



# Hydro-Québec's experience with High Voltage XLPE insulated Cable Systems

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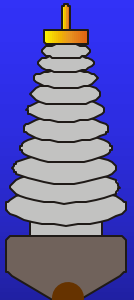
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## Presentation outline

- Introduction
- Hydro-Quebec underground transmission system
- HV XLPE insulated cable and accessories technology
- Main steps in technology switch
- First 120 kV cable project
- 230kV and 315 kV cables
- Cost reduction solutions
- Partnership agreement
- New cable system design
- Civil work
- First project using the new cable system
- Conclusion
- Question period

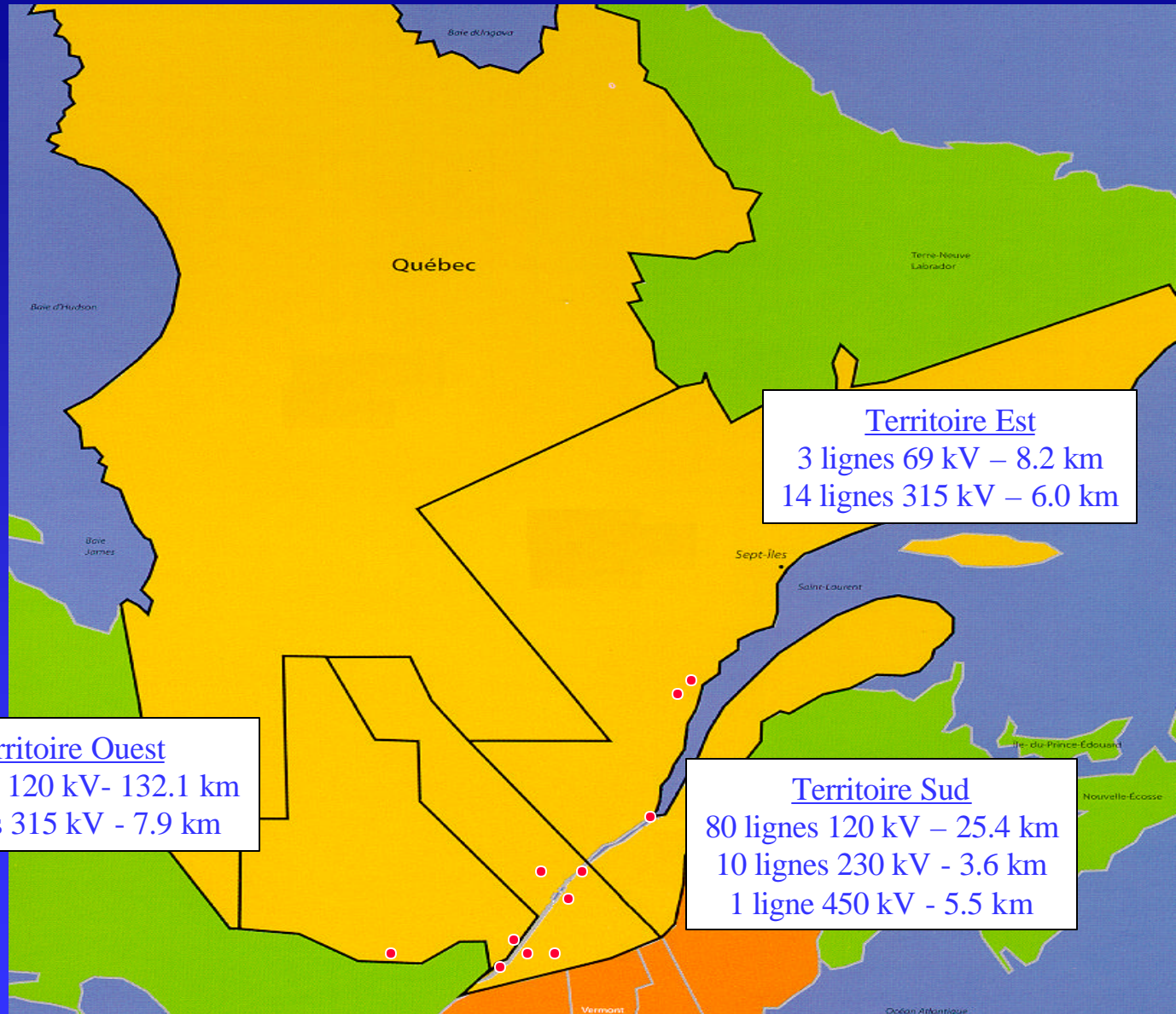




# Hydro-Quebec Underground HV Transmission System

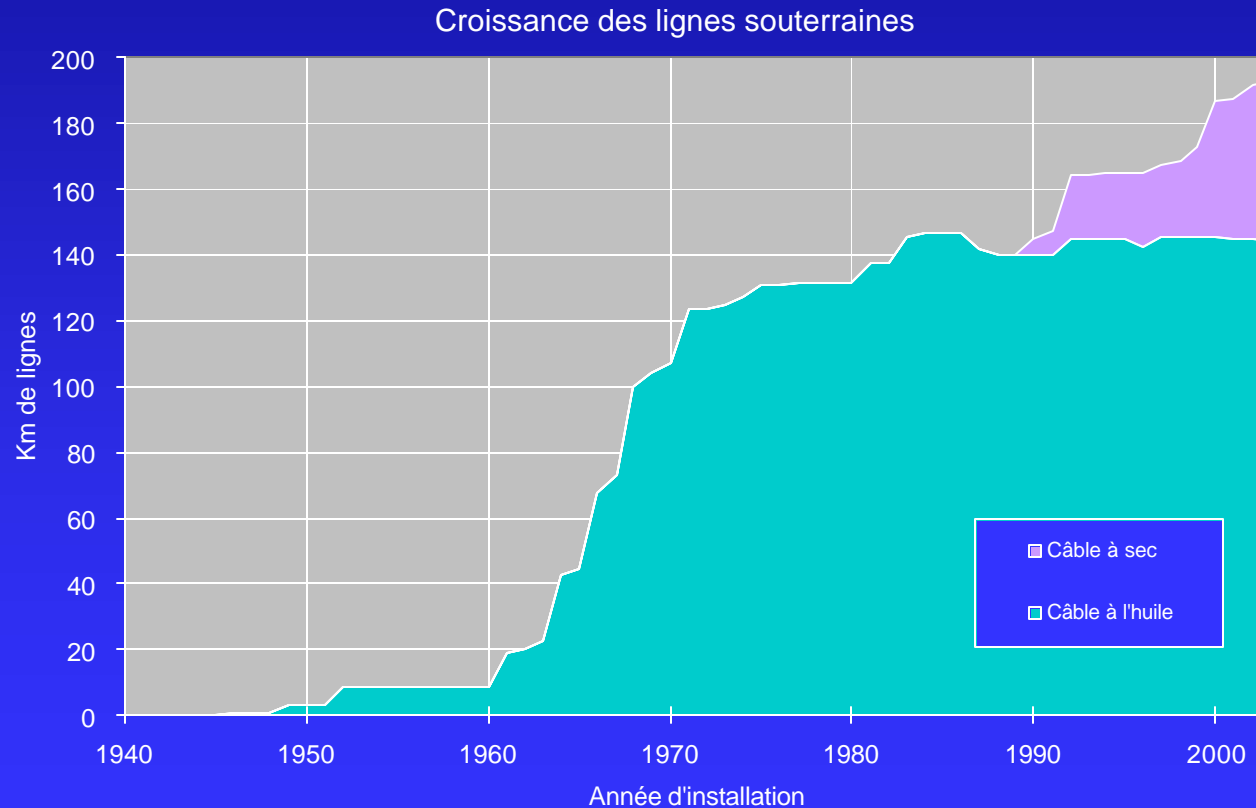


# Hydro Quebec experience with High Voltage XLPE insulated cables





## The rate of increase in the underground HV Cables





## HV XLPE insulated Cable Technology switch from Oil Filled to XLPE

- In 1987 Hydro Quebec decided to use XLPE insulated cables for the 120 kV underground network
- Techno-economical studies showed that cost of new lines will be reduced by 15% ;
- Maintenance cost will be reduced by 50%
- Three new projects were planned for in service dates between 1990 and 1991





## The main steps

- Qualification testing of the new cables
- Rethinking of the design parameters (cables, accessories and installation); ducts, joints arrangement and anchoring etc.
- Purchasing of new tools
- Training of Hydro Quebec splicers on actual cables and accessories
- New policy on cable and accessories spare materials





## First 120 kV Cable Project

- 120 kV, 5,2 km between Belanger and Rosemont SS in Montreal
- Cable :
  - 1600 MCM (811 sq.mm), Cu. Conductor,
  - Isulation thickness 21,6 mm
  - Metallic sheath: lead alloy
  - Outer sheath: Black Polyethylene with graphite coating
  - Accessories :
    - ◆ Joints: Premoulded, sectionalized with copper casing and outer heat shrinkable sleeves and tapping
    - ◆ Potheads: Premoulded stress cones and porcelain







## First 120 kV Cable project

- Average cable length: 350 m
- Cross Bonding System: Transposition with Zinc Oxide lightning arresters
- Installation:
  - Cables in ducts and joints in manholes (rigidly clamped)
  - Cables were produced using Triple extrusion and DRY CURING process



## 230 kV and 315 kV XLPE cables

- Nine 230 kV new circuits were added in 1991-1992 at a thermal power station
- Qualification testing on the 315 kV (400 kV class) were carried out in 1995-1996
- On supplier qualified his cables for 500 kV class
- First project is planned for 2004

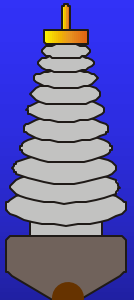




## Cost reduction the new challenge

- In 2000, Hydro Quebec strategic plan (2000-2004) requested that underground HV cables should be made more competitive with OHTL
- Cost reduction was in order

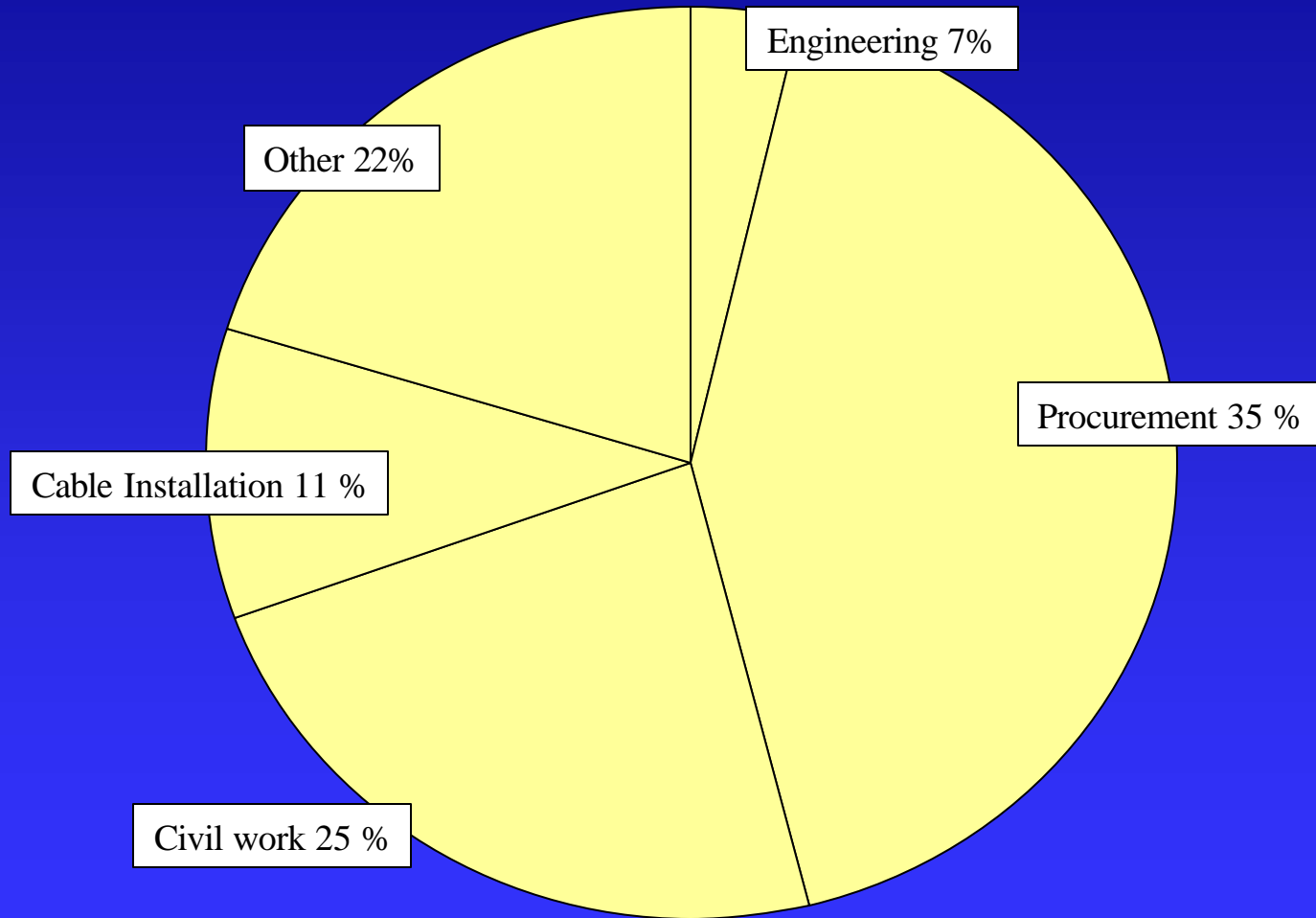




# Cost reduction solutions



## Cost breakdown in a standard 120 kV project





## Cost reduction solutions

36 solutions were evaluated

- Close interactions between solutions
- Local regulations were taken into consideration
- Mid term and long term solutions are still under consideration





## Cost reduction solutions, main categories

- Procurement : Changes in cable design (lighter cables, longer lengths, reduced insulation thickness etc.)
- Civil work : Introducing prefabricated joint bays
- Other costs : Reduction of project duration from three years to 18 months



# Partnership agreement







## Partnership agreement

- Development of new cable design
- Reduction of eprocurement lead time
- Optimal design, engineering and installation
- Reduction of strategic spare material





# New cable system design





# New cable system design

	Old design	New design
Conductor	811 mm <sup>2</sup>	811 mm <sup>2</sup>
Insulation	21,6 mm	13,7 mm
Lead	3,2 mm	2,8 mm
PE jacket	4 mm	4 mm
Diameter	103 mm	86 mm
Working stress	5 kV/mm	7 kV/mm
Weight	24 kg /m	19 kg /m
Max length	550 m	850 m





## Qualification testing

- Bending test
- PD measurement
- Tan  $\delta$  measurement
- 30 cycles at 150 kV
- Hot impulse 650 kV BIL (10 +, 10-)
- AC 230 kV, 1 hour
- Impulse and HVAC test to breakdown





Civil work





## Civil work

- Premoulded Joint bays
  - Smaller dimensions
  - Faster installation
  - Longer cable lengths allowed
  - Maintenance free





# First project using the new cable system



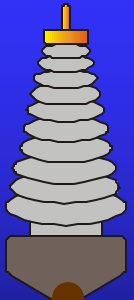


## Mt-Royal/Royalmount 120 kV project

- Circuit length 4,2 km
- 5 Premoulded joint bays
- Average length between bays 700 m (was 350 m)
- 1 new transition compound (OHTL to UG)
- Total project duration 11 months for procurement, construction and commissioning



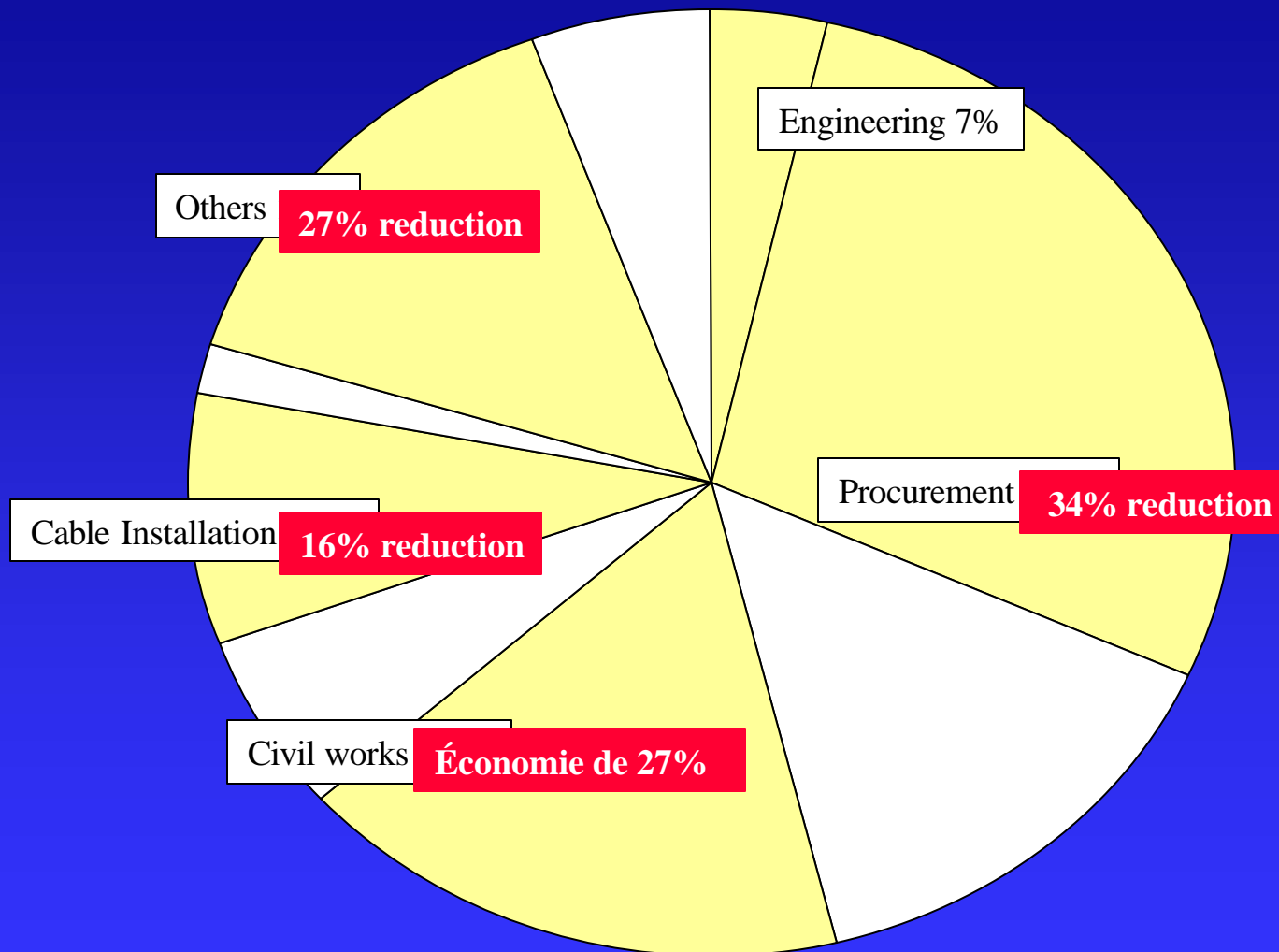




Cost reduction achieved



# Breakdown of cost of first project using new cable system

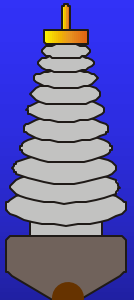


**Global cost reduction 25%**

## CONCLUSION

- XLPE insulated high voltage cables are reliable, environment friendly, easy to install and maintain
- Performance record (over 14 years) has been very satisfactory
- Cost reduction is possible by rethinking of cable and accessories design as well as installation technique selection





Questions ?

