ABSTRACT
This paper presents Hydro-Québec’s distribution vision and roadmap. First a quick overview of the inputs (industry benchmark, customers’ expectations, Québec’s context...) that were used to build the vision and roadmap will be described. Then from these inputs, business objectives were stated by Hydro-Québec’s management. To meet these objectives, the vision selected a set of applications and technologies. It covers the overall evolution of the distribution system by proposing strategies for asset management, data management and technology management. Finally to move from today’s distribution network to tomorrow’s Smartgrid, the vision and roadmap shall evolve to consider influence factors in the years to come.

INTRODUCTION
Today’s distribution utilities are facing the challenge of managing a network made up of assets originating from mature and proven designs, while having to integrate new technologies aimed at optimizing the quality of service to customers and the efficiency of its activities. The basic assets (poles, conductors, underground cables, civil-engineering structures and major apparatus) of present distribution networks represent 97 % of the value of Hydro-Québec Distribution (HQD) network assets. Just like other distributors, HQD is concerned about the impact of the ageing of its infrastructures on network performance and on increasing refurbishment and maintenance costs. Considerable effort is being made to establish new network refurbishment criteria in conjunction with risk management in order to optimize investments and maintain service quality. On the other hand, control and measurement technologies are increasingly present on the entire distribution network. For now, they represent only about 3 % of HQD’s assets. But since telecommunications and computerized control technologies are more accessible to the electrical distribution industry, the trend is to make use of such technologies to enhance distribution network performance through dynamic information management leading to active distribution systems.

INPUTS TO DEFINE HYDRO-QUÉBEC'S BUSINESS OBJECTIVES
The inputs to build Hydro-Québec's distribution business objectives are based on industry benchmarking, customers’ expectations for both reliability and power quality and existing Hydro-Québec’s development plans. All this information was regularly presented to HQD upper management to validate the different steps leading to the final vision and roadmap.

Benchmarking
Basic infrastructure
Benchmarking shows that the basic assets (poles, conductors, underground cables, civil-engineering structures and major apparatus) of future distribution networks will be more or less made up of the same technologies that are currently used [1]. Another conclusion of the benchmark is that the investment ratio to renew the distribution infrastructure is generally insufficient for most utilities. The industry is looking to optimize investment through risk management, extending the life of the assets, etc.

Active distribution systems
The general industry trend is really toward the development of active distribution systems through telecommunications and computerized technologies. Control and measurement technologies are the focus of major initiatives in Europe (Smartgrid) [2] and the U.S. (Advanced Distribution Automation [3]) regarding the development of such “smart” distribution networks. These initiatives propose different active distribution systems that can be summarized by some common points:
- The future of the distribution industry is secure, at least through 2025; there is no technology on the horizon that will replace the grid
- The future distribution system will integrate DER to become an energy exchange network
- The grid has to get more intelligent

Customers’ Expectations
Considering the general view of the industry, HQD has to take into account its immediate context and its existing development plan. The level of customer satisfaction regarding the reliability of the electrical service is relatively high (close to 8 out of 10). For the power quality, the latest
survey and benchmark demonstrates that HQ power quality is among the best of North-American power utilities.

**HYDRO-QUÉBEC’S BUSINESS OBJECTIVES**

From all these inputs (benchmarks, Hydro-Québec customers’ expectations, existing development plans …) the retained business objectives regarding reliability and power quality can be summarized as follows.

**Reliability**

To maintain the high level of customer satisfaction regarding the reliability of the electrical service (close to 8 out of 10), two business objectives were retained:

For all customers

- Ensure a standard system average interruption duration index (SAIDI) of 100 minutes, without exceeding 110 minutes with a 95% probability level. This represents a global improvement of about 20%.

For the Montreal downtown area, which is characterized by high economic density:

- Maintain reliability to under 60 minutes during business hours (6:00 a.m. to 9:00 p.m.).

The distribution automation program is the main contributive effort to the SAIDI and SAIFI improvement. HQD will continue to improve the reliability of its network and adjust its objectives based on its performance, its customers’ expectations, technological options and costs.

**Power Quality**

HQD is seeking to maintain its ranking as one of the leading companies in North America for Power Quality.

To do so, two business objectives have been set:

- Continue information and support services to customers whose installations are sensitive to Power Quality.
- Measure the Power Quality in order to qualify it and be able to respond at the right time to satisfy customers.

**HYDRO-QUÉBEC DISTRIBUTION NETWORK VISION**

To meet these business objectives, Hydro-Québec has defined an integrated vision of the distribution network roadmap grouped into seven major domains of activity: operation, maintenance, metering, distribution system energy efficiency, dispersed generation, network renewal, and design of overhead and underground networks. Their development over the period 2008-2023 is represented as in Fig 1.

The three domains that will be the most affected by technological change are operation, maintenance and metering. They will be – and already are – affected by the availability of telecommunications and new control and metering technologies. These domains, which require the same type of information, will migrate to telecontrol, telemetering, and maintenance by remote diagnostics.

![Fig. 1 Hydro-Québec's distribution network Vision and Roadmap](image-url)
The analyses performed using the data and measurements obtained with these technologies will help improve network performance. The new information will be integrated while favoring the existing data management systems.

**Evolution of Distribution Operation**

The first years will be spent on implementing feeder remote control programs. Network telemonitoring will then lead to better real-time network management through the acquisition of information from the network (overhead and underground). At the end of the plan’s timeframe, data coming from the network will enable the command of the technologies to allow automatic distribution network restoration systems for ongoing improvement of network performance.

**Evolution of Distribution Maintenance**

Systematic corrective and preventive maintenance is expected to evolve towards conditional preventive and forecasting maintenance to reduce the number of service interruptions and ensure better management of work on the network.

**Evolution of Metering**

As a first step, to reduce operating costs, the domain will evolve from manual to remote meter reading, basically through the use of RF meters. Then, depending on customers’ expectations and market conditions, smart meters are expected to be implemented. Data coming from metering will also be used by other domains to improve overall network performances.

**Evolution of Distribution System Energy Efficiency**

The main driving force is the reduction of the Distributor’s energy costs through optimized control of energy consumption, demand and losses. For the project involving voltage reduction and the control of feeder capacitors, energy savings of roughly 2.0 TWh are expected for 2015. Then, depending on customers’ expectations and market conditions, demand side management should be integrated.

**Evolution of Dispersed Energy Resources**

HQD is able to integrate these technologies but does not expect a high penetration level as long as decentralized generation is not able to keep abreast with Quebec energy costs. However studies are undergoing to prepare the introduction of electrical power vehicles.

**Distribution System Renewal**

Through a gradual increase in the renewal rate of network assets combined with maintenance strategies that are prioritized based on their impact on reliability improvements, HQD is seeking to strike a balance between target performances, the optimization of its facilities, and the required level of financial resources.

**Evolution of Distribution Overhead and Underground Design**

The civil-engineering and electrical infrastructures will see slow development based on performance improvements and optimized costs. Overhead networks will see the design of lines tailored to local, climatic and other conditions (an example would be the reinforced or robust network as a result of the 1998 ice storm).

**STRATEGIES TO FULLFIL THE VISION**

**Asset Management Strategy**

The basic infrastructure represents 97% of the value of the assets. Therefore it is important to optimize these assets through maintenance strategies, extending the life of the system, managing the risk, etc. Although several actions are already undergoing, there is still place to further studies and improvements. These will need more accurate data and analysis.

HQD already designed a strategy to establish a proper investment ratio for the future. The following diagram describes the short-term financial approach. It shows annual renewal investment versus time. The methodology used will determine the current level of investment and the potential level of investment to ensure network renewal. The latter relies mostly on rebuilding cost and lifetime of components. The time to reach the average level required to ensure network robustness relies mainly on demographics, asset condition and replacement strategies.

**Data Management Strategy**

The data management strategy is to prepare for tomorrow’s distribution system by structuring the existing data systems and by preparing the tools and staff to face these changes. The identified data needs are intended for:

- asset management and operations optimization
using existing HQD information systems in order to provide proper and essential information for evolving customers’ need.

The development of the future applications and technologies shall be made through “smart” engineering and “smart” management that will help to fulfill the present and future business objectives. These developments will be done through a step by step process (stage gate) using both R&D and Distribution resources. The control and measurement equipment represent 3% of the value of the assets. However these technologies will be the source of most of the electrical information needed to increase the performance of the future active distribution system. It is wise to invest in these technologies to better know the quantity and quality of the product delivered to customer.

**EVOLUTION OF THE VISION AND ROADMAP**

The roadmap and vision shall be updated every two years to include the impact of internal and external influence factors that might change the future business objectives in the years to come. For the future, HQD is looking closely to the impact of electric transportation, green distributed resources and load management.

**CONCLUSION**

Hydro-Québec Distribution has designed an integrated vision and roadmap based on business objectives. From this vision three major strategies were defined:
- Asset management strategy
  - To establish a proper investment ratio for the future.
- Data management strategy
  - To obtain a better knowledge of today’s distribution system and prepare for tomorrow’s active distribution system to take the right decisions to meet the evolving business objectives.
- Technology strategy
  - To focus on the technologies most likely to achieve Hydro-Québec’s business objectives on reliability and Power Quality

**REFERENCES**

