Principles for Defining and Allocating Costs to Density-Based Sub-Classes

A Report Prepared by Elenchus Research Associates Inc.

On Behalf of Hydro One Distribution

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Executive Summary

Hydro One has asked Elenchus Research Associates (ERA) to prepare a report on the principles for defining and allocating costs to density-based customer classes.

The report is divided into seven sections. Section 1 is the Introduction. Section 2 provides an overview of ERA's survey of other jurisdictions to identify the extent to which density-based classes are used by other electricity distributors. The relevant regulatory principles for defining customer classes and allocating costs are reviewed in Section 3. Sections 4 and 5 discuss options for defining density-based sub-classes and for allocating costs to those classes, respectively. Section 6 examines the significance of certain density-based cost factors for purposes of defining classes based on those cost differences. The report's conclusions are summarized in Section 7.

DENSITY-BASED CLASSES IN OTHER JURISDICTIONS

ERA has been unable to find any other jurisdiction or electricity distributor that has defined distinct urban and rural classes based on explicit density criteria. As a result, examples from other jurisdictions do not provide insight into possible alternatives to the Hydro One approach for defining classes based on explicit density criteria.

It is not uncommon; however, for customers inside municipal boundaries to be classified as urban (sometimes with a minimum population threshold for the municipality) and those outside the urban municipal boundaries to be classified as rural.

The unique nature of the HOD density-based class definitions was included in the presentation to stakeholders at the May 25th session. Stakeholders did not express any significant concerns with respect to HOD's unique approach.

RELEVANT RATEMAKING PRINCIPLES

The central principal to be used in assessing the appropriate approach to designing density-based rates and to allocating costs to the resulting density-based classes is that the approach used should achieve fairness by grouping customers with similar causal cost factors and similar cost levels. Doing so will facilitate the allocation of costs on an objective basis that ensures that like customers are being treated in a like manner.

The first step in applying this principle is to address the preliminary question of whether customers in the urban and rural classes, however defined, are "equals" or "unequals".

In the stakeholder session it was noted that that there are many ways to look at the differences between urban and rural customers. For example, they can be viewed as different from the perspective of the quality of service they enjoy. From this perspective, since service quality standards related to reliability and response times tend to be lower in rural areas, rates should be correspondingly lower. This is the reverse of relating the difference to density which results in higher rates for rural customers.

OPTIONS FOR DEFINING DENSITY-BASED SUBCLASSES

Although the conceptual foundation for the existing HOD density-based residential and small business classes is weak and ERA has been unable to identify other jurisdictions that utilize a similar approach (i.e., classes based on explicit density-related criteria), there are several pragmatic reasons that they might be retained. Change can be disruptive for customers and the benefits of revising the rate classes are likely to be minimal. Further, to the extent that the urban/rural rate differential is ultimately more reflective of fairness considerations rather than cost differences, any restructuring of the rate classes may result in more of a change than an improvement in horizontal and vertical equity.

If the definition of HOD's urban and rural rate classes is changed, it will be necessary to examine other issues that are linked to the urban rural definitions, including:

- Rural or Remote Rate Protection (RRRP)
- Service Quality indicators (SQI)
- Feasibility Test (DCF Model)

OPTIONS FOR ALLOCATING COSTS

Each alternative to HOD's current methodology for allocating costs to the density-based classes (i.e., detailed analysis of USofA cost data; regression analysis; sample data; and engineering analysis) will require significant effort and cost to be incurred by HOD. The benefits of any resulting improvement in the precision of HOD's allocated costs is unclear, particularly if strictly cost-based rates will be adjusted to reflect urban/rural rate differentials that are deemed to be acceptable from a policy perspective.

Ultimately, the choice of cost allocation methodology will be determined primarily by making a judgement call with respect to the appropriate trade-off between precision and cost/feasibility.

THE SIGNIFICANCE OF DENSITY-RELATED COST FACTORS

Factors that cause costs in rural (and remote) areas to be higher include the following.

- Storm damage occurs primarily in rural areas: HOD plant is less protected by the natural/man-made environment outside of urban centres
- Brushing is done only in rural areas (HOD's annual cost is about $28 million)
- Travel time is 2-3 times higher for each job in rural areas
- Distribution Stations (DS) are standardized
    - The area a DS can serve efficiently is limited and the maximum customers/ load is fixed (minimum 10 kVA transformer)
    - In urban areas, customer density is sufficient to fully utilize DS capacity (allowing for growth)

  - In rural areas, customer/demand density can be too low for optimal utilization; hence, significant excess capacity results and cost/customer and cost/kW are higher than in urban areas
- In rural areas the number of poles/customer and km of line can be 5-10 times greater: hence, these costs are higher per customer and per kW

Factors that cause costs in rural (and remote) areas to be lower include the following.

- Some urban areas have high costs due to congestion (usually only dense commercial areas, such as downtown Toronto, etc.)[1]
- Underground facilities are more costly and are rarely used outside urban areas

HOD currently has very limited information on the differences in most of these cost categories in urban and rural areas.

ERA'S CONCLUSIONS ON THREE CENTRAL QUESTIONS

Should Separate Urban and Rural Classes be Maintained ?

Whatever the historical basis of HOD's urban and rural rate classes, I believe that it is appropriate to commence any review of the definitions of the classes and the allocation of costs to those classes with an examination of whether it is appropriate to retain a distinction between urban and rural classes however they are defined.

Generally accepted ratemaking principles provide very limited support for maintaining separate urban and rural classes on the basis of differences in customer or demand densities that affect causal costs.

How Should Separate Urban and Rural Classes be Defined?

Assuming the Board determines that it is appropriate for HOD to maintain separate residential and small business urban and rural rate classes, for reasons other than meeting the legislative requirements associated with the RRRP, it is my view that it would be appropriate to ask whether the current density-based class definition are appropriate at this time.

It should be recognized, however, that the implementation of any change in the definition of the urban and rural classes will create winners and losers and could be costly, especially if a detailed analysis is undertaken to establish a more defensible cost basis for the different rates. Furthermore, any change to the definitions of the urban and rural classes, particularly if combined with a refined approach to allocating costs to the classes, will have an impact on the revenue-to-cost ratios of the urban and rural classes. Consequently, an important policy question prior to investing considerable effort in redefining the classes and developing a more sophisticated cost allocation methodology is what, will be done in response to the new revenue-to-cost ratios.

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[1] This factor may not be relevant in HOD's urban areas.

If there is a limit to the difference that would be considered fair and equitable (and the existence of the RRRP suggests that this is the case), then the only cost information that is needed is evidence that difference in the cost of service for urban and rural customers is at least equivalent to the acceptable rate differential. That information would be sufficient to demonstrate that the urban and rural rates are just and reasonable.

I therefore conclude that if separate urban and rural classes are to be maintained, either the current definitions should be retained or the current density-based definitions should be replaced with the more standard approach that defines urban areas based on municipal boundaries.

How Should Cost be Allocated to the Urban and Rural Classes?

If the Board determines that it is appropriate for HOD to maintain separate urban and rural rate classes, however, defined, a decision will have to be made about the appropriate balance between precision and cost in adopting a cost allocation methodology.

All things considered, it is my view that the most practical and cost effective approach is likely to be to use sample data to derive an estimate of the average cost (or cost differential) of serving urban and rural customers under the definitions that are approved for future use. The resulting cost estimates could then be used to test the reasonableness of the weightings used in HOD's existing cost allocation methodology, and possibly to refine the weighting methodology if necessary. Having provided support for the reasonableness of the results of the weighting methodology, it could be used in the future so that the cost and potential instability of continually updating a more detailed approach to allocating costs can be avoided.

In the alternative, it may be appropriate to rely on engineering analysis to establish an appropriate rate differential between urban and rural customers that isolates the density-related cost differential for urban and rural service (i.e., by removing factors such as the impact of the age of assets on the NBV of assets and on maintenance costs).

I therefore conclude that either approach could be used to check the reasonableness of the current weighting methodology, serve as a new cost allocation methodology for determining cost based rates, or to confirm that a rate differential that is deemed the maximum acceptable form a fairness perspective is not excessive from a cost perspective.

1 INTRODUCTION

In its Decision establishing 2008 rates for Hydro One Networks Inc. (EB-2007-0681), the Ontario Energy Board (OEB or Board) stated in its Findings at pages 30 – 31:

> *Accordingly, the Board directs Hydro One to provide a more detailed analysis on the relationship between density and cost allocation to the Board. This should consider whether the number of Residential and General Service customer classes in the new class structure is adequate, and whether the customer class demarcations approved in this Decision offer the best reflection of cost causation. The study should include consideration of alternative density weightings, with descriptions and criteria for comparing alternatives. Comparisons with the costs of distributors similar in size and location to Acquired Distributors would also be useful. The Board requires that Hydro One submit this information in its next cost of service application.*

As a first step to conducting "a more detailed analysis on the relationship between density and cost allocation" it is appropriate and necessary to review the principles that should guide the design of rate classes in general and density-based rate classes in particular. The existing density-based rate classes of Hydro One Distribution (Hydro One or HOD) and the methodologies used to define those classes[2] were inherited from Ontario Hydro. As a result, HOD's current class structure reflects the historic class definitions of the predecessor company rather than the systematic application of regulatory principles in the context of HOD's current customer base. Much has changed in terms of the operations of Ontario Hydro and Hydro One, which is the successor distributor, the structure of the Ontario electricity market and the structure of electricity rates, which have been unbundled since Ontario Hydro's density-based rates were originally established. Given the extent of the transformation of the sector and electricity rates, it is important to re-examine the fundamentals underpinning the density-based classes in order to ensure that any changes implemented by HOD in the future are consistent with principles, objectives and methodologies that have been reviewed and approved by the Board.

In addition, the density weightings that serve as the basis for allocating costs among the residential and small business density based classes should also be reviewed within the context of principles that have been considered and approved by the Board. Like the classes themselves, the Hydro One approach for allocating costs based on density is the continuation of an approach that was adopted in a very different operational and market context. It would not be appropriate to adjust the weightings without first confirming that the approach itself is consistent with Board-approved principles that are implemented in a manner that is appropriate at this time.

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[2] HOD's current density-based classes are the three residential classes, Urban Density (UR), High Density (R1) and Normal Density (R2), and three small business classes, Urban Density, Single Phase and Three Phase. The three business classes are being reduced to two (urban and non-urban) as part of Hydro One's approved harmonization process.

Hydro One has accordingly asked Elenchus Research Associates (ERA) to prepare a report on the principles for defining and allocating costs to density-based customer classes.[3]

As background to this report, HOD conducted two stakeholder sessions. The first session, which was held on April 15 addressed the process to be used to respond to the above-quoted directive in the Board's EB-2007-0681 Decision. In accordance with HOD's April 20 Letter to the Board, it held a second stakeholder session on the May 25 during which John Todd presented his preliminary analysis on these issues and solicited comments and suggestions from the participants. The issues that were raised at the second stakeholder session included:

1. Are there any other principles that should be addressed in the ERA Report?
2. Are there other issues that are relevant to the OEB's consideration of the matter:
    - Are density-based rates equitable?
    - What is the appropriate way to define density-based rate classes (e.g., UR; R1; R2)?
    - What is the appropriate way to allocate costs to density-based rate classes?
3. If the cost (rate) differential increases, should the urban-to-rural cross-subsidy (RRRP) be increased?

The facilitator's reports on each of these stakeholder sessions are part of the evidence being filed by HOD in this proceeding.

This report is divided into six additional sections. Section 2 provides an overview of ERA's survey of other jurisdictions to identify the extent to which density-based classes are used by other electricity distributors. The relevant regulatory principles for defining customer classes and allocating costs are reviewed in Section 3. Sections 4 and 5 discuss options for defining density-based sub-classes and for allocating costs to those classes, respectively. Section 6 examines the significance of certain density-based cost factors for purposes of defining classes based on those cost differences. The report's conclusions are summarized in Section 7.

[3] This report has been prepared by John Todd, President of Elenchus Research Associates Inc. His resume and curriculum vitae are available at www.era-inc.ca.

2 DENSITY-BASED CLASSES IN OTHER JURISDICTIONS

ERA reviewed the structure of customer class in use by other major electricity distributors across Canada to determine the extent to which density definitions are a consideration in classifying customers. A non-exhaustive review of U.S. jurisdictions was also conducted.

In conducting this survey, it was observed that while explicitly defining classes on the basis of density criteria is extremely unusual, regional rates and separate urban and rural rates are common. Both regions and the urban/rural classes can be viewed as proxies for density although the definitions of the classes are not explicitly based on density criteria. It is therefore appropriate to consider regional and urban/rural class definitions in searching for examples of density-based class definitions and cost allocation/rate design methods.

2.1 EXAMPLES OF DENSITY-BASED CLASSES

ERA's survey of Canadian and U.S. jurisdictions did not identify any cases in which customer classes were defined using explicit density-based definitions similar to the density-based class definitions used for HOD's residential and small business classes.

The most recent North American regulatory decision indicating that customer density was a relevant factor in defining customer classes that was identified was a 1958 decision of the California PUC. The decision states:

> *"The Staff's approach gives consideration to the number of customers, the location of the customers, the number of customers per mile of distribution pole line, area growth pattern, and the history of rates." (San Diego Gas & Electric, Decision No. 57509, Oct 1958)*

In this case, it appears that density (number of customers per mile of distribution pole line) was just one of several considerations. Furthermore, there is no evidence that a quantitative criterion, similar to HOD's, was used in defining the regions with different rates or in allocating costs and setting rates. Rather the approach appears to have been simply to recognize that different regions within the service area of San Diego Gas and Electric had different cost factors that justified establishing regional rates rather than adopting a postage stamp rate approach.

2.1.1 REGIONAL RATES

Regional rates can be found in several jurisdictions, although ERA has not found any that explicitly refer to density in defining the regions. For example, BC Hydro defines Rate Zones that are geographic areas. One of the differences across these Rate Zones is almost certainly that customer density differs; however, they apply to broad regions and do not distinguish between high and low density areas in defining the zones. Each zone includes a mix of densities although average density, which is not quantified, undoubtedly differs and may have been a consideration when the Rate Zones were originally established. Manitoba Hydro also once had regional rates that may have

reflected differences in average density in different regions of Manitoba Hydro's service area; however, these regional rates were phased out in the 1990's.

It may be noted that in the process of introducing competition in the telecommunications market the Canadian Radio-television Telecommunications Commission (CRTC) introduced the concept of High Cost of Serving Areas (HCSAs) which consisted of low-density, remote communities. These HCSAs were recognized as regions of Canada that were unlikely to ever enjoy the benefits of telecom competition. Essentially, the CRTC recognized that in these HCSAs the incumbent service provider would be able to charge rates above their costs without attracting competitive entry. As a consequence, price regulation would be required indefinitely in these areas.

In addition, it was recognized that cost-based rates in the HCSAs would be excessively high in the absence of a cross-subsidy. Since a cross-subsidy financed by incumbents would place them at a competitive disadvantage in the rest of Canada, an explicit subsidy regime was put in place that was designed to reduce the regulated rates charged in the HCSAs while ensuring that all telecom providers would contribute to funding the subsidy on an equitable basis.

While the HCSA concept is an example of rates that reflect density considerations, the rationale (a level competitive playing field) and the design provide no obvious lessons for HOD's density-based rates.

2.1.2 URBAN/RURAL RATES

Hydro One is not unique in having residential rate sub-classes that are labelled urban and rural. What is unique about HOD's classes is that the urban/rural division is based on density parameters. As discussed in section 4.1 below, areas defined as urban by HOD must meet two criteria. An Urban Density Zone must have 3,000 or more customers, which can be viewed as an indicator of area density (i.e., density in a geographic area); and a line density of 60 residential customers/km or more, which is an indicator of linear density (frequency of customers along the distribution line).

Maritime Electric (Prince Edward Island), New Brunswick Power, and SaskPower all have urban and rural residential rates. SaskPower also has a separate rural commercial rate. None of these distributors use density as the basis for defining the urban and rural areas, however. Both Maritime Electric and New Brunswick Power define as urban those customers that are located in an incorporated city, town or village with population over 2000. In the case of SaskPower, all areas within a city, town or village (i.e., with no minimum population threshold) are defined as urban.

Fortis Alberta does not use the labels urban and rural; however, Rate 21 (effectively a rural rate) is charged to all customers located outside of city limits, resulting in an urban/rural split similar to that relied on by SaskPower. In Ontario, Veridian has Residential Urban and Residential Suburban rates in its Gravenhurst service area.

In the United States most jurisdictions that have had urban and rural rates in the past have eliminated that distinction. However, the ERA survey identified a few jurisdictions that have retained the distinction. For example, some of the electricity distributors in the State of Wisconsin charge a specific rate to rural customers. In particular, North

Western Wisconsin Electric Company ("NWWEC") applies two rates for residential customers: a) the Residential Service rate; and b) the Rural Residential Service rate.

According to NWWEC's tariff, the Rural Residential Rate is applied to customers living outside the distribution system of any city or village or in a locality where the density of population is less than that encountered ordinarily in urban districts and to all seasonal residential customers.

Another example is the Wisconsin Public Service Corporation ("WPSC") which is a regulated electric and natural gas utility. WPSC serves approximately 436,000 electric and approximately 316,000 natural gas customers. Wisconsin customers accounted for 94.5% and Michigan customers accounted for 5.5% of WPSC's 2008 revenues. WPSC's rates are approved by the Public Service Commission of Wisconsin and the Michigan Public Service Commission and in both jurisdictions rates have been set for rural and urban customers. The categorization of rural and urban customers relies on a schedule that assigns cities, villages and communities served by WPSC to class rate territories. Rural customers are located in municipalities assigned to Class II rate territories, creating what is, in effect, a rural rate class.

2.2 CONCLUSIONS REGARDING USE OF DENSITY-BASED RATES IN OTHER JURISDICTIONS

ERA has been unable to find any other jurisdiction or electricity distributor that has identified distinct urban and rural classes based on explicit density criteria. As a result, examples from other jurisdictions do not provide insight into possible alternatives to the Hydro One approach for defining classes based on explicit density criteria.

It is not uncommon; however, for customers inside municipal boundaries to be classified as urban (sometimes with a minimum population threshold for the municipality) and those outside the urban municipal boundaries to be classified as rural. Using municipal boundaries to establish urban and rural rate classes would appear to be a proxy for establishing high and low density classes similar to those established for Hydro One. This approach could be simpler and more consistent than the current HOD approach in that it would not be based on quantitative criteria that may not be robust. In addition, the reclassification of customers would be straightforward in that it would only occur when municipal boundaries are altered.

It should be noted, however, that it is common for municipalities in Ontario to have defined boundaries that extend far beyond what might normally be considered their high density urban core. In particular, the municipal amalgamations driven by provincial legislation has resulted in a large number of municipalities with one or more small urban cores surrounding by large, lightly-populated non-urban areas. It is far from clear that there is a cost-based difference between residents outside these municipalities and residents inside the municipal boundaries but outside the urban core, that would serve as an equitable basis for charging them different distribution rates.

The unique nature of the HOD density-based class definitions was included in the presentation to stakeholders at the May 25th session. Stakeholders did not express any significant concerns with respect to HOD's unique approach.

3 RELEVANT RATEMAKING PRINCIPLES

The Ontario Energy Board Staff Discussion Paper on Rate Classification for Electricity Distribution Customers (EB-2007-0031) dated January 29, 2009 observes that:

> *The objective of classification is to achieve fairness by grouping customers with similar cost causation and similar cost levels. This allows cost allocations to be as objective as possible (i.e. relying less on judgement and assumptions) and ensures that like customers are being treated in a like manner.* (page 5)

This statement of the primary objective in designing customer classes is consistent with the generally accepted rate making and rate design principles reflected in the literature and in the practices of regulators across Canada and most U.S. jurisdictions.

ERA's review of the standard literature revealed that none of the primary references include discussion of the principles and practices for defining customer classes. For guidance on the generally accepted principles for defining customer classes it is therefore necessary to consider the appropriate application of the generally accepted ratemaking principles to the specific issue of defining customer classes which is one of the steps in the standard rate setting process use by most regulators.

3.1 GENERALLY ACCEPTED RATEMAKING PRINCIPLES

The seminal work of James Bonbright provides the most widely cited statement of the principles that guide regulatory ratemaking processes. His original 1961 principles[4] were revised in the second edition of his book[5] which succinctly sets out 10 attributes of a sound rate structure. Of those ten, the most relevant to the issues relate to the design of customer classes are:

> *4. Static efficiency of the rate classes and rate blocks in discouraging wasteful use of service while promoting all justified types and amounts of use."*
>
> *6. Fairness of the specific rates in the apportionment of total costs of service among different ratepayers so as to avoid arbitrariness and capriciousness and to attain equity in three dimensions:*
>
> *(1) horizontal (i.e., equals treated equally)*
>
> *(2) vertical (i.e., unequals treated unequally);*
>
> *(3) anonymous (i.e., no ratepayer's demands can be diverted away uneconomically from an incumbent by a potential entrant.*
>
> *7. Avoidance of undue discrimination in rate relationships so as to be, if possible, compensatory (i.e., subsidy free with no intercustomer burdens).*

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[4] Bonbright, James C., (1961) *Principles of Public Utility Rates*, Columbia University Press, p. 291.

[5] Bonbright, James C., Albert L. Danielson and David R. Kamerschen, (1988) *The Principles of Public Utility Rates* (Second Edition), Public Utilities Reports Inc., pp. 383-384. Published posthumously.

Building on the foundation of the Bonbright principles, the OEB identified three rate design principles in the Rate Design Review[6]:

> *The Board identified three rate design principles for the purposes of this process. These principles encompass all of the "Bonbright attributes of a sound rate structure" identified in the March 2007 Staff Discussion Paper:*
>
> *1. full cost recovery;*
>
> *2. fairness; and*
>
> *3. efficiency.*

This statement of the principles that the OEB considers relevant for the Rate Design Review were the basis for the above-quoted statement of OEB staff regarding the objective of classification, which appeared in the subsequent Staff Discussion Paper.

3.2 PRINCIPLES FOR DEFINING CUSTOMER CLASSES

In applying both the broad ratemaking principles and the more specific rate design principles to the even narrower issue of defining customer class, it appears that the essential principle for defining customer classes is to ensure that "like customers are being treated in a like manner", in the words of OEB staff, or in the words of Bonbright et al., equals are treated equally and unequals are treated unequally.

The implication of this core principle for defining customer classes is that "like customers" should be included in a common rate class while unlike customers should be assigned to different rate classes.

3.3 COST ALLOCATION PRINCIPLES

Given that the primary purpose of defining distinct customer classes is to establish an appropriate basis for allocating costs in a manner that is consistent with the general ratemaking principles, it follows that the same principles serve as the basis for defining customer classes and for cost allocation.

3.4 APPLYING THE PRINCIPLES IN PRACTICE

The accepted approach to applying these core principles in practice is generally to identify customers that require different categories of facilities (e.g., sub-transmission only, sub-transmission and primary only, sub-transmission, primary and secondary) or that have different load profiles (e.g., residential vs. commercial/GS) that cause differences in their causal costs in relation to the billing parameters being used (i.e., high load factor customers have lower costs than similarly connected low load profile customers on a per kWh basis although their causal cost may be no different on a kW basis).

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[6] Staff Discussion Paper (EB-2007-0031) June 6, 2008 revised version, section 3, page 15.

Hence, in general the basis for separating groups of customers into different classes is either:

- the customers in the different classes use different categories of assets, or
- the customers in the different classes have different intensities of usage that is not captured by the billing factors.

Cases where customers require different categories of assets and therefore are placed into different classes are fairly clear cut. For example, customers that are directly connected to primary distribution facilities (e.g., at voltages in the 32 kV to 4.8 kV range) will not use low voltage facilities. They are placed in a separate class from small volume residential and GS customers so that they can be allocated the causal costs associated with their use of the sub-transmission and primary facilities, without being allocated any share of the costs of secondary facilities. In terms of the principles, customers that are different in terms of the categories of distribution assets that they require are treated differently in terms of the costs that are allocated to them. Separating the customers into different classes on this basis is clearly consistent with both horizontal and vertical equity.

Differentiating customer classes on the basis of the intensity of usage is a more complicated and controversial process because what constitutes equals and unequals is often unclear in the context of differences in intensity of usage. The following examples illustrate the challenge.

- Two residential (or small business) customers that use the same distribution/ connection facilities and have the same peak demand but utilize different amounts of power on average will be billed different amounts under the current rate structure which includes a kWh charge to recover distribution costs. The difference in monthly bills reflects different intensities of usage (i.e., customers with higher energy consumption pay more even if their load factor is high and the two customers have identical monthly demand). As a result, the difference in their bills will not reflect differences in causal costs as determined by the distributor's cost allocation study. Causal distribution costs are determined primarily by peak demand, not monthly or annual energy consumption. Hence, the differences in the energy (kWh) rates charged to residential and small business customers result primarily from differences in average load factor rather than a difference in the required connection facilities. Treating residential and small business customers as "unequals" may not longer be relevant in the context of advanced metering that facilitates billing on the basis of demand. Differences among these small volume customers may be more appropriately associated with demand (which could be adopted as a billing determinant) rather than whether the customer is a residential household or a small business.
- Customers located in different parts of a distributor's service area may be equal in terms of their connection requirements and usage, but may be unequal in terms of the distance (and cost) of facilities required to serve them (excluding differences related to use of underground or overhead facilities). The OEB does not support the concept of distance-based rates and generally applies postage based rates instead. If the OEB were to adopt a strict cost causality approach to

determining the differential between HOD's urban and rural rates, it would be arguable that the differential is partially attributable to the greater distance, on average, between the relevant Distribution Station (DS) and rural customers as compared to the average distance from the DS to urban customers. It would be difficult to extract the distance-related costs from other costs so as to isolate the costs differences that are strictly associated with density. Indeed, the difference between the distance from the DS (or service centre) to the customer and the distance between customers is a distinction that is hard to justify conceptually.

- There is no obvious difference between the usage of urban and rural residential customers (or urban and rural small business customers), or the types of facilities required to serve them. Differentiating customers on the basis of density would appear to be a distinction based on the distance of low voltage facilities required to serve them. The distance factor is accentuated where there is a low concentration of customers because the average distance (km of distribution line and number of poles) per customer increases as the density declines, all other things being equal.

3.5 CONCLUSIONS REGARDING RATEMAKING PRINCIPLES

The central principal to be used in assessing the appropriate approach to designing density-based rates and to allocating costs to the resulting density-based classes is that the approach used should achieve fairness by grouping customers with similar causal cost factors and similar cost levels. Doing so will facilitate the allocation of costs on an objective basis that ensures that like customers are being treated in a like manner.

The first step in applying this principle is to address the preliminary question of whether customers in the urban and rural classes, however defined, are "equals" or "unequals". This is not an easy question to answer.

- Based on usage, urban and rural customers would appear to be equals. In the absence of a careful empirical study of the usage patterns of urban and rural residential customers, it is reasonable to expect that the usage of residential customers will be impacted less by whether they reside in an urban or rural location (i.e., the density of customers) than by the demographics of the individual household, the available alternatives for space heating (e.g., natural gas), and a myriad of other factors. Given that the general principle of postage stamp rates precludes the creation of high and low load factor residential (or small business) subclasses or the creation of distance-based rates for residential (or small business) customers, it would seem to be inconsistent to justify different urban and rural rate classes on the basis of usage differences even if they exist.
- As discussed in section 6 below, it is reasonable to assume that based on the average cost of serving urban and rural customers, they are unequals. That is, the cost per customers (or per kW or kWh) is higher, on average, for rural residential and small business customers than it is for urban customers with similar usage. As already noted, however, this cost difference does not relate to the type of facilities used to serve them: urban and rural customers both use substantially similar elements of the distribution system. Rather the primary

difference that is attributable to customer density is the intensity of use of the facilities (i.e., the distance of wires and number of poles per customer).

Looked at from these perspectives, it is not clear whether cost differences due to the density of customers and/or demand (i.e., economies of scale/intensity of use) should be reflected in rates. However, rationales that might justify rates that differ based on density are the following.

- **Competitive issues:** In a competitive context (e.g., telecom) the absence of density-based rates may lead to market failure since competitors can "cherry-pick" service areas if incumbents are required to cross-subsidize high cost of service areas. This is not an issue for electricity distributors.
- **Rate comparison issues:** Neighbouring customers served by different LDCs compare rates which may reflect different customer mix (and intra-class cross-subsidies). Density-based rates reduce apparent anomalies between distributors.
- **Fairness Principle:** The fairness principle implies the need for different classes if urban and rural customers are viewed as being "unequals". The basis for defining them as "unequals" as opposed to "equals" is controversial, however.

In the stakeholder session it was noted that that there are many ways to look at the differences between urban and rural customers. For example, they can be viewed as different from the perspective of the quality of service they enjoy. From this perspective, since service quality standards related to reliability and response times tend to be lower in rural areas, rates should be correspondingly lower. This is the reverse of relating the difference to density which results in higher rates for rural customers.

4 OPTIONS FOR DEFINING DENSITY-BASED SUBCLASSES

This section examines the pros and cons of two alternate approaches to defining urban and rural customer classes for HOD's residential and small business customers: a "granular" density-based methodology and an urban/rural split based on municipal boundaries, similar to the approach used by other electricity distributors that have urban and rural customer classes.

To provide context for the consideration of these alternatives, section 4.1 provides a brief overview of the current density-based definitions used by HOD to assign customers to its urban and rural Density Zones.

4.1 HYDRO ONE'S CURRENT URBAN/RURAL RATE CLASSES

The definitions currently used by HOD for its urban and rural residential and small business customer classes has been unchanged since it was established by Ontario Hydro prior to the restructuring of the electricity industry and market in Ontario as a result of the introduction of the Energy Competition Act, 1998. The portions of the HOD service area that are defined to be within an Urban Density Zone must meet two criteria:

- each local Urban Density Zone must have 3,000 customers, and
- each local Urban Density Zone must have an average line density of 60 customers/km or more

There does not appear to be any significant documentation of the original basis for this definition, except that the threshold of 3,000 or more customers appears to be based on the average LDC size at the time the concept of Urban Density Zones was first created. There would have been significantly fewer residential customers in Ontario at the time and the number of LDCs would have been about 312 as compared to the 85 LDCs remaining. If this calculation of the average number of customers per LDC were updated, the 3,000 customer threshold would become roughly 50,000.[7]

No record of the basis of the line density criterion of 60 customers/km is available. However, it may be noted that the current provincial average is slightly over 20.[8] It therefore appears that 60 customers/km was not based on the provincial average at the time. It may well have been that the criterion was based on the judgment of Ontario Hydro staff at the time, although the basis of that judgment is not apparent.

Hydro One staff have also indicated that in general each Urban Density Zone is delineated by extending the area outward from a dense geographic core (e.g., a town) to a logical boundary such as a main road or river that is selected so as to ensure that

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[7] The OEB's 2007 Yearbook of Electricity Distributors published August 26, 2008 reports that there were 4,158,957 residential customers (page 10) served by the 83 LDCs included in the Yearbook. Hence, the average customers per LDC was 4,158,957/83 = 50,107.9.

[8] The OEB's 2007 Yearbook reports that the 83 LDCs had 196,242 km of line installed (page 10). Hence, the average number of residential customers per km of line was 4,158,957/196,242 = 21.2.

the resulting area meets both criteria for an Urban Density Zone. Furthermore, as HOD's service area changes due to amalgamations and population growth/decline the Urban Density Zones are periodically updated to maintain consistency with the criteria. For example, if population growth moves an area from below the 3,000 customer threshold to a level in excess of 3,000, the area will be reclassified as an Urban Density Zone and customer within that Zone will be moved from the rural to the urban class.

HOD divides its residential customers that are not in an Urban Density Zone (UR class) into two rural classes:[9]

- High Density (Rural) Zone (R1) is defined as a discrete geographic area with 100 or more customers and a line density of at least 15 customers per km; and
- Normal Density (Rural) Zone (R2) is the remainder of its service area that does not qualify as either an Urban Density Zone or a High Density (Rural) Zone.[10]

HOD residential customer base consists of roughly 156,000 customers (17.7%) in Urban Density Zones, about 365,000 (41.5%) in High Density (Rural) Zones and 358,000 (40.7%) in Normal Density (Rural) Zones.

It could be suggested that HOD's existing density-based urban/rural class structure is consistent with the customer classification/rate design principles identified in section 3 above, provided that the definitions of the Urban, High (Rural) and Normal (Rural) Density Zones are accepted as appropriate definitions for identifying like and unlike customers. However, there is no available evidence to demonstrate that the criteria used to define these classes reflect either usage or cost differences for customers in the different classes.

There are at least three threshold questions that are relevant to the consideration of HOD's existing urban/rural classes:

1. Is density, measured in terms of area density (customers/km^2), linear (customers/km of line) or both, a meaningful indicator of differences in usage and/or cost of service?
2. Assuming usage and or cost of service differences are correlated with density, are the current thresholds consistent with appropriate "break points" between customers with significant differences in usage or cost of service?
3. Assuming there are significant differences in usage and/or cost of service that can be captured by appropriate density definitions, is residential customer density a basis for discriminating among customers in terms of the rates they are charged, that is consistent with the fairness principle that suggests that equals (i.e., like customers) should be treated equally (i.e., same rate structure) and unequals should be treated unequally. In other words, is it consistent with the principle of fairness that customers in areas with different customer density should pay different rates?

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[9] HOD's small business customers that are not Urban Density currently are also divided into two additional classes but they are not density based. The division is in Single Phase and Three Phase classes. This distinction is being phased out as part of the harmonization process.

[10] Rural or Remote Rate Protection applies only to Normal Density (Rural) Density Zone customers.

With respect to the first question, there is no obvious conceptual basis for suggesting that density would have a systematic and significant impact on the electricity usage of residential and small business customers. As discussed in section 6 below, however, it is reasonable to expect that a detailed cost study would demonstrate that there is a relationship between average cost of service per customer and customer density. Whether these costs differences should be reflected in rate differences is a separate question: what makes differences in density a cost factor that should be reflected in rates when cost differences due to difference in location (e.g., distance based rates), differences in geography (e.g., building distribution lines in rocky areas vs. areas with deep soil), differences in use of underground facilities, or differences in vulnerability to storm damage are not factored in?

With respect to the second question, there is no evidence that the criteria that are currently used to define the Urban, Medium and Low Density Zones were originally based on an analysis of the appropriate break points in the level of costs resulting from density differences. Certainly there is no analytic support for the appropriateness of these criteria at this time. The primary justifications for retention of the existing criteria would include the following. These justifications are pragmatic rather than principled.

a) Any change in definition would create winners and losers (i.e., some customers would enjoy rate reductions while others would experience rate increases). Research has shown that the perception of harm for a financial loss is greater than the perception of gain for a comparable financial benefit. It could be argued that any “tweaking” of the criteria would be disruptive to customers, could result in rate instability, and would not result in any aggregate net gain for customers.

b) Any revision to the existing class definitions that retains criteria based on density would be unlikely to increase simplicity and transparency for the typical residential customer, would be unlikely to eliminate the apparent arbitrariness of the dividing lines as the relationship between cost of service and density is most likely a continuum with no obvious break-point. Furthermore, the relationship between customer density and cost of service is almost certainly to be weakened by the numerous other factors affecting cost of service such as the distance to other distribution facilities and the transmission system, the local terrain, the age of assets, etc. Separating out the unique impact of density on cost of service will be a very difficult and expensive task if it is done with a reasonable degree of precision and credibility.

c) Overall, while no criteria will be perfect for differentiating customers on the basis of customer density, as a rough indicator of higher, medium and lower cost of service residential customers, the status quo criteria are directionally correct and may be as good as any alternative set of criteria.

d) Maintaining the status quo in terms of the definition of density-based classes will avoid the cost and disruption of developing and implementing alternative cost based criteria.

e) To the extent that the existing differences in rates are more reflective of the rate differentials that are deemed to be just and reasonable for customers that are essentially the same in all respects other than the customer density in their area,

any effort to determine the true underlying cost differences may be of little relevance. In an environment that views Rural or Remote Rate Protection to be an appropriate policy, it would appear that the rate differentials for the residential classes will be limited to what is deemed to be equitable, rather than being determined by the true underlying cost differences. If that is the case, it is difficult to see any benefit in undertaking a study to better understand the relationship between customer density and cost of service, when it could be considered inequitable to use the results as the basis for setting rates in any case.

With respect to the third question, it is not at all clear that considering customers that differ only in terms of the residential customer density in their areas to be unequals is consistent with the generally accepted interpretation of the fairness principle by Canadian and U.S. regulators. In surveying other jurisdictions, ERA did not find any other company or regulator that maintains different residential or small business rate classes using density criteria. At the same time, however, establishing urban and rural classes based on municipal boundaries is not unusual and as discussed in section 2.1.2 some jurisdictions have adopted a minimum population threshold for their urban rate class. Arguably, using municipal boundaries as the basis for defining urban and rural rate classes is actually a proxy method for defining high and low density rate classes.

4.2 ALTERNATIVE DENSITY-BASED URBAN/RURAL DEFINITION

When examined from the perspective of generally accepted ratemaking principles – in particular the fairness principle which calls for equal treatment of equals, one weakness of the existing approach to defining the Urban, High (Rural) and Normal (Rural) rate classes is readily apparent: at the customer level, there are undoubtedly some portion of customers classified as Urban Density that would be indistinguishable from High (Rural) Density customer. This is the case because the Urban Density Zones include not only dense urban cores with relatively small lots but also some of the surrounding area that would normally be considered rural in all respects including the density of the electricity customers. Put differently a HOD customer in a rural setting could be included in an Urban Density Zone provided they do not contribute to exceeding the urban density threshold on average, while an identical customer that does not happen to be near an urban core would not be included in an Urban Density Zone.

Conceptually, a more granular approach to classifying customers can be envisioned that would be more consistent with the fairness principle. An approach that focused on density in much smaller geographic areas (hence, more granular) would result in a more intuitive and consistent classification of customers. For example, it would not be hard to visually identify, using Google maps for example, areas with urban concentrations of housing so that Urban Density Zones included only customers that are close to their neighbours (smaller, contiguous lots that typify urban areas). Implementing such an approach in practice, however, could be labour intensive (and therefore expensive) and would require an on-going process of reclassification as new housing is built. In addition, it is not clear how large a concentration of customers in close proximity is required to achieve the economies of density in the provision of distribution services.

Many strategies can be envisioned for implementing a granular approach to classify customers into density based classes. For example, classification as Urban or Rural Density could be performed on a postal code basis. If the customer density within the area covered by a six character postal code is above a threshold level, the area would be defined as Urban Density. Alternatively, urban density could be defined on the basis of the number of customers connected to a single transformer. This approach would have the advantage of being directly related to at least one cost factor that is affected by customer density. Similarly, classification as Urban or Rural Density could be based on the km of line required to serve small groups of customers.

While these granular approaches to classifying customers as urban and rural (and High and Normal to be consistent with the current HOD rural classification and legislation that underpins the RRRP) would clearly result in a more intuitive and consistent urban/rural split, there can be little doubt that any such approach would be onerous for any distributor to establish and would require significant on-going management. It would be difficult to justify the resulting costs given that the only impact on the distributor's overall revenue requirement would be to increase it (i.e., there is essentially no prospect for efficiency gains), the benefit in terms of increased fairness would be modest, the potential for complexity and customer confusion would be high, and the frequency of reclassifications that cause disruptions for customers would be relatively high. Perhaps most significant in practical terms is that there would be significant resistance to such a change as it would almost certainly result in a significant number of customers currently classified as being in Urban Density Zones being reclassified as Rural.

Based on the foregoing observations, it can be concluded that any attempt to redesign HOD's current approach to make it more consistent with the fairness principle by classifying customers on a more granular basis will create practical difficulties that will be expensive and onerous to address. While there may be conceptual merit in adopting an approach that provides for a more intuitive division of customers into urban and rural classes, the practical reality is that a simplified approach, while imperfect, is almost certainly in the best interest of customers overall.

4.3 ALTERNATIVE MUNICIPALITY-BASED URBAN/RURAL DEFINITION

Given that a granular approach that would be more consistent with the fairness principle probably would not be practical, it may be worthwhile to consider adopting for HOD the simplified approach to defining urban and rural classes that is commonly used in other jurisdictions -- which is to base them on municipal boundaries.

As the earlier discussion of urban/rural rate classes used in other jurisdictions (section 2.1.2) points out, all other jurisdictions having urban and rural residential classes use municipal boundaries, rather than density criteria, to define the areas within each class.

Using municipal boundaries to define urban service areas has some advantages over HOD's density-based approach. In particular, it is probably simpler for customers to understand and therefore would result in a more transparent method from the perspective of customers. Moreover the urban/rural classification does not create boundary issues wherein debate over the precise criteria affects whether customers fall just above or below the defined threshold for the urban class. Customers are either

inside or outside the municipal boundary, and the same distinction is used for other, more significant issues such as the municipal taxes they pay and the municipal services they receive. Their electricity rate would be just one more thing that is different for households that are within a municipality as compared to those that are not within a municipality. In addition, reclassification of customers would tend to be less common if municipal boundaries were used for rate classification purposes. When reclassifications occur, it would be done in conjunction with a municipal boundary change or some other significant municipal government event that is not controlled by the distributor.

In the absence of legislative change, it will be necessary to maintain two rural classes by separating the customers outside municipal boundaries between High (Rural) Density Zones and Normal (Rural) Density Zones such that the Normal (Rural) Density Zones properly identify those customers that qualify for Rural or Remote Rate Protection (RRRP). Consequently, if the current density-based classes are replaced with residential classes based on municipal boundaries, the composition of the Normal (Rural) Density Zones would not be changed although the assignment of customers to the Urban and Rural classes that do not qualify for the RRRP would be changed.

4.4 DETERMINING APPROPRIATE BREAK POINTS BETWEEN CLASSES

In defining customer classes, it is desirable to minimize “boundary issues” that arise when the criteria for defining classes result in very similar customers falling on different sides of the break point between classes. This concern is accentuated when customers can easily shift back and forth between classes due to relatively small changes in demand or any other factor used to divide customers into classes.

For example, this problem may arise when industrial customers are divided into classes based on their demand. It is minimized by examining the actual demands of customers (e.g., on a scatter diagram plotting the demand of a distributor’s industrial customers) and selecting boundaries between classes at levels of demand where there are gaps between clusters of customers, if possible.

In the context of density-based classes, the implication is that perceived fairness will be optimized by selecting criteria for defining urban and rural classes that create a clean separation between the classes. Relying on municipal boundaries is one way to achieve this goal; however; it relies on a political rather than a cost-based categorization of customers into classes. If a cost-based definition of urban and rural classes is used, it follows that it would be desirable to select criteria that are relatively intuitive and that result in a relatively small number of customers that are on the boundary between classes. For example, the granular approach could be used to ensure that all customers in what might be viewed as an urban cluster (e.g., housing developments) would be classified as Urban Density, while all those that are not in urban clusters would be classified as rural (either high or normal, as dictated by legislation).

4.5 IMPLICATIONS OF CHANGING URBAN/RURAL CLASS DEFINITION

If the OEB were to direct HOD to change the definition of its urban and rural rate classes, it would be important to recognize that there are several another issues linked to the urban/rural rate classes.

- Rural or Remote Rate Protection (RRRP)
  - RRRP is based on legislation and applies only to customers in Normal (Rural) Density Zones; hence, legislative implications of any change affecting the definition of Normal (Rural) Density Zones would need to be considered
  - The customers benefiting and magnitude of the individual subsidy may change
  - Total value of the RRRP may change
- Service Quality indicators (SQI)
  - Different SQIs apply in urban and rural areas
  - SQI standards may have to be reviewed if composition of urban and rural regions is changed (e.g., response time; reliability; SAIDI; SAIFI)
- Feasibility Test (DCF Model)
  - DCF uses estimated construction cost for actual projects but standardized values for future costs (e.g., maintenance, customer service, etc.)
  - Redefined classes may require changes to DCF model to reflect differences in future costs

It would also be appropriate to recognize that the implementation of a different urban/ rural split could involve the expenditure of significant effort that would involve incremental costs that should be recovered in rates. The cost and effort involved would be particularly significant if the change involves a study of the actual costs incurred to provide service to customers in Urban Density, High (Rural) and Normal (Rural) Zones, however defined. Unless incremental resources are utilized for this work, other priorities will suffer. It may be appropriate to establish a deferral account to capture costs related to this work.

4.6 CONCLUSIONS RE: OPTIONS FOR DEFINING DENSITY-BASED CLASSES

Although the conceptual foundation for the existing HOD density-based residential and small business classes is weak and ERA has been unable to identify other jurisdictions that utilize a similar approach (i.e., classes based on explicit density-related criteria), there are several pragmatic reasons that they might be retained. Change can be disruptive for customers and the benefits of revising the rate classes are likely to be minimal. Further, to the extent that the urban/rural rate differential is ultimately more reflective of fairness considerations rather than cost differences, any restructuring of the rate classes may result in more of a change than an improvement in horizontal and vertical equity.

An alternate approach that would divide customers into urban and rural classes that would be more consistent with the causal cost incurred to serve high and low density customers would be to take a more granular approach to defining the classes. Although the granular approach would be more precise in allocating customers to density based classes it would almost certainly be onerous to implement and maintain. A more practical option would be to adopt the approach to defining urban and rural classes that is used in other jurisdictions: that is relying on municipal boundaries to define the areas included in the urban class. This approach would be relatively straightforward to implement since the boundaries to be used already exist. The challenges of determining the relative cost of serving urban and rural areas defined in this manner are addressed in section 5.

If the definition of HOD's urban and rural rate classes is changed, it will be necessary to examine other issues that are linked to the urban rural definitions, including:

- Rural or Remote Rate Protection (RRRP)
- Service Quality indicators (SQI)
- Feasibility Test (DCF Model)

5 OPTIONS FOR ALLOCATING COSTS

Whatever definition is used for density-based customer classes, it is necessary to allocate HOD's costs to those classes. If costs are not differentiated appropriately by class, the class distinctions will not be meaningful and rates will not reflect difference in causal costs.

This section provides an overview of HOD's current cost allocation methodology and alternatives that could be expected to result in a more precise allocation of costs to density-based classes, or urban/rural classes based on municipal boundaries.

All of the cost allocation methodologies discussed in this section could be applied (at least conceptually) to any of the customer classification methodologies addressed in the previous section.

5.1 HYDRO ONE'S CURRENT URBAN/RURAL COST ALLOCATION METHODOLOGY

HOD's 2008 cost allocation methodology used density weighting factors to allocate costs related to overhead lines and transformers. These density weighting factors have two components[11].

- **Customer Density Weighting Factors:** used to allocate fixed costs:
  - for overhead line costs, the weights are based on the number of customers by class for each feeder; and
  - for transformer costs, the weights are based on the net book value of transformation assets by class for each feeder.
- **Demand Density Weighting Factors:** used to allocate variable costs:
  - for both overhead line costs and transformation costs, the weights are based on the energy by customers by class for each feeder.

While this methodology is reasonable in that more precision is not achievable with currently available data, it is acknowledged that the approach is not conceptually ideal. In particular, the customer density weighting factor for overhead line costs makes the implicit assumption that the density of all customer classes served by a feeder is the same. In fact, it may well be the case that a very short section of a feeder serves a large number of Urban Density customers, while much longer sections of the feeder serve customers in High (Rural) and Normal (Rural) Density Zones. If that is the case, overhead line costs would be over-allocated to the UR class under the current methodology. Of course, without detailed information on the km of each feeder that is within each Density Zone, a more precise allocation of overhead line costs is not possible. It would clearly be a very costly undertaking to determine the km of each

[11] Details of HOD's cost allocation methodology are presented at Exhibit H, Tab 12, Schedule 66 of HOD's 2009 rate filing. See USofA Accounts 1830-3B and 4B, 1835-3B and 4B, and 1850-2 for allocation of overhead lines and transformer costs.

feeder that serves the different density zones on a feeder specific basis so that the current weighting factors could be improved.

Furthermore, as discussed in section 6 below, there are several categories of costs in addition to overhead lines and transformers that conceptually should be allocated based on density factors. A more comprehensive density-based cost allocation could be expected to result in more precise allocation of costs to HOD's density-based rate classes and hence would provide a more precise measure of the causal costs for each class. Again however, as with all elements of cost allocation studies, it is important to balance the costs and benefits of greater precision.

5.2 ALTERNATIVES FOR ALLOCATING COSTS TO URBAN AND RURAL CUSTOMERS

This section identifies and briefly discusses four options for allocating costs to urban and rural customer classes that would, in principle, result in a more precise allocation of causal costs than HOD's existing weighting factor methodology. Before adopting any of these alternatives, however, it will be important to consider the cost and expected benefit in terms of improved fairness resulting from the implementation of each of these alternatives.

The alternatives considered are:

1. **Detailed Analysis of USofA Cost Detail:** This approach requires a detailed breakdown of distribution plant assets and relevant O&M costs on a feeder-segment basis to identify the feeder segments being used to serve each individual urban and rural zone. The disaggregated costs to serve each group of customers would then be directly allocated to the sub-classes.
2. **Regression Analysis:** Regression analysis could be used to estimate cost of wires/poles/ transformers to serve different customer classes. This approach would require detailed cost information on a feeder-segment basis to be identified for a large enough sample to feeders to produce statistically significant results; however, it would avoid the need to disaggregate HOD's plant and O&M costs for its entire service area.
3. **Sample Data:** Actual capital and O&M costs incurred to serve customers could be analyzed for selected "typical" urban and rural areas. This approach would be similar to the regression methodology, but would involve a much smaller sample, resulting in a lower level of confidence in the accuracy of the results.
4. **Engineering Analysis:** Appropriate cost differentials for the different classes could be determined using engineering analysis for a representative "normal" network configuration for each customer class. This approach would not be based on actual embedded costs, but would reflect the expected current cost of serving customers with densities that are typical of the various customer classes using current technology.

The trade-offs involved and feasibility of each approach, given currently available data, are briefly considered below.

5.2.1 DETAILED ANALYSIS OF USOFA COST DETAIL

The primary attraction of this approach is that it is the most direct way to accurately determine the actual cost of servicing each class of customer, based on HOD's embedded costs that are included in its revenue requirement.

Essentially, it would view the facilities used to serve a single class of customers, such as a transformer that serves a group of customers that are all in the same class (UR, R1 or R2), however those classes are defined, in a manner that is analogous to the treatment of a transformer that is used exclusively to serve one or more Large Users – the assets in question and associated O&M costs are directly assigned to the class.

Where facilities are used to provide service to customers in more than one class, for example a feeder that starts in an Urban Density Zone and then extends into a High (Rural) Density Zone and perhaps continuing into a Normal (Rural) density Zone, the costs would have to be allocated to the classes on the basis of allocators such as peak demand for variable costs and customer count for fixed costs.

The primary downside of this approach is the fact that the detailed information required to allocate the costs is not currently available. There can be little doubt that the effort required to complete a comprehensive disaggregation of all relevant plant records and O&M costs would be very onerous and costly. It is far from clear that this work would be a good use of HOD's resources given its other priorities.

It should also be noted that while asset values (e.g., for overhead lines and transformers) could be determined based on a detailed analysis of plant records, it would be extremely difficult, if not impossible, to determine O&M costs based on a review of existing cost information. Hence, it would be necessary to implement more detailed O&M cost tracking procedures and then to monitor costs for a period of time.

Given the level of effort required to implement this approach, it would be consistent with standard cost allocation practices to adopt a simplified approach. For example, each category of assets (e.g., overhead lines) could be allocated to classes based on an appropriate proxy, such as a weighting factor. This is the approach currently used by HOD and it would appear that the only way to improve on the existing weighting factor approach would be to undertake detailed analysis on a feeder-by-feeder basis to produce a more precise determination of the feeder segments that are used to provide serve in each Density Zone.

As discussed in the next section, there are a number of cost factors that are density-dependent in addition to the two (overhead lines and transformers) that are allocated on the basis of density by HOD's existing methodology. Any effort to capture the impact of these additional factors would further complicate, and increase the cost of, undertaking a detailed analysis of causal cost that should be allocated to the urban and rural customer classes.

5.2.2 REGRESSION ANALYSIS

Using regression analysis to determine the average relationship between various costs and (i) customer density and (ii) demand density would have the benefit of reducing the

effort required in examining feeder-specific information to determine the embedded costs incurred to serve customers. The effort would be reduced in two ways. First, not all feeders would have to be analyzed. Second, it would be reasonable to focus on HOD's feeders for which it has the best information available (assuming the resulting selection of feeders would not be a biased sample).

The data collected for the regression analysis would also serve as the basis for determining the actual average customer and demand densities in HOD's Urban, High (Rural) and Normal (Rural) Density Zones. These average densities would be used to estimate the costs to be allocated to the classes, given the average densities.

While this approach would be less onerous than conducting an exhaustive analysis of all assets and O&M costs that directly serve the urban and rural classes, it would still be resource intensive in that it would require detailed analysis of all feeders included in the sample. In order to obtain a statistically significant sample, the sample size could not be small. It may be feasible however to start with a moderate sample size, perform the required regression analysis and examine the results to determine whether the results are statistically significant and therefore whether it would be necessary to expand the sample size and rerun the regression.

5.2.3 SAMPLE DATA

The least onerous approach to developing an allocation of costs to the urban and rural rate classes that is based on a direct examination of HOD's actual cost of serving these customers would be to rely on sample cost data for a small number of "typical" feeders serving these classes. Ideally, the identification of "typical" feeders would take into account a wide range of factors including:

- the mix of customers in the various urban/rural classes;
- the age of assets (the NBV of assets is age dependent, as are O&M costs);
- construction costs factors such as remoteness and terrain; and
- the overall average customer and demand densities.

Assuming the selection of feeders is appropriate, it should be expected that a relatively small sample of feeders could provide an acceptable estimate of the "true" allocated costs. The cost of undertaking this approach would be a fraction of the cost of the preceding methods. Of course, it would still be necessary to institute procedures for tracking O&M costs for the feeders that are included in the sample.

One way that the sampling approach could be utilized would be to use it as a check on the reasonableness of the weighting factors currently used by HOD. The rationale for using it only as a reasonableness check (and perhaps for adjusting the weightings if necessary) is that it would be far easier to update the weighting factor methodology for future rate applications than it would be to implement an on-going, credible process based on sampling. Sampling would inevitably involve a margin of error that could result in instability of the allocation factors through time due to unique occurrences (e.g., storm damage that affects one or more of the feeders being sampled). It would also be difficult to ensure that any given set of feeders remain "typical" through time and it would

be problematic to rely on a sample that is not consistent through time. The weighting methodology avoids the risk of excessive instability in the weighting factors; hence, if the Board's primary concern is to ensure that the weighting factors are reasonable, it may be more effective to undertake a point-in-time analysis of a sample of feeders as a cross-check on the weighting factors methodology, than it would be to replace the existing methodology with an alternate approach that is either expensive or unstable.

5.2.4 ENGINEERING ANALYSIS

The preceding three approaches are methods that involve different trade-offs between cost and precision in seeking to determine the correct allocation of HOD's embedded costs to its urban and rural customer classes. A conceptually different approach would be to develop a basis for allocating costs to these classes using an approach that isolates the impact of density from all other factors. A practical way to implement this approach would be through engineering analysis.

The engineering analysis approach would involve the creation of one or more standardized scenarios as a basis for determining the relative cost of supplying a group of customers with differing customer and demand densities. The differing densities would be representative of the different rate classes. The scenarios would hold all other factors constant, including customer mix, cost drivers such as remoteness, terrain, weather and brushing requirements.

This analysis could serve as either a cross-check on HOD's existing weighting factors, or it could be used to derive new allocation factors.

5.3 CONCLUSIONS ON COST ALLOCATION GENERAL IMPLEMENTATION ISSUES

Each alternative to HOD's current methodology for allocating costs to the density-based classes (i.e., detailed analysis of USofA cost data; regression analysis; sample data; and engineering analysis) will require significant effort and cost to be incurred by HOD. The benefits of any resulting improvement in the precision of HOD's allocated costs is unclear, particularly if strictly cost-based rates will be adjusted to reflect urban/rural rate differentials that are deemed to be acceptable from a policy perspective.

Ultimately, the choice of cost allocation methodology will be determined primarily by making a judgement call with respect to the appropriate trade-off between precision and cost/feasibility. The effort required to implement an alternative approach to allocating costs to the urban and rural classes is difficult to anticipate precisely; however, it is clear that it will be significant due to the limitations of existing cost detail.

Furthermore, if a more detailed approach is adopted, HOD should also review its cost allocation model and identify all USofA accounts that should either be directly allocated to these classes or need specific density-related allocators. For example,

- it may be appropriate to allocate losses based on average distance to the load on low voltage (LV) facilities; and
- it may be appropriate to allocate brushing costs and storm damage primarily or exclusively to rural classes.

6 THE SIGNIFICANCE OF DENSITY-RELATED COST FACTORS

If an effort is made to undertake a comprehensive analysis of causal costs for HOD's urban and rural customer classes, it would be appropriate to ensure that all cost factors that differ significantly with the density (or the municipality-based definition of urban and rural) are taken into account. It is clear that the relevant cost factors include much more than the two (overhead lines and transformers) that are included in HOD's current methodology for allocating costs to these classes.

In order to develop a more complete list of important cost factors that result in cost differences between higher density urban areas and lower density rural areas, ERA interviewed Hydro One engineering staff to identify costs that were typically either higher or lower in rural (and remote) areas than in urban areas. The following factors were identified during this interview session.

Factors that cause costs in rural (and remote) areas to be higher include the following.

- Storm damage occurs primarily in rural areas: HOD plant is less protected by the natural/man-made environment outside of urban centres
- Brushing is done only in rural areas (HOD's annual cost is about $28 million)
- Travel time is 2-3 times higher for each job in rural areas
- Distribution Stations (DS) are standardized[12]
    - The area a DS can serve efficiently is limited and the maximum customers/ load is fixed (minimum 10 kVA transformer)
    - In urban areas, customer density is sufficient to fully utilize DS capacity (allowing for growth)
    - In rural areas, customer/demand density can be too low for optimal utilization; hence, significant excess capacity results and cost/customer and cost/kW are higher than in urban areas
- In rural areas the number of poles/customer and km of line can be 5-10 times greater: hence, these costs are higher per customer and per kW

Factors that cause costs in rural (and remote) areas to be lower include the following.

- Some urban areas have high costs due to congestion (usually only dense commercial areas, such as downtown Toronto, etc.)[13]
- Underground facilities are more costly and are rarely used outside urban areas

HOD currently has very limited information on the differences in most of these cost categories in urban and rural areas.

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[12] The lower cost due to standardization outweighs the high cost of utilizing over-sized standard equipment in areas with low customer and demand density. This raises the question of whether rural customers should pay higher rates because they are served by under-utilized standard equipment.

[13] This factor may not be relevant in HOD's urban areas.

7 CONCLUSIONS

This section summarizes John Todd's conclusions based on the analysis conducted in preparing this report. The conclusions relate to three central questions.

- Should separate urban and rural classes be maintained?
- How should separate urban and rural classes be defined?
- How should costs be allocated to the urban and rural classes?

7.1 SHOULD SEPARATE URBAN AND RURAL CLASSES BE MAINTAINED ?

Whatever the historical basis of HOD's urban and rural rate classes, i believe that it is appropriate to commence any review of the definitions of the classes and the allocation of costs to those classes with an examination of whether it is appropriate to retain a distinction between urban and rural classes however they are defined. Reasons for reconsidering this issue include the following.

- There are many factors that affect the cost of serving specific groups of customers, including locational differences (e.g., distance from transmission facilities, etc.), differences in geography (e.g., rocky ground vs. deep soil), differences in vulnerability to storm damage, and overhead vs. underground construction, as well as the density of customers using a feeder. It is not clear why low density customer should pay higher rates, while customers with a high cost of service for other reasons do not pay higher rates.
- Density-based rate classes could be viewed as a violation of the postage stamp rate principle, which implies customers that are similar in terms of their demand characteristics pay the same rates. For example, the facilities required by urban and rural customers are identical; the differences relate to the efficiency with which the facilities are utilized.
- Part of the higher cost of serving rural customers is associated with the use of standardized equipment which is oversized when used in some rural areas. Given that standardization results in lower costs for all facilities, the rationale for penalizing those in areas where facilities are under-utilized is weak.
- Regulators in many jurisdictions have phased out class differences base on such factors as residential heating and no-heating load and urban vs. rural locations.
- Rural customers do not enjoy a superior standard of service as compared to urban customers. Based on the different service quality standards for urban and rural customers, it can be argued that on a value of service basis, rural customers should be paying lower, rather than higher rates.

At the same time, it must be recognized that there is strong evidence that the cost of serving rural customers is higher due to their lower average customer and demand density. This is a difference that may justify different cost-based rates.

I therefore conclude that generally accepted ratemaking principles provide very limited support for maintaining separate urban and rural classes on the basis of differences in customer or demand densities that affect causal costs.

7.2 How Should Separate Urban and Rural Classes be Defined?

Assuming the Board determines that it is appropriate for HOD to maintain separate residential and small business urban and rural rate classes, for reasons other than meeting the legislative requirements associated with the RRRP, it is ERA's view that it would be appropriate to ask whether the current density-based class definition are appropriate at this time. There are several reasons for addressing this question.

- HOD's current density-based class definitions appear to be unusual, if not unique, among electricity distributors that have urban and rural rate classes.
- The current density-based definitions of the urban and rural classes are based on historical precedent. There is no evidence that there was ever a clear cost-based justification for the defined thresholds.
- The origins of the current HOD urban and rural class definitions appear to be based more on pragmatic considerations than cost analysis.
- The more common approach, which is to define urban customers as those within municipal boundaries (sometimes with a minimum population threshold), would be a definition that is consistent with differences in other charges and services (i.e., municipal taxes and services). As such it may be more understandable to customers. This alternate definition may also be more stable, and where reclassification occurs it would be driven by well-understood municipal restructuring. Counter-balancing this consideration is the reality that any change to the status quo can cause customer confusion and angst.
- A more granular approach to assigning customer to the urban and rural classes would still be unique, but it would probably result in a closer correspondence between density-related costs and the rates customers pay. Hence, a more granular approach to identifying urban and rural customers could be expected to improve fairness, while having little impact on efficiency. The change, however, could compromise rate stability & simplicity.
- Adopting a more rigorous cost-based approach to allocating density-based cost will be challenging.

At the same time, it should be recognized that the implementation of any change in the definition of the urban and rural classes will create winners and losers and could be costly, especially if a detailed analysis is undertaken to establish a more defensible cost basis for the different rates.

It is clear that any change to the definitions of the urban and rural rates, particularly if combined with a refined approach to allocating costs to the classes will have an impact on the revenue-to-cost ratios of the urban and rural classes. Consequently, an important policy question prior to investing considerable effort in redefining the classes and

developing a more sophisticated cost allocation methodology is what, if anything, will be done in response to the new revenue-to-cost ratios. In particular:

- if the impact of changes is modest, there may be little if any impact on customer rates, which would raise questions about whether the effort was worth the cost (except to provide empirical confirmation that the current approach is reasonable despite being pragmatic); and
- if the impact of change is significant, the response may be to mitigate the impact so that there is little impact on rates, which would be appropriate if the ultimate determinant of the differential between urban and rural rates is actually what is considered to be a just and reasonable differential from a fairness perspective rather than a just and reasonable differential from a cost of service perspective.

If there is a limit to the difference that would be considered fair and equitable (and the existence of the RRRP suggests that this is the case), then the only cost information that is needed is evidence that difference in the cost of service for urban and rural customers is at least equivalent to the acceptable rate differential. That information would be sufficient to demonstrate that the urban and rural rates are just and reasonable.

It should also be noted that a policy decision that rural rates and urban rates should differ so as to reflect the cost differential would imply that consideration should be given to the question of whether to apply the policy on a provincial basis. It is not clear why, as a matter of principle, such as policy should apply within the service area of Hydro One only, and not across the province as a whole. Province-wide adoption of urban and rural rates using consistent definitions and levels of cross-subsidy would result in rates that are more equitable for electricity customers throughout the Province and rates that are more comparable across LDCs.

I therefore conclude that it separate urban and rural classes are to be maintained, either the current definitions should be retained or the current density-based definitions should be replaced with the more standard approach that defines urban areas based on municipal boundaries.

7.3 How Should Cost be Allocated to the Urban and Rural Classes?

If the Board determines that it is appropriate for HOD to maintain separate urban and rural rate classes, however, defined, a decision will have to be made about the appropriate balance between precision and cost in adopting a cost allocation methodology.

All things considered, it is my view that the most practical and cost effective approach is likely to be to use sample data to derive an estimate of the average cost (or cost differential) of serving urban and rural customers under the definitions that are approved for future use. The resulting cost estimates could then be used to test the reasonableness of the weightings used in HOD's existing cost allocation methodology, and possibly to refine the weighting methodology if necessary. Having provided support for the reasonableness of the results of the weighting methodology, it could be used in

the future so that the cost and potential instability of continually updating a more detailed approach to allocating costs can be avoided.

In the alternative, it may be appropriate to rely on engineering analysis to establish an appropriate rate differential between urban and rural customers that isolates the density-related cost differential for urban and rural service (i.e., by remove factors such as the impact of the age of assets on the NBV of assets and on maintenance costs).

I therefore conclude that either approach could be used to check the reasonableness of the current weighting methodology, serve as a new cost allocation methodology for determining cost based rates, or to confirm that a rate differential that is deemed the maximum acceptable form a fairness perspective is not excessive from a cost perspective.