



# *Findings, Recommendations* **Comparators and Cohorts**

*for the consideration of:*

**Ontario Energy Board  
and Stakeholders**

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# Topics

- ❑ Objectives of Comparators and Cohorts
- ❑ Nature of Power Delivery
- ❑ Cost Implications; a Testable Hypothesis
- ❑ Assessment; Alternative Methods
- ❑ Unbundled Services
- ❑ Approach
  - Stakeholder Priors; Proof of Concept Test
- ❑ Data and Information Reporting
- ❑ Analysis Findings; Recommendations
- ❑ Remarks

# Objectives of Comparators and Cohorts

- ❑ *Context:* The Board faces the nearly overwhelming task of setting individual rates for Ontario LDCs
- ❑ *Issue:* How to facilitate and obtain the necessary efficiency within the regulatory process?
- ❑ *Plausible Approach:* Develop a mechanism to help Board staff expedite the rate review process

*C&C mechanism:* *a model-based assessment of LDC costs to highlight anomalous cost experience*

# Nature of Power Delivery

- ❑ *Technology:* radial and loop systems
  - various voltages ~ 2 – 35 kV
  - single- and 3-phase circuits
  - underground and overhead lines and service drops
  - pole- and pad-mount transformers
  
- ❑ *Markets Served:* urban and rural areas
  - substantial variation in load and customer density
  - differences in customer mix
  - issues of accessible facilities, customer turnover
  - differences in load growth and scale of operations
  - substantial variation in topography, terrain, tree coverage

# Nature of Power Delivery (2)

## □ *Modus Operandi:*

- Legacy: individual LDCs establish ways of doing things over many years
  - maintenance, training, procurement, inventory, power restoration, preferences for equipment and vendors
  - billing (settlements) and customer interface

## □ *Structure:*

- LDCs may outsource internal activities or complete functions – *i.e.*, virtual LDCs
- shared services
- embedded and host systems

# Cost Implications

- ❑ LDCs reveal considerable cost differences
- ❑ Cost comparisons (analysis) must adequately account for the relevant differences
- ❑ *Testable C&C Hypothesis:*
  - LDC costs are related to the services provided and resource inputs, *given the relevant attributes (markets, technology)*
- ❑ *Fundamental Empirical Issues:*
  - Are existing data regarding attributes sufficiently complete?
  - If not, how are the effects of attributes to be accounted for?

# C&C Approach Options

- *Unit Cost approach:*

$$\text{Cost}/Q = (\text{Resource Inputs, Input Costs, Z})^*$$

- *Total Cost approach:*

$$\text{Cost} = (Q, \text{Resource Inputs, Input Costs, Z})^*$$

where,

$Q$  = the level of LDC services provided (customers, kWh, peak demand, etc.)

$Z$  = the relevant attributes of LDC markets and technology

\* Depending upon analysis approach, input costs – *i.e.*, *cost per* unit of the various inputs – may not be particularly relevant

# Unbundled Services

- ❑ Wires and Interconnection
- ❑ Settlements (Billings and Collections)
- ❑ Customer Services
  - DSM, energy management/assistance, special services, etc.
  - may not be currently present with all LDCs

## Administrative Overheads

Each service category employs capital (assets) and non-capital resources (operating expenses)



# Stakeholder Priors

(expectations, *prior beliefs*)

## □ *Potential Comparators:*

<b>O&amp;M/Customer</b>	<b>Billing &amp; Collections/Customer</b>	<b>Admin/Customer</b>
<b>Capital/Customer</b>	<b>Distribution Losses</b>	<b>Cost/MWh</b>
<b>Cost/km of Conductor</b>	<b>O&amp;M/km of Conductor</b>	<b>O&amp;M/MWh</b>
<b>Total Customers/FTEs</b>	<b>Revenue/kWh Delivered</b>	

## □ *Example Cost Drivers (Attributes):*

<b>Age of Plant</b>	<b>Service Territory, km</b>	<b># Customers</b>
<b>Customers/km</b>	<b>Topography</b>	<b>Tree Coverage</b>
<b>Customer Mix</b>	<b>Urban/Rural</b>	<b>Municipal Policies</b>
<b>Accessibility</b>	<b>Transformer Configuration</b>	<b>Metering Tech (AMR)</b>
<b>SCADA System</b>	<b>Operating Voltages</b>	<b>Load Growth</b>
<b>Customer Turnover</b>	<b>Regional economic situation</b>	

# Proof of Concept

## □ *Approach:*

- total cost model, augmented by unit cost-based diagnostics
- assess cost categories, including assets and O&M by unbundled service; administrative overheads
- employ statistical methods
  - procedures objectively determine relationships between comparators and cost drivers
- conduct a search to determine the relevant cost drivers
  - intuition and knowledge of distribution guides our thinking

# Proof of Concept (2)

## Strawman C&C Mechanism

*Step 1: Screen Cost Drivers* with factor analysis/correlation methods

*Step 2: Determine Cost Drivers* for pre-defined cost categories (comparators) with regression analysis

*Step 3: Determine Cohorts* with cluster analysis based upon the cost drivers determined in *Step 2*

*Step 4: Inspect and Report Comparative Diagnostics* for the identified cohorts

# Step 1: Screen Potential Cost Drivers

## Factor Analysis/Correlation

- ❑ Factor analysis/correlation expedites the search process to determine *candidate cost drivers*
  - useful with large data sets
  
- ❑ Results of factor analysis difficult to interpret
  - depending on application, however, interpretation may not be necessary

# Step 2: Determine Cost Drivers

## Regression Analysis

- Regression is a widely applied method to determine relationships among data
  - dependent variable (LHS): LDC costs, by category
  - independent variables (RHS): candidate cost drivers (resource inputs, attributes)
    - cost categories of each LDC estimated by its cost drivers
  - procedure determines a coefficient for each of the RHS variables (cost drivers)
    - impact of costs *wrt* a change in a cost driver

# Step 3: Determine Cohorts

## Cluster Analysis

- ❑ LDCs grouped according to cost drivers
- ❑ *Analysis specification:*
  - choice of distance\*
  - choice of criteria (objective function)
    - average distance
  - # of cohorts
    - four and ten

\* *Euclidean squared distance used herein*

# Step 4: Report Unit Cost Diagnostics

## □ *Such As:*\*

O&M/Customer

O&M/km of Conductor

Billing & Collections/Customer

Admin/Customer

Capital/Customer

Cost/km of Conductor

O&M/MWh

Total Customers/FTEs

## □ *Reporting:* Revealed for individual LDCs

- shown wrt to the mean value of the respective cohort
- shown for each cost category

\* these diagnostics are largely consistent with the potential comparators identified by the stakeholders

# Data and Information Requirements

## ❑ Wires and Interconnection Services

- gross assets and accumulated depreciation\*
  - for conductor, transformers, poles, SCADA, etc.
- operating and maintenance expenses for labor and non-labor inputs, including outsourced or jointly provided services\*

## ❑ Settlements

- gross assets and accumulated depreciation
  - for customer meters, software, facilities, etc.
- operating expenses, including outsourced or jointly provided services\*
- operating and maintenance expenses for meters

\* as currently provided



# Data and Information Requirements (2)

- ❑ Customer services
  - gross assets and accumulated depreciation
    - software, facilities, buildings, etc.
  - operating expenses
    - outsourced or jointly provided services
- ❑ Administrative expenses\*
- ❑ Other
  - # of employees\*
  - employee benefits\*
  - depreciation rates for the various elements of capital

\* as currently provided

# Data and Information (3)

- ❑ Measures of services provided (outputs)\*
  - MWh sales by sales category
  - peak demand
  - # of customers
  - total km of conductor
  
- ❑ Candidate attributes (LDC markets and technology)\*
  - service territory descriptors
  - composition of conductor
  - # of transformers
  - customer turnover

\* as currently provided

# Findings

## □ *Proof of Concept:*

- relationships between comparators and cost drivers exist; much variation in cost categories can be explained
  - relationships are overwhelmingly consistent with expectations, and other studies
  - nonetheless, non-trivial estimation error is present
- such relationships provide a basis to build and implement a practical Comparators and Cohorts mechanism for application in the 2006 EDR

# Findings (2)

## ❑ *Data and Information:*

- data regarding cost drivers currently exist and are reported
- data regarding costs should be unbundled in the manner described
  - assets and O&M expenses for Wires and Interconnection, Settlements, and Customer Services

# Remarks

- ❑ Substantial data error exists
  - errors in reporting
  - possibly, errors in recorded data regarding costs and resource inputs
  
- ❑ “Fits” between costs and cost drivers can (and are being improved)
  - it is possible that the experience of some LDCs will not be used in the modeling

## Remarks (2)

- ❑ Measurement of capital inputs is always an issue
  - if possible, real capital stock will be constructed and used in lieu of an accounted-based measure, shown as assets
  - capital, however defined, will likely play only a limited role in the C&C mechanism
  
- ❑ Accounting records may not provide the means to report unbundled costs in the manner described

## Remarks (3)

- ❑ The proposed C&C Mechanism is likely to be viable for the task of scrutiny of and inquiry about LDC rate applications, by Board staff
- ❑ The proposed mechanism is not an appropriate basis to gauge overall LDC performance

# About Christensen Associates...

- ❑ *Originating from 1976; diversified technical staff*
  - economists, engineers, accountants, market researchers, systems/programmers, econometricians
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