RTU):

- Recloser



- Voltage regulator



- Switch



- Capacitor Bank



Customer premises

- Revenue meters:



Substation

- Revenue meters:



- IED:



- Control (RTU):

- Feeder Breaker:

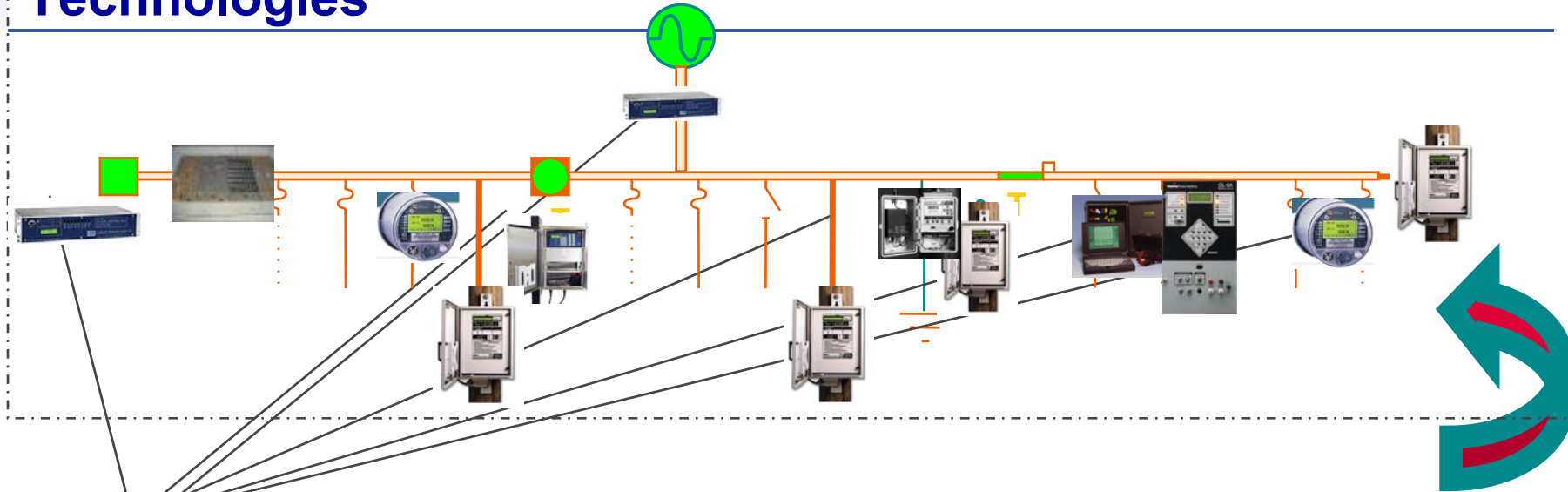


Distribution IEDs (Controls/RTUs) and Data Acquisition

- Metering available on three-phase basis:
 - Voltage, Current,
 - Power, Energy,
 - PF,
 - Frequency,
 - Voltage & current harmonics + THD,
 - Phase angle (available on very limited number of controls),
 - Symmetrical sequences,
 - **Waveform capture** (available on reduced number of controls).
- Communication interface and protocols:
 - Multi-port (serial, infrared, FO, Ethernet, modem, wireless),
 - Multi protocol access (DNP 3.0, Modbus, IEC 61850,..).
- GPS
 - port IRIG-B.

Smart Distribution System - Flow of Information

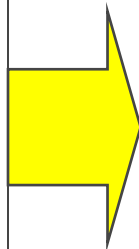
Technologies



Data

(Using what?)

- Power, Energy
- Voltage
- Fault Currents
- Load Currents
- Temperature
- Number of Operations
- Alarms
- ...



Applications

(How?)

- Remote controlling of MV Equipment
- Volt and VAR Control
- Fault Location
- Load Management
- Power Quality Evaluation
- ...

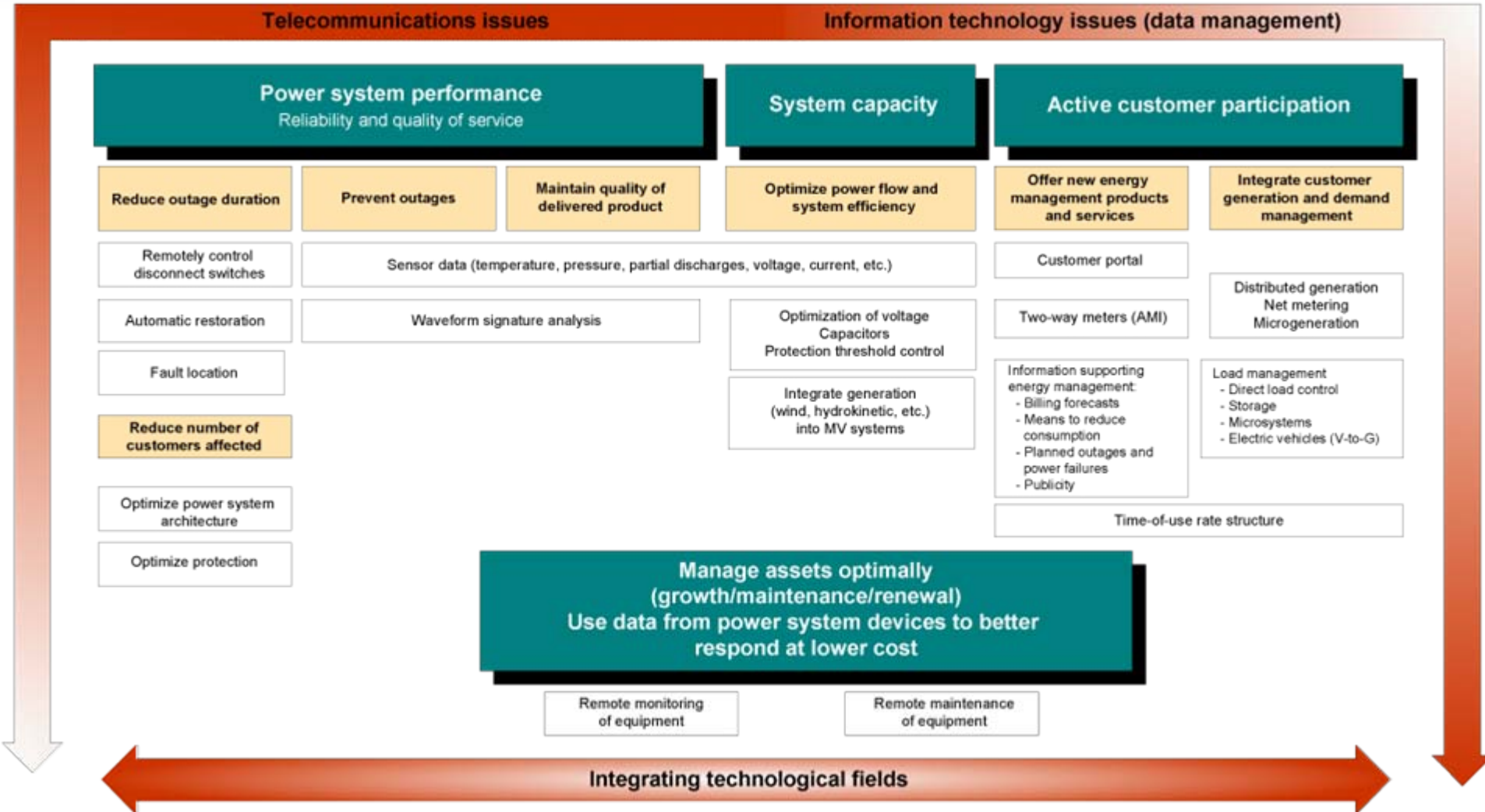


Business needs

(Why?)

- System Performance
 - Reliability and Power Quality
- Power Flow and Energy Efficiency
- Customer Empowerment (not in the near future)
 - Distributed Resources
 - Load Management
- ...

HQD Smart Distribution - Framework



Hydro-Québec's Monitoring Project – (EPRI PQA/ADA conference 2007 & IEEE PES GM 2008)

- Facilities available at HQ's Research Center:
 - Distribution test feeder
 - Control room



Controls tested during the Monitoring project

Pole-mounted equipment Manufacturer/Model	Associated control Manufacturer/Model
Recloser Cooper/VWVE	SEL-351R, 651R
Recloser Cooper/NOVA	Cooper – Kyle/Form 6
Recloser Joslyn/TRIMOD	Joslyn/SEL-351J
Recloser ABB/OVR3	ABB/PCD-2000
Switch S&C	S&C/M Series
Voltage regulator McGraw Edison/VR-32 50A	Cooper/CL-6A

Meters tested during the Monitoring project

Company	Meter Model
Schneider/PML	ION 8500, ION 8600, ION 8800
Electro Industries	Nexus 1252, 1270, 1500 , Futura +, Shark 100
Landys & Gyr	MaxSys Elite
GE Energy	kV2c+

Hydro-Québec's Monitoring Project (continued)

Conclusions on metering:

– Control Measurement Accuracy and Linearity

The accuracy of controls measurement is acceptable, but the measurements do not fully comply with international standards. The question remains whether controls/RTU can meet **class S criteria** as defined by IEC 61000-4-30.

– Control Sampling Rate

Controls have a sampling rate ranging from 16 to 32 samples/cycle. A sampling rate of 16 samples/cycle gives a low resolution. A rate >32 samples/cycle offers a better resolution for ADA applications.

– Meter Accuracy and Sampling Rate

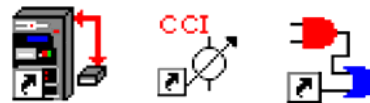
The accuracy of meters is higher than that of controls. The meters comply with some of the international standards. Their sampling rate ranges from 128 to 1024. Some of them comply partially or fully with **class A criteria** as defined by IEC 61000-4-30.

Communication software for controls and meters

- Recloser:



- Voltage Regulator:



- Switch:



- Capacitor Bank:



- Meters:



Communication software for controls (continued)

Conclusions on software

- Controls, relays and meters come with home made software interface, not compatible with each other, making it difficult for distribution engineers and technicians to communicate with the equipments, retrieve and interpret data.
 - Most of the software interfaces are user friendly; some interfaces are more complex and difficult to use.

- Data file format:
 - Data provided by controls, relays and meters come in different file formats: text, PQDIF, COMTRADE, SQL, etc. The data handling should be done manually, most of the time. Very rare exceptions.

Smart Distribution Equipment Controls – The RTU/IEDs of Tomorrow

- Major Power Distribution Equipments and Controls
 - Already in place on the grid
 - In a constant evolution
 - Controlled remotely (communication available)
- Metering available and useful for Smart Distribution applications and Integrated PQ Monitoring System

Recloser control



Recloser

Switch control



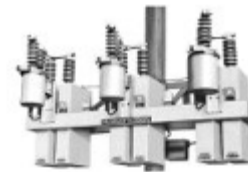
Switch

Voltage regulator control



Voltage Regulator

Capacitor bank control



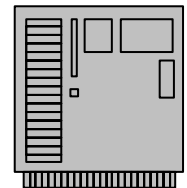
Pole mounted Capacitor Bank

Revenue Meter



Pole mounted Transformer

Standardized control



Data Acquisition – Metering Options

- Metering options:

- Instrument transformers (CT \approx 2K\$, PR \approx 2K\$, Combo \approx 3 to 4k\$),
- Sensors (combo \approx 2.5K\$) + Electronic Interface (2k\$),
- Distribution transformers ($<$ 1K\$),
- Integral CT & PT (included in the cost of the equipment)

- Metering accuracy:

- Instrument transformers (0.15% to 0.3%),
- Sensors (0.2% to 1%),
- Distribution transformers (0.6%),
- Integral CT & PT (1% to 2.5%),
(*phase angle error $\pm 1.5^\circ$*).



Data Acquisition – Update needed for controls of equipment such as reclosers and

- Today's major distribution equipment and controls are better performing than 2007 models.
- Equipment with integral
 - Transducers,
 - CTs,
 - PTs.
- Recloser Controls follow the path that intelligent meters took some time ago:
- Measurement:
 - Load Profile
 - Synchrophasor Measurements
 - Oscillography
 - Length 15, 30, or 60 cycles for a total storage of 11 seconds of analog and binary
 - Sampling:
 - 128 samples per cycle unfiltered
- Communication ports:
 - EIA-232, EIA-485 (optional)
 - Baud Rate 300—57,600 bps
 - USB Ethernet
 - *IRIG-B*
- Protocols:
 - Mirrored Bits® Communications
 - IEEE C37.118 Synchrophasors
 - IEC 61850
 - Modbus® TCP, RTU
 - Telnet
 - DNP3 Serial, IP
 - *Web Server*
- Maintenance:
 - Recloser Wear Monitor
 - Battery System Monitor

HYDRO-QUÉBEC (IREQ)'s DACCORD Project

- *Suggest/Propose a new strategy for conception, integration, deployment and utilization of a RTU/IED/Control (DACCORD):*
 - *Three stages :*
 - *New concept of RTU/IED:*
 - *Strategy for integration, deployment and **operation** compatible with the Smart Grid architecture (new feature: **P&P (interoperability)**)*
 - *New strategy of how to use RTU/IED's advanced functions developed for Smart Distribution applications:*

HYDRO-QUÉBEC's DACCORD Project (continued)

- ***New concept of RTU/IED:***
 - *Hardware (modular)*
 - *Main board with CPU,*
 - *Front panel (including screen),*
 - *Communication interface,*
 - *Electronic interface (required by voltage and current sensors)*
 - *Contacts blocs.*
 - *Backup power supply.*
 - *Firmware multi platform (CIM?) including advanced functionalities:*
 - *Main function,*
 - *Metering,*
 - *Maintenance,*
 - *PQ,*
 - *Security.*
 - *User interface (communication software + protocols).*
 - *IEC 61850 version for Smart Distribution?*

- **Strategy for integration, deployment and *operation* compatible with the Smart Grid architecture (new feature: *P&P (interoperability)*)**
- **New strategy of how to use RTU/IED's advanced functions developed for ADA applications:**
 - *Main functionality (protection, regulation, reconfiguration, VAR control)*
 - *Remote-metering*
 - *Remote-predictive maintenance*
 - *Smart Distribution Applications (VVC/CATVAR, Fault Location/MILE, Feeder Restoration, PQ Monitoring,..... *Feeder Reconfiguration (future)*)*

Hydro-Québec's DACCORD Project — Next Steps

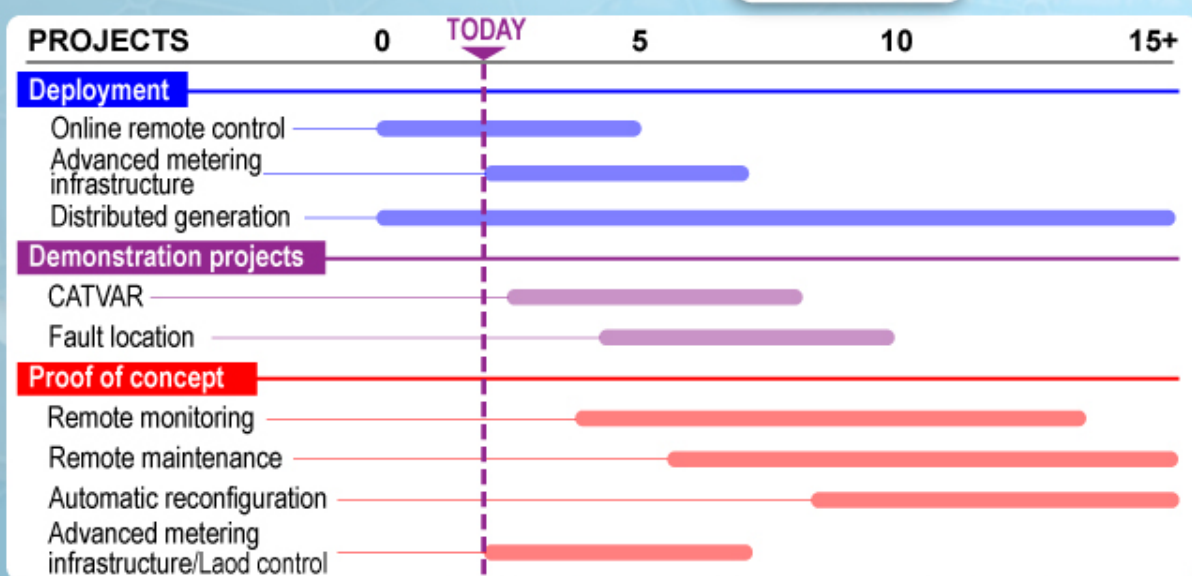
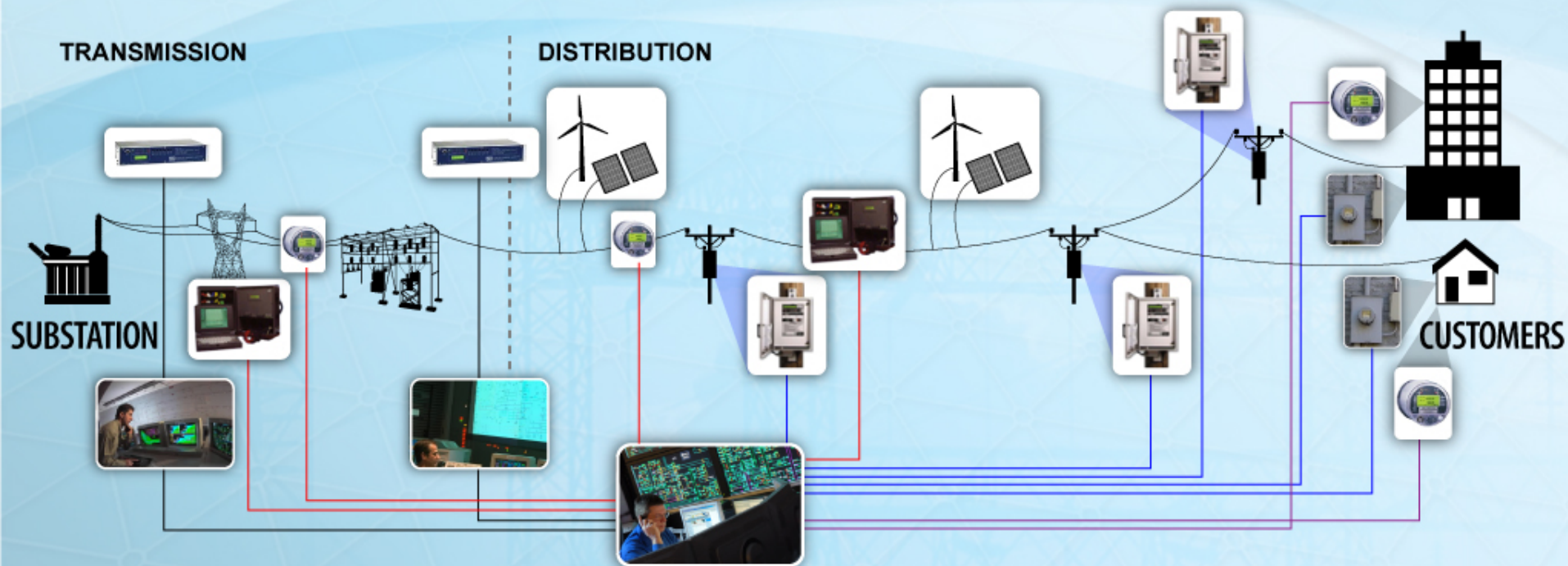
Hydro-Québec's project tries to:

- initiate a debate, within Smart Distribution related Working Groups, on “*Improving the potential of distribution IEDs for the sake of Smart Distribution Applications*”
- Influence Smart Grid related Working Groups to start working on definitions of standardized RTU/IEDs modular hardware and software in order to make possible the edition of future related standards.
- Influence distribution equipment manufacturers to develop standardized models.
- Collaborate with others utilities, manufacturers and organizations.

Final goal:

- **Influence future standards**

Achieving a Truly Smart Grid



Developing a smart grid based on a plug-and-play approach supported by international standards