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December 11, 2016

VIA RESS AND COURIER

Kirsten Walli
Board Secretary
Ontario Energy Board
P.O. Box 2319
2300 Yonge Street, 27th Floor
Toronto, Ontario M4P 1E4

Dear Ms. Walli:

RE: EB-2016-0160 Hydro One Networks Inc. ("Hydro One") Transmission Rates Application – HONI Compendium for Environmental Defence

Hydro One's Compendium for its cross-examination of Mr. Lusney is enclosed.

Yours truly,

McCarthy Tétrault LLP
Per:

For: Gordon M. Nettleton

GMN

ONTARIO ENERGY BOARD

IN THE MATTER OF

HYDRO ONE NETWORKS INC. (HONI)

TRANSMISSION COST OF SERVICE APPLICATION

PROCEEDING ID NO.: EB-2016-0160

EVIDENCE
OF TRAVIS LUSNEY

On behalf of

ENVIRONMENTAL DEFENCE (ED)

Q1. Please provide a summary of your evidence.

Efficiency in a transmission system can provide benefits to rate-payers and support Ontario's Conservation First framework. There are many options available to reduce transmission losses ranging from relatively inexpensive operational measures (e.g., increasing operating voltage within the standard above the nominal level) to large-scale capital investments (e.g., reconductoring transmission lines). These options need to be carefully assessed to determine cost-effectiveness and potential impacts on other considerations such as reliability and safety.

There are also several approaches for regulating and managing transmission losses. Recommended best practices include:

- Measuring, verifying and reporting consistently on the amount of transmission losses;
- Benchmarking of transmission losses to relevant jurisdictions with similar physical characteristics (e.g., size and geography) or policy characteristics (e.g., emphasis on conservation);
- Integrating transmission losses into operational and capital investment planning processes; and
- Considering encouraging loss reductions through explicit incentives.

For example, National Grid Electricity Transmission has integrated losses into planning processes by considering the benefits of transmission loss reductions while assessing options for asset replacement, equipment specification, procurement, operation, and new system developments including the impact of new technologies. It also has a robust monitoring and reporting program. Examples of incentive regulation to encourage loss reductions include rewarding transmission loss reductions through overall productivity targets (e.g. Norway), providing a revenue disincentive relating to transmission losses above a pre-determined rate (e.g. Austria), and assigning a value to transmission losses and rewarding or charging a transmitter if the cost of transmission losses are lower or higher than the reference value (e.g. Germany).

Overall, understanding the amount of losses within a transmission system is an important first step to determine if transmission loss reduction is a beneficial investment for rate-payers.

Q2. Please state your name, business address, and the nature of your business.

A. My name is Travis Lusney. I am a Director at Power Advisory LLC (Power Advisory). My business address is 55 University Ave – Suite 605, Toronto, Ontario.

Power Advisory is a management consulting firm focusing on the electricity sector and specializing in electricity market analysis and strategy, power procurement, energy policy development, litigation and regulatory support, and electricity project feasibility assessment.

Power Advisory's clients include power planning and procurement agencies, regulatory agencies, generation project developers, transmission companies, consumer advocates, non-governmental organizations and electric utilities.

Q3. Please describe, at a high level, where transmission system energy losses come from and the operational measures and capital investments that can be undertaken to reduce transmission system energy losses. Please provide a focused response containing only the background information that is necessary to understand your answers to the remaining questions.

A. Transmission losses occur from the transfer of energy production at generation sites to electricity demand centers through transmission infrastructure such as power transformers, transmission circuits (i.e., overhead transmission lines) or transmission cables (i.e., underground transmission lines) and switching assets (e.g., switchgear). Losses can be categorized into two general areas:

- Fixed losses that occur when infrastructure is energized. Fixed losses are independent of amount of load on the transmission assets. In other words, fixed losses do not depend on the amount of energy flowing through the equipment. An example of fixed losses is core losses from energization of power transformers.

- Variable losses occur from loading of the transmission equipment and are determined based on the current passing through the equipment. An example of variable losses are the heat losses that occur on transmission circuits or cables. The amount of losses is proportional to the square of the current loading on the transmission lines (i.e., I^2R).

There are many causes for losses within a transmission system. Options for reducing transmission losses often require a balance between reducing losses in one part of the transmission system while attempting to minimize increases in losses in other parts. In addition, reduction of transmission losses must be cost-effective (i.e., the dollars invested in loss reduction should be less than the cumulative future value of losses) and maintain transmission system reliability and stability. Implementation of one or more options to reduce transmission losses should consider the variety of impacts on the transmission system along with the option's cost-effectiveness.

Below I have presented a summary of transmission loss reduction options through operational measures and capital investments.

Operational Measures for Loss Reduction.

Operational measures to reduce transmission losses are based on adjustments to the planning and operation of the power system balanced against other operational considerations such as reliability, safety, cost, environmental impacts, etc. The following provides a summary of operational measures for reducing transmission losses

- Transmission system modeling is an excellent tool to assess loss reduction strategies and determine the optimal configuration of the power system. Modeling can provide a baseline understanding of the existing system configuration before alternative configurations, operational practices or investments are assessed. Modeling can also assist to maintain accurate records of installed infrastructure and system configuration, allowing transmission system operators to analyze the benefits and costs of loss reduction actions or programs across the entire system. Inclusion of transmission system modeling of transmission losses can be used on a daily basis to optimize the configuration of the transmission system.

- Increasing the voltage of the transmission system can decrease transmission losses by reducing the current for a given power transfer amount. The smaller current resulting from the higher operating voltage reduces the transmission losses. From an operational measure perspective, voltage increases can be accomplished by raising the operating voltage on an existing transmission system within the acceptable standard bound from a nominal voltage level. The Independent Electricity System Operator's (IESO's) Market Rules Appendix 4.1 stipulates that operating voltage can be over 10% from the nominal voltage for some voltage classes.[1]

- Another operational change for loss reduction is through the inclusion of the value of loss reduction in the planning process. By including the calculation and value assessment of losses as part of asset management or transmission system expansion planning, a transmitter is able to determine when loss reduction is cost-effective as part of the broader planning process objectives. Since utilities typically invest in long-life assets (i.e., 40+ year life expectation), it is important to consider loss reduction options in the decision making process for the procurement and arrangement of new or replacement equipment.

- Benchmarking the level of transmission losses in a transmission system to other jurisdictions can be helpful in determining if loss reduction strategies should be considered. Determining a benchmark requires the calculation of losses within a system and can establish a precedent regarding the validity of inputs and the approach to calculation of losses within a system. Benchmarking over multiple periods can provide a historic reference to

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[1] The maximum continuous voltage is 550 kV for a nominal voltage of 500 kV, 250 kV for nominal voltage of 230 kV, and 127 kV for nominal voltage of 115 kV. IESO – Market Rules – Chapter 4 Grid Connection Requirements – Appendices.

understand how a system's losses naturally evolve over time and when action may be required. In other words, establishing a process to regularly assess transmission losses (e.g., annually) can be beneficial in understanding how a transmission system's losses compare against other similar systems and how losses change due to external forces.

Capital Investments for Loss Reduction.

Transmission conductor losses occur due to heating loss in the transmission line. The loss is a combination of the current the line is carrying and the resistance of the transmission line. The properties of the transmission circuit or cable (i.e., conductors), such as size, distance, temperature, or material, determine its resistance. The heating loss is determined by the square of the carrying current and the resistance (i.e., I^2R).

- One option for reducing transmission line losses is to reconductor the line to reduce the resistance. A common approach to reduce the resistance through reconductoring is to increase the size of the transmission conductor using the same material as the previous conductor. The larger size reduces the per unit resistance of the conductor and increases the thermal capacity transfer capability. Limits to reconductoring are primarily due to integration with existing transmission infrastructure such as the supporting capability of transmission towers and insulators. If the new transmission conductor is too large for the existing infrastructure, then additional investments are required that can reduce the cost-effectiveness of the reconductoring approach.

- A second option to reduce transmission conductor losses is to replace the conductor with materials that have extremely low resistance, sometimes referred to as superconductors. Superconductors achieve low resistance by cooling the material below a specific threshold temperature, while achieving substantially higher power transfer capability at the same voltage level and size as conventional materials[2]. The need to cool the

[2] U.S. Department of Energy, Office of Electricity, Superconductivity for Electric Systems Annual Peer Review Meeting, presentations available online: http://www.superpower-inc.com/content/technical-documents, July 2008, Arlington, VA.

superconductor means that the use is primarily restricted to underground applications where cooling capabilities are easier to apply compared to overhead transmission lines. The superconductor materials are expensive compared to conventional conductor materials[3] limiting the application to specific circumstances.

- A third option for reducing transmission conductor losses is to reduce the flow of reactive power on the transmission conductor. Reactive power is the result of current and voltage not being in phase and leads to total current on a line being greater than what is required to deliver the required power to a load. Reactive power compensation can be used to remove reactive power and reduce the additional transmission system losses. Reactive power compensation can be provided by a Flexible Alternating Current Transmission System (FACTS). FACTS is defined by the IEEE as "a power electronic based system and other static equipment that provide control of one or more AC transmission system parameters to enhance controllability and increase power transfer capability"[4]. FACTS can provide Shunt Compensation or Series Compensation.

    - Shunt compensation
        - Devices connected in parallel with the transmission line. Shunt-connected reactors are used to reduce the line over-voltages by consuming reactive power.
    - Series compensation

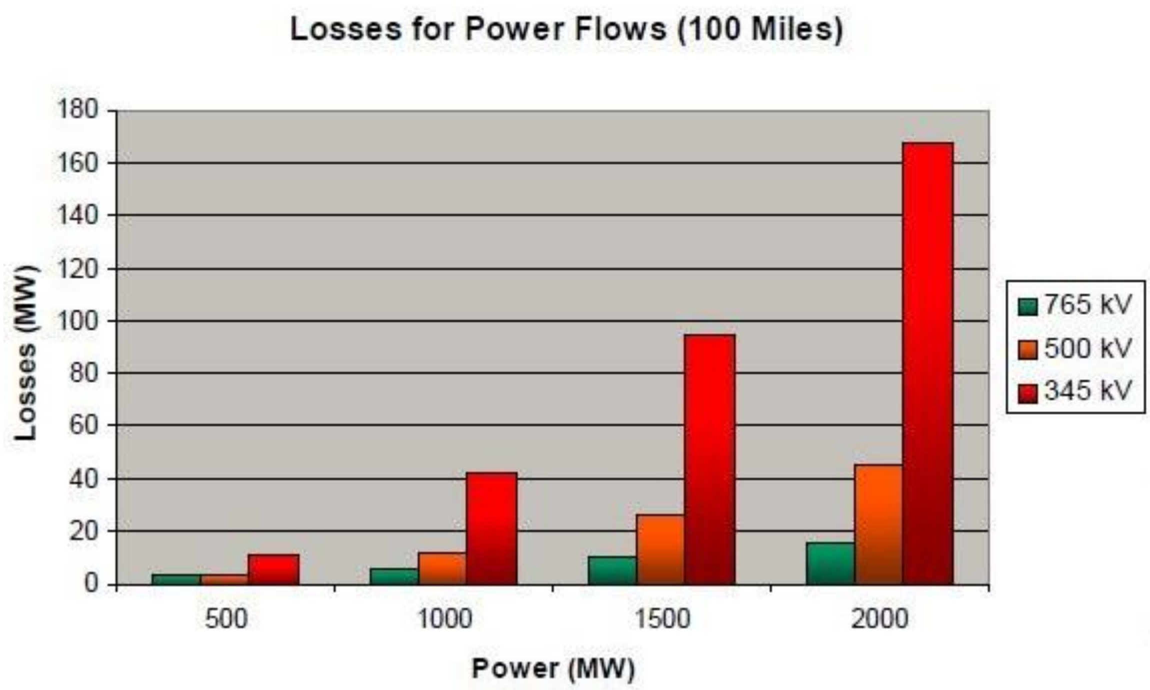
        Device connected in series with the transmission line and modifies the line impedance.

- Operational changes to increase voltage levels above the nominal amount to acceptable higher levels has been discussed under operational measures. Larger voltage increases to higher voltage levels (e.g., 230 kV to 500 kV) require investment in transmission infrastructure to ensure the transmission system can reliability operate at the higher voltage level. The

[3] *The Economist* 2001. "At last! The first practical superconducting power cables are now being installed." http://www.economist.com/node/691254 .

[4] *Proposed terms and definitions for flexible AC transmission system(FACTS)*, IEEE Transactions on Power Delivery, Volume 12, Issue 4, October 1997, pp. 1848–1853

impact on losses of higher voltages and the resulting loss reduction for equivalent power flows are shown in the figure below.



Source: Evan Wilcox, "765 kV Transmission System Facts For the Southwest Power Pool (SPP) Cost Allocation Working Group," May 28, 2008, page 17.

There are generally two types of transformer losses. The first is loading losses and depends on the amount of power the transformer is transferring. Loading losses are primarily created by the heating losses in the windings of the transformer, similar to the transmission conductor losses. The second type of transformer losses are core losses. Core losses are also referred to as no-load losses because the losses occur regardless of the power transfer in the transformer. As such, the losses occur at all times that the transformer is connected to the transmission system.

Design of transformers are consistently improving to increase efficiency and reduce loading losses and core losses. Replacement of transformers, primarily older transformers, can realize the benefits of new transformer design and materials to reduce transformer losses.

In summary, there are many options available to reduce transmission losses through operational measures or capital investment. Loss reduction options should be assessed to determine the cost-effectiveness and the impact on other considerations such as reliability and safety. Most operational measures involve identifying and understanding the level of transmission losses within a transmission system. The knowledge gained from understanding transmission losses can be leveraged when considering capital investments to reduce transmission losses.

Q4. Please discuss, at a high level, whether transmission companies such as Hydro One should actively monitor and manage transmission system energy losses.

A. The reduction of transmission losses increases the efficiency of the transmission network. Lowering transmission losses decreases the need for replacement energy production to meet Ontario's electricity demand which lowers costs for rate-payers. The Ontario government has emphasized energy efficiency through the Conservation First framework. The framework prioritizes conservation first, before new generation, where cost-effective[5]. The importance of electricity conservation was enshrined in the objectives of the Board by the Ontario government in 2009.

- "To promote electricity conservation and demand management in a manner consistent with the policies of the Government of Ontario, including having regard to the consumer's economic circumstances".[6]

Cost-effective reduction of transmission losses can be an important component of Ontario's conservation efforts and can support meeting the Board's conservation objectives.

Transmission loss reduction options require changes to operational practices or investments in transmission system infrastructure. As the owner and operator of the transmission system, HONI should be a primary participant in assessing the

[5] Ontario Conservation First: Part I - http://www.energy.gov.on.ca/en/conservation-first/#introduction

[6] Ontario Energy Board Act, 1998 Board Objectives, electricity 1 (1) 3 - https://www.ontario.ca/laws/statute/98o15

cost-effectiveness of transmission loss reduction strategies. The impact of operational changes and the cost of new transmission infrastructure will require HONI's input, cost estimates and analysis to determine the potential outcome and benefit (or drawback). While the IESO has responsibility for power system planning in Ontario, the IESO must rely on HONI to provide input on the impact of power system planning assessments and decisions[7].

Q5. Please discuss and analyze potential actions that Hydro One could be required to take to monitor and manage transmission losses, such as:

a) Developing a transmission loss reduction plan including, among other things, the identification of cost-effective operational measures to reduce losses;

b) Accounting for the benefits of loss reductions in investment planning; and

c) Adopting a policy to undertake operational or capital projects to reduce transmission losses whenever the overall benefits to consumers outweigh the costs.

There are several approaches for regulation of transmission losses. In Europe, a directive of the European Parliament and the Council on Energy Efficiency set a legislative framework that required national energy regulators to take into account energy efficiency in their decisions for transmission and distribution system operation and investment.[8] National regulators across Europe have adopted incentive regulation with three main components or considerations for transmission efficiency (i.e., loss reduction) regulation.[9]

The first component of transmission efficiency regulation is allocation of responsibility for procurement of losses. In some countries (e.g., Norway), the transmitter/network operator is responsible for procurement of energy to replace

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[7] Bill 135, Energy Statute Law Amendment Act, 2016 - Royal Assent received Chapter Number: S.O. 2016 C.10 - http://www.ontla.on.ca/web/bills/bills_detail.do?locale=en&BillID=3539

[8] Article 15 – Directive 2012/27/EU - http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:315:0001:0056:en:PDF

[9] Grid Regulation Incentives for Network Loss Reduction – The ICER Chronicle Edition 1 – December 20, 2013 - http://www.icer-regulators.net/portal/page/portal/ICER_HOME/publications_press/ICER_Chronicle/Art_9

losses and those transmission loss costs are included in allowed revenue. Where the transmitter/network operator is responsible for procuring transmission losses, the energy is typically secured through real-time energy markets, bi-lateral agreements or through auctions/tenders for generation of firm energy. In other countries (e.g., Spain), the network operators are not responsible for procurement of losses and instead generators/suppliers are obliged to cover losses. This is sometimes accomplished through the calculation of transmission loss factors, similar to the approach used in Alberta.[10] The generators or suppliers are expected to supply energy to compensate for anticipated losses.

The second component of transmission efficiency regulation is how transmission loss costs are distinguished. If the loss costs are considered non-controllable, then the costs are passed through to rate-payers and are not the responsibility of transmitter. If the costs are considered controllable, then the costs would be part of the incentive-based regulation formula which influences the revenues a transmitter can receive and supports action by the network operator where prudent.

The third component of transmission efficiency regulation includes an explicit loss reduction incentive scheme as part of an overall incentive based regulation approach. There are many different incentive arrangements utilized by regulators.[11]

- In Norway, incentives for network losses are bundled with incentives for any other costs through their incentive-based regulatory model. Increased productively, which could include reduced transmission losses, beyond a specific target is rewarded.

- Another incentive arrangement is for the regulator to establish an acceptable rate of losses that are included in the transmission tariff. This approach encourages transmitters to maintain transmission losses below the pre-determined rate or else the cost of losses have a negative impact

[10] AESO – Loss Factors - https://www.aeso.ca/grid/loss-factors/

[11] EU Practices in treatment of technical losses in the high voltage electricity cost – Ad hoc Expert Facility under the INOGATE project "Support to Energy Market Integration and Sustainable Energy in The NIS"

on the overall revenue of the transmitter. This approach is sometimes used by jurisdictions where the transmitter is not responsible for procurement and therefore is typically passing the cost of losses through to customers (e.g. Austria).

- An incentive mechanism can assign a value to transmission losses and reward or charge a transmitter if the cost of transmission losses is lower or higher than the reference value (e.g., Germany)

Example of Transmission Loss Regulation

An example of transmission loss regulation is the transmission license of National Grid Electricity Transmission (NGET), a transmission company located in the United Kingdom (UK), which requires a report on transmission losses within its transmission system.[12] NGET is required to publish an annual transmission losses report and to publish a strategy on how NGET will address the level of transmission losses on its transmission system.[13]

> *Licence Condition: 2K.3.(a):* A description of the methodology used by the licensee to take Transmission Losses into account when planning load related reinforcements to the licensee's Transmission System.
> *Licence Condition: 2K.3.(b):* A description of the licensee's methodology to take Transmission Losses into account when the licensee is planning

Transmission Losses Report

The annual transmission losses report submitted by NGET includes three sections. The first section is a summary of the transmission losses in the transmission system since the previously published transmission losses report. The losses report provides a breakdown of transmission losses by major areas of the NGET service territory. The second section of the transmission losses report is a

[12] Ofgem – National Grid Electricity Transmission Plc – Special Conditions. https://epr.ofgem.gov.uk//Content/Documents/National%20Grid%20Electricity%20Transmission%20Plc%20-%20Special%20Conditions%20-%20Current%20Version.pdf

[13] National Grid Electricity Transmission, Transmission Losses Incentive, http://www2.nationalgrid.com/UK/Industry-information/Electricity-system-operator-incentives/transmission-losses/

progress report on the implementation of the previous NGET transmission losses strategy report. The progress report includes an estimate of the reduced transmission losses from the strategy plan. The final section of the annual transmission losses report provides an overview of any proposed changes to the transmission losses strategy. In addition, there is a high-level summary of the transmission losses strategy document. The annual transmission losses report also includes a description of any calculations used to estimate transmission losses in the transmission system.

For reference, National Grid's transmission system is composed of almost 8,000 km of transmission lines (i.e., overhead and underground).[14] HONI's transmission system is roughly three and half times larger at 29,000 km.[15]

Current National Grid Strategy for Transmission Losses

NGET's approach to the management of transmission losses has been relatively unchanged since the December 2013 strategy was published. The strategy employed by NGET can be summarized in five parts

1. Consideration of transmission losses through investment planning.
    - NGET uses a Whole Life Value (WLV) framework to make consistent investment decisions as it relates to alternative investment and policy options. The WLV includes consideration for transmission losses to ensure that investment planning accounts for the losses in comparison to other investment priorities.
2. Accounting for transmission losses in equipment specifications and procurement processes.
    - NGET assesses the benefit of reduced transmission losses versus the potential higher equipment costs. The transmission losses are determined by the specifications, procurement and operation of new equipment.
3. Impact on transmission losses from key load related developments.

[14] http://www2.nationalgrid.com/Contact-us/UK-Transmission/

[15] http://www.hydroone.com/ourcompany/pages/quickfacts.aspx

  - Estimating the impact of transmission losses from transmission system expansion or reinforcement to supply new electricity demand.
4. Impact on transmission losses from transmission asset replacement
    - Estimating the impact of transmission losses from replacement of transmission assets.
5. Consideration of the impact of new technologies on transmission losses
    - Assessing the potential impacts on transmission losses of new technology options available to NGET (e.g., adoption of HVDC).

In summary, NGET has integrated transmission losses assessment into their annual investment planning process through the WLV framework. NGET considers the benefits of transmission loss reduction while assessing options for asset replacement, equipment specification, procurement, operation, and new system developments including the impact of new technologies. On an annual basis, NGET reports transmission losses for their transmission system and provides an update on the implementation plan for cost-effective transmission losses.

Recommendations for the Board

Reductions in transmission losses improve the efficiency of the transmission system, reducing costs for rate-payers and assisting the Board in achieving its objective of promoting conservation. HONI, as the owner and operator of the majority of Ontario's transmission system, is an important component of any transmission loss reduction strategy. Given the potential benefits of transmission loss reduction, Power Advisory makes the following recommendations for the Board to consider for transmission loss management in the HONI transmission system. The recommendations are intended to be initial actions to assist the Board in determining whether further regulation, analysis or action is prudent.

1. Annual Measurement, Verification and Reporting of Transmission Losses

    Annual assessment of transmission losses for HONI can provide two primary benefits. The first benefit is that the annual assessment of transmission losses, including the measurement, verification and reporting, would assist in establishing a standard method for calculating transmission losses. Since

HONI has indicated that they do not maintain information on transmission losses, the annual reporting of transmission losses will likely lead to a discussion on how to accurately estimate transmission losses and what, if any, part of those losses should be addressed by HONI's operational procedures or capital investments. The annual transmission loss calculation will also increase the awareness of the impact of transmission losses on supply resource needs and alignment with the Conservation First framework adopted by the Government of Ontario. Without adequate data on transmission losses, it is difficult to determine if loss reduction options are cost-effective or not.

The second benefit is that a history of transmission loss changes can be established to determine if losses are increasing or decreasing. Data on historical transmission losses can provide the ability for HONI, the Board or intervenors to determine if possible actions are required to address changes in transmission losses or if further information is required to determine the nature of changing transmission loss values. The measured, verified and reported transmission losses can be a valuable input into any future benchmarking or consideration for incentives to reduce transmission losses.

2. Benchmarking HONI's Transmission Losses against Other Relevant Jurisdictions.

The HONI response to Environmental Defense on October 21, 2016, stated "Hydro One does not maintain information on energy losses, let alone use this type of information in its own transmission investment planning process."[16] An initial recommendation would be for HONI to benchmark transmission losses within their transmission system against other relevant jurisdictions. Benchmarking involves estimating transmission losses for HONI's system and comparing the transmission loss amount to transmission losses in other jurisdictions, preferably transmission systems with similar physical characteristics (i.e., size, generation supply mix, geography, climate, etc.) and policy characteristics (e.g., emphasis on efficiency and conservation measures). Any differences between transmission loss values should be assessed to determine if there are practical options to reduce the difference (e.g., capital

[16] Submissions by Hydro One Networks Inc. in Response to Environmental Defence – EB-2016-0160 – pg 2 of 7

investments or operational measures) or if there are prudent reasons that support the difference (e.g., transmission system size, generation supply mix, etc.). Benchmarking to other jurisdictions can provide an adequate foundation for determining if further actions are required by HONI on transmission loss reductions.

3. Integrate Transmission Losses Assessment in HONI's Planning Process

   Consideration for the reduction of transmission losses, either existing or in the future, should be integrated into the HONI planning process. Transmission losses are one of many factors that determine the cost and reliable operation of HONI's transmission system. Similar to other cost-benefit assessments, HONI should consider higher capital investment or operational costs in exchange for lower transmission losses. By including transmission loss assessment in their planning process, HONI may be able to identify alternatives that are cost-effective at reducing transmission losses without impacting other system planning priorities. In addition, HONI would be able to consider the impact of transmission losses in other planning process such as the regional planning process and possibly LDC distribution planning, both of which HONI is involved in as a transmitter.

4. Consider Incentives for Transmission Loss Reduction

   As discussed, many jurisdictions include incentive regulation to reduce transmission losses where the reductions are cost-effective. The transmission loss reduction regulation could include the Board establishing a cap on the acceptable transmission losses in the system, incentivizing HONI to maintain losses below a specific threshold, similar to how Austria's national regulator sets an "allowed rate of losses". Alternatively, the Board could consider including a value threshold for transmission losses and reward or penalize HONI for losses below or above the value threshold (i.e. similar to Germany). Another option is for the amount of transmission losses to be included as part of a broad set of incentives should future regulation focus on incentive based regulation for HONI. Including transmission losses would allow HONI to determine if reduction of transmission losses is a cost-effective approach versus other productivity improvements.

Overall, the recommendations by Power Advisory require a clear understanding of the current level of transmission losses within the HONI transmission system. Without knowing the amount of transmission losses that are in the transmission system and the potential benefits of loss reduction strategies, it is difficult to determine if any action is required.

Q6. What is your professional and academic background? Have you appeared before the Ontario Energy Board (Board)?

A. I am an electricity market analyst and power system planner with over 10 years of experience in the electricity sector. I specialize in energy market analysis, electricity policy analysis and development, power procurement and contracting, generation and transmission project evaluation, power system planning and strategy development. I am experienced in the evaluation and analysis of electricity markets and the competitiveness and operation of various generation technologies and transmission projects within these markets.

I joined Power Advisory after a position as the Senior Business Analyst of Generation Procurement at the Ontario Power Authority, where I was responsible for management and development of the Feed-In Tariff program. Prior to joining Generation Procurement, I worked as a Transmission Planner in Power System Planning at the Ontario Power Authority where I was actively involved in regional transmission planning, bulk system analysis and supporting system expansion procurements and regulatory procedures. I also worked for Hydro Ottawa Limited as a Distribution Engineer responsible for reliability analysis, capital budget planning, power system planning, and project management.

I have testified on behalf of the Alberta Utilities Commission as part of the Alberta Electric System Operator's 2014 General Tariff Application (Proceeding 2718), Proposed Approach for Designating Transmission Projects (February 2014).

I have a Master's of Science in Electrical Engineering and a Bachelor of Science in Electrical Engineering, both from Queen's University.

My resume is attached in Appendix A.

I have not appeared before the Board before.

Q7. Does this conclude your written evidence?

A. Yes

Power Advisory LLC

APPENDIX A: Travis Lusney CV

Travis Lusney
Director

Power Advisory LLC
55 University Ave., Suite 605
Toronto, ON M5J 2H7
Cell: 647-680-1154

tlusney@poweradvisoryllc.com

Professional History
- Ontario Power Authority
- Hydro Ottawa Limited

Education
- Queen's University, MSc Electrical Engineering, 2007
- Queen's University, BSc Electrical Engineering, 2004

Mr. Lusney is a Professional Engineer (P.Eng) with 10 years of experience working in both the commercial and regulated areas of the electricity sector. Mr. Lusney is a knowledgeable industry leader with a focus on generation development, market assessment, policy analysis, business strategy, and risk mitigation. Mr. Lusney is a former distribution and transmission planner with a deep expertise in power system planning and resource integration.

Mr. Lusney provides clients with a unique perspective into the integration of power system resources with existing transmission and distribution networks through project risk assessment and strategic planning. He has advised clients through connection capability assessment, procurement mechanics, power system resource requirements and due diligence as part of strategic development and acquisitions, with an emphasis on both renewable and conventional generation resources. Travis acts for Canadian and non-Canadian clients throughout Canada and the United States.

Mr. Lusney joined Power Advisory after a position as the Senior Business Analyst of Generation Procurement at the Ontario Power Authority, where he was responsible for management and development of the Feed-In Tariff program. Prior to joining Generation Procurement, Mr. Lusney worked as a Transmission Planner in Power System Planning at the Ontario Power Authority where he was actively involved in regional transmission planning, bulk system analysis and supporting system expansion procurements and regulatory procedures. Mr. Lusney also worked for Hydro Ottawa Limited as a Distribution Engineer responsible for reliability analysis, capital budget planning, power system planning, and project management.

PROFESSIONAL EXPERIENCE

Strategic Investment and Risk Assessment

- Developing an Ontario generation supply outlook to determine future resource needs and related future procurement processes with consideration for power system expansion. The power system outlook considered key areas of risk assessment, supply development scenarios, investment opportunities based on connection capability and project economics.

- Advising generation developers on new competitive procurement processes and determining strategy to help ensure successful participation while reduce exposure to risk. Participated in consultation and stakeholder engagement as an expert in transmission planning, procurement design, and proposal bid development.

- Working with renewable energy developers (mainly wind and solar PV) to plan, construct and successfully reach commercial operation for projects with long-term. Work includes assessment of project risk, investment opportunities, development strategy, solutions for connection issues and advice for securing construction approvals and permits.

- Analyzed the Long-Term Transmission Plan (LTP) for Alberta and developed a comprehensive forecast of Capital Expenditures over the planning time period (2014-2032). The forecast includes an estimate of Development Capital Expenditures by project and region over the three time periods considered in the LTP. Estimated Capital Expenditures for General Plant and Sustainment based on the growth expectations of Alberta's transmission rate base. The analysis provides a detailed view of the long term trend for capital investment in Alberta's transmission system and includes an alternative scenario for lower economic growth and oil sand development.

- Primary consulting resource for CanSIA's Distributed Generation Task Force (DGTF). The DGTF objective included developing a customer based generation model for solar generation after the conclusion of the Feed-In Tariff (FIT) program in Ontario (post-FIT solution), to identify transitional changes to the existing FIT program to support the post-FIT solution and to support solar market growth in the long-term. Responsible for jurisdictional review to identify best practices for customer based solar generation, technical and policy analysis to support the post-FIT solution and development of recommendation report and accompanying communication plan with key stakeholders.

- Co-leader of Solar Development Evolution Working Group which has participation and support from key solar PV project developers, EPC firms, asset operators and owners. The mandate of the working group was to develop policy for a long-term customer centric procurement approach for solar PV generation and identify priorities for transition of the existing FIT program.
- Modeling procurement mechanics and Ontario system characteristics for renewable energy developers to establish a strategic direction for successfully securing power purchase agreements. This work included modeling connection capability within both the distribution and transmission system and assessing attrition risk of currently contracted and under development projects.
- Working with manufacturers of solar PV and wind generation components regarding strategic advice and solutions to meet Provincial content requirements and ultimately increase their market share.
- Completed due diligence on project economics, connection capability and estimated generation operating performance for wind and solar PV developers as part of strategic acquisitions.
- Constructed a quantitative project attrition model for projects with FIT PPAs to determine opportunities for future investment for clients. The model determined probabilistically which contracted FIT projects were at risk of failing to reach commercial operation and identify where new connection capacity would become available.

Generation Resource Procurement and Contracting

- Worked as the Renewable Electricity Administrator in Nova Scotia responsible for the developing and administrating a Request For Proposal (RFP) process to procure over 300 GWh of low impact renewable energy. The process included engagement with stakeholders, development of an RFP document and Power Purchase Agreement and filing the Power Purchase Agreement for regulatory approval with the Nova Scotia Utility and Review Board On August 2nd 2012, after completing the evaluation of all 19 proposals that were submitted, the process successfully concluded with the execution of 355 GWh of contracted facilities.

- Provided support to Non-Utility Generators (NUGs) in negotiations with the Ontario Power Authority for extension of existing Power Purchase Agreement. Support included economic dispatch analysis, development of net revenue requirement pro formas to determine contract value, leading negotiation and providing strategic advice.

- Technical expert for procurement participation for a variety of resource developers including renewables and energy storage. Provided detailed analysis and assessment of procurement process and documentation including strategy for development of proposed projects to maximize opportunities within the Request For Proposal (RFP) and Contract in the multiple procurement processes.

- Responsible for development and ongoing management of the standard offer Feed-In Tariff program for Renewable Energy. Involved with a wide range of stakeholders including project developers, manufactures, investors, regulatory agencies and Government. Analyzed ongoing project costs and market rates to update and maintain Feed-In Tariff price assumptions. This work included analysis of supply chain evolution, equipment providers capability and assessment of project economics.

- Involved in domestic content development within the Feed-In Tariff program as chair of the Domestic Content Working Group. Advised and clarified expectations for project developers and manufactures in understanding the domestic content requirements.

Transmission System Planning

- Provided strategic advice and power system analysis to generation development clients on connection capability of proposed generation projects. Assisted clients in determining optimal project location and estimation of connection cost for different interconnection options.

- Assisted in leading engagement with distributors, transmitters and system operators for variety of clients. Engagement included determining interconnection options, assessing connection risks and establishing timelines and milestones to support overall project development.

- Supported analysis for the Integrated Power System Plan (IPSP) dealing with bulk and regional system considerations, including reliability assessment. Developed regional integrated plans for constrained areas. Lead stakeholder consultation with local distribution companies, regulatory agencies, transmitters and local government officials to develop 10 to 20 year plans and activity coordination.

- Represented through expert evidence and testimony the Utility Consumer Advocate Alberta during Transmission Rate Tariff hearing in front of the Alberta Utility Commission as an expert witness on transmission planning and cost allocation.

- Advised and supported a major gas generation procurement for the Province of Ontario. Work included analysis of regional power system needs and constraints. Assisted in the development of evaluated criteria considerations.

- Developed procedures and policy for system connection assessment under the Feed-In Tariff program, in particular lead the development of the Transmission Availability Test (TAT) and Distribution Assessment Test (DAT) used to assess connection capability. Oversaw development of custom database to support the connection assessment process and coordination with over 80 local distribution companies. Managed staff for regional system analysis as part of the Feed-In Tariff program to determine connection capability for contract awards.

- Lead a study on Distributed Generation impacts and opportunities in the major urban centers as part of a long term energy plan. Lead analysis on behalf of the Ontario Power Authority to determine the distribution generation potential in Central and Downtown Toronto along with the associated cost to develop the distributed generation resources. Worked closely with the local distribution companies, city officials and key stakeholders in understanding specific and general barriers and benefits.

Distribution Reliability and Planning Assessment

- Developed capital work planning process for Asset Management department to ensure accountability and situation and issue identification. Lead the development of the capital budget and work plan for all distribution projects including a 25 year capacity plan for Distribution rate filing. Oversaw capital project tracking and reporting metrics to ensure accountability and transparency for senior management requirements

» Managed reliability statistical reporting as part of regulatory requirements and senior executive requests. Involved in evolution of information gathering methods and worst feeder identification. Lead reliability engineer working closely with planning, design and construction personnel in identifying issues and resolution members. Chair of the asset management committee which oversaw the expectations of future capital sustainment work and associated risk levels

» Involved in the development of the distribution and station asset management plan as key support for current and future Distribution Rate filing.

Selected Speaking Engagements

» Solar Ontario 2016: Moderator for panel on Ontario Electricity Market Renewal Implications for Solar Generation, May 2016

» Clean Energy BC - BC Generate 2015: Panelist on Overview of Canadian Renewable Energy Markets, November 2015

» CanWEA 2015: Panel Member on Wind Generation Integration in Canadian Wholesale Electricity Markets, October 2015

» Solar Ontario 2015: Panel Member on Lessons Learned for the Large Renewable Procurement, May 2015

» Green Profit 2015: Plenary Panel Member on The Future is Now: The Economic Case for Renewables, March 2015

» CanSIA's Solar Canada 2014: Panel Member on Setting Precedents for the Future of Solar Distributed Generation Utility Programs, December 2014

» CanSIA's Solar Ontario 2014: Moderator on Balancing Supply: A look inside Ontario's Electricity System during Peak Demand on July 17, 2013, May 2014

» CanSIA's Solar Ontario 2013: Presenter and Moderator on Electricity Consumer Empowerment – Enabling Distributed Solar Power Generation, May 2013

» Ontario Feed-In Tariff Forum: Panel Member on Barriers to Connection Solar Projects at the Local Level, April 2012

» EUCI's 3rd Annual Conference on: Ontario's Feed-In Tariff, June 2011

- 4th International Conference on Integration of Renewable and Distributed Resources, Albuquerque, December 2010
- OSEA Community Power Conference, November 2010

List of Expert Testimony

- Alberta Utilities Commission, Alberta Electric System Operator's 2014 General Tariff Application (Proceeding 2718), Proposed Approach for Designating Transmission Projects (February 2014)

ONTARIO ENERGY BOARD

EB-2016-0160

IN THE MATTER OF the *Ontario Energy Board Act*, 1998, S. O. 1998, c. 15, Schedule B;

AND IN THE MATTER OF an application by Hydro One Networks Inc. (Hydro One) pursuant to section 78 of the *Ontario Energy Board Act*, 1998 for electricity transmission revenue requirement and related changes to the Uniform Transmission Rates beginning January 1, 2017 and January 1, 2018.

ACKNOWLEDGMENT OF DUTY

1. My name is Travis Lusney and I am a professional engineer with Power Advisory LLC. I live in Toronto, Ontario.
2. I have been engaged by or on behalf of Environmental Defence to provide evidence in relation to the above-noted proceeding before the Ontario Energy Board.
3. I acknowledge that it is my duty to provide evidence in relation to this proceeding as follows:
   a. to provide evidence that is fair, objective and non-partisan;
   b. to provide evidence that is related only to matters that are within my area of expertise; and
   c. to provide such additional assistance as the Board may reasonably require, to determine a matter in issue.
4. I acknowledge that the duty referred to above prevails over any obligation which I may owe to any party by whom or on whose behalf I am engaged.

Date: November 9, 2016　　　　Signature: ____________

V. INTERNAL AUDIT REPORTS

Q.20 Please describe the internal audit reports that Hydro One has been required to file.

A.20 The two internal audit reports, entitled "Investment Planning" and "Transmission Lines Preventative Maintenance Optimization" have been filed with the Board under a separate cover letter given the interim confidential status of this information. The cover letter to this separate filing describes Hydro One's reasons for maintenance of the confidential status of these reports.

VI. TRANSMISSION LOSSES DISCUSSION

Q.21 Please summarize the Motion Decision regarding Transmission Losses.

A.21 The Motions Decision requires Hydro One to either provide estimates of transmission losses and their cost, using the approaches described in footnote 9 of Environmental Defence's ("**ED**") Reply Submission dated October 25, 2016,[25] or explain why these estimates cannot be provided or are otherwise inappropriate.

Q.22 Are the estimates of transmission losses and their costs as per ED's Motion Reply inappropriate?

A.22 Yes, for the following reasons. Transmission losses arise as part of the ongoing operation of the integrated power system. Losses associated with each transmission element carrying electrical current ("**Transmission Element**") are determined by the following equations:

$$\textit{Transmission Element Losses} = (\textit{Current})^2 \times \textit{Resistance}$$

The overwhelming majority of Transmission Elements are either: (1) line conductors; or (2) transformers. The summation of all Transmission Element losses equals total transmission system losses:

$$\textit{Transmission System Losses} = \sum \textit{Transmission Element Losses}$$

[25] Motions Decision, p 7; EB-2016-0160, Reply Submission filed by Environmental Defence (25 October 2016), p 3, footnote no. 9.

Q.23 What factors influence the "Current" variable?

A.23 "Current" is a function of many factors, including:

- demand level;
- distribution of that demand;
- dispatch of generation (i.e. source of current);
- grid operation, as directed by the Independent Electric System Operator ("**IESO**");
- scheduled transactions;
- loop flows; and
- customer requirements and restrictions.

Current flow may vary along each Transmission Element in each hour and throughout each year. Current, measured in Amperes (A), is the dominant factor in quantifying losses. Depending on system conditions, Current ranges from 100 A to more than 1000 A for each Transmission Element (typically, the range is around 200-500 A, although it is difficult to make such generalizations).

The dominance of the current variable stems from the square relationship in the equation. For example, a 30% change in Current (e.g. an increase of 30%, from 100 A to 130 A) results in a 69% overall increase in Transmission Element Losses (130^2 / 100^2 ≈ 169%).

Overall system demand significantly affects Current flow. The higher the demand, the greater the Current flowing through the system. Distribution of demand across the system also impacts Current flow. The loading profiles at each transmission load centre or transmission customer connection point are determined by the operation patterns and characteristics of load customers.

The location and output levels of generators supplying power to the system determines how much Current will flow across different parts of the transmission system to supply transmission load centres and customers. Transactions (such as exports) and loop flows also result in higher Current flows. Generators located further from load centres result in current flows across a greater number of Transmission Elements for the delivery of energy. Higher losses result when generators are located further away from load centres.

Generation dispatch varies significantly throughout the year between peak, off-peak and shoulder periods. Ontario's IESO directs the day to day operations of the provincial grid. These activities include generation dispatch, transmitter operations, setting voltage levels across the transmission system, and providing ancillary services. Current flows across Transmission Elements, and thus the entire transmission system, are significantly influenced by the IESO's actions, which are essential to ensure the reliable operation of the transmission system as well as electricity market efficiency.

Q.24 Do transmitter operations decisions impact Current flow?

A.24 No. Transmitter operations decisions do not control or affect the level of Current flow in any meaningful way from a Transmission System Losses perspective. The Transmitter may require outages to perform maintenance and repairs, and outages may temporarily change the distribution of current flows. However, all transmission element outages are approved by and under the direction of the IESO. Transmitters' facilities do, however, affect the second variable, "Resistance".

Q.25 Please describe the Resistance variable used in the Transmission Element Losses equation.

A.25 Resistance is a concept analogous to friction. Resistance impedes the flow of Current through a Transmission Element causing some electric energy to be transformed into heat and resulting in losses.

Q.26 Is the quantity of Resistance of line conductors equal to the Resistance with transformers?

A.26 No. In Ontario, the losses that occur on line conductors are more than four times the losses that occur on transformers. Correspondingly, Resistance in aggregate on line conductors is significantly larger than Resistance on transformers.

Q.27 What are the key factors that affect the Resistance of a line conductor?

A.27 There are four such factors:

- Conductor size. The larger the conductor, the lower the Resistance.

- Conductor length. Resistance is directly proportional to the length. For example, (and holding all other variables constant) a typical conductor rating is 0.086 Ohms/km. If the line conductor was 100 km in length, then this Transmission Element would have a Resistance of 8.6 Ohms.

- Conductor temperature. Resistance increases with higher temperatures, which is linked to Current. Higher temperatures are a function of current. The higher the Current level, the higher the temperature (and thus the higher the Resistance).

- Conductor material. Different conductor materials have different Resistance characteristics. Aluminum, particularly aluminum conductor steel reinforced ("**ASCR**"), is the main standard used in North America.

Q.28 Can the inherent Resistance level for a line conductor change once it is placed in operation?

A.28 No. Once line conductors are installed, the Resistance characteristic of that conductor remains constant for the life of the asset, usually for a period ranging between 60 and 80 or more years. Historically, Hydro One has replaced less than 1% of its conductor fleet each year. Going forward, Hydro is projecting a need to replace 1.7% or approximately 500km annually. This means that the Resistance level of 98.3% of Hydro One's conductor fleet would remain unchanged from year to year.

Q.29 Can Resistance improvements occur through oversizing conductors that are replaced annually?

A.29 Annual conductor investments provide only marginal improvements to Resistance. Assuming existing lines and towers can accommodate a larger conductor, Resistance improvements due to a larger conductor typically yields a 10% to 20% reduction in Resistance. Overall cost of the larger conductor, including assessment of whether existing towers and lines could be used for a larger conductor would also require consideration.

Q.30 Please provide an example that illustrates the level of investment needed to materially reduce the Resistance of line conductors.

A.30 Assume Hydro One has a 440 circuit km proposed for conductor replacement in 2018, representing approximately 1.5% of its conductor fleet. Assume also that the overall economic impact of Total System Losses is, as suggested by ED, equal to $390 million given that losses are directly proportional to Resistance (note that this value is given for the purposes of illustration; it is not proven that this is the overall economic impact of Total System Losses).[26] For the purposes of simplicity, also assume that this amount is entirely due to line conductor losses in Ontario.

Under this scenario, the maximum opportunity to reduce losses from the conductor replacement would equal $6 million (i.e. 1.5% of $390 million). However, the maximum opportunity assumes that Resistance could be entirely eliminated, which is not the case. As stated, Resistance improvements range between 10% and 20%, and are due primarily to physical and technological constraints. Assuming a midpoint of 15%, the Resistance improvement opportunity would be valued at $1 million (i.e. 15% x $6 million).

Such incremental reductions in Resistance should be placed in context of the associated costs. A program to increase line conductor sizes would incur costs that far exceed the $1 million benefit level, given the magnitude, scope and length of the line conductors involved. For example, a 440 circuit km conductor replacement would be expected to cost in the range of $180 million.

Resistance improvement through increasing conductor size assumes that all existing towers and other lines components supporting the replaced conductor would have the design capacity to structurally support and allow for the operation of larger conductor.

[26] ED's estimate differs significantly from the Total Transmission System Loss-related amounts recovered by the IESO through the wholesale competitive electricity market in 2015 and 2016 to-date. According to the IESO, the Total Transmission System Loss-related amount recovered in 2015 was approximately $66.3 million. For the period January 1 to September 30, 2016, this amount was approximately $36.1 million. Hydro One was advised by the IESO that these amounts were recovered through Charge Code 150 (Net Energy Market Settlement Uplift), which covers differences between the amount paid to suppliers for the commodity and the amount paid by buyers in a given hour. The IESO administers Charge Code 150, not Hydro One.

This is unrealistic given the fact that tower sizes and lines are designed to support the existing in-service conductors, and the opportunities to replace them with a larger conductor are very limited. Overall costs in this illustration would increase dramatically if changes to towers and line design are necessary.

Q.31 Would this analysis change if it was assumed that greater conductor replacement occurred than historical levels?

A.31 Under this scenario, assume Hydro One decided to replace 3% of its conductor fleet. This would mean that 1.5% of that fleet would be replaced before reaching end of life. This outcome alone would impose significant costs that could have been avoided by allowing continued operation of the conductors now in service. The magnitude of those costs would further escalate by inclusion of the full cost of the larger conductor along with additional reinforcements that may be required. It also assumes that resources are available for double the level of conductor replacement work. For 440 circuit km, conductor replacement costs would be expected to be in the range of $180 million. Again, further significant costs would be incurred if changes to towers and lines were also necessary to support the operational design of the new larger conductor. On the benefits side, the Resistance improvement would only increase to approximately $2M (3% x 390M x 15%). The main conclusion from this scenario is that increased levels of conductor replacement for the sole purpose of improving Resistance would result in significant costs with very marginal economic benefits.

Q.32 The illustrations above address Transmission Element Losses. How does this analysis impact Total System Losses?

A.32 Recall the formula for Total System Losses is the summation of all Transmission Element Losses. The summation formula means that Resistance for 98.5% of Hydro One's remaining Transmission Element Losses would remain unchanged. Any Resistance improvement from a Transmission Element is still muted by the fixed nature of Resistance on all remaining Transmission Element Losses. Again, the far more substantive change shown in this analysis is the significant costs that would be incurred to effectively "chase" a relatively small economic benefit.

Q.33 The illustrations above focus on conductor size. Do any of the other factors that contribute to Resistance provide opportunities for improvements?

A.33 As noted above, the other factors affecting Resistance are conductor length, conductor temperature and conductor material.

Hydro One has little or no opportunity to reduce the length of conductors. In the case of conductor replacements, the length is effectively predetermined by the location of existing rights of way and towers. When new lines are proposed, the shortest route is selected, subject to other physical, technical, environmental and existing land use constraints.

Conductor temperature is a function of Current flow; it is not a variable that Hydro One can manage independently.

With respect to conductor material, ASCR is widely recognized as having the best overall performance and cost balance for most transmission operations. ASCR is a standard that Hydro One uses for most of its line conductors, including annual line conductor replacement.

Q.34 Why does collecting information on Transmission System Losses not inform the identification of candidate transmission investments?

A.34 The Transmission System Losses is an aggregate value, and as explained above is the sum of the losses on all transmission elements. It is largely a reflection of the Current flow that is driven by the operation of market participants other than the Transmitter. Transmission line investments rely on locational and situational specifics and the associated information to assess need, identify solutions and determine the cost-benefit trade-offs. The level of Transmission System Losses as an aggregate value does not assist in determining locational and situational specifics. It does not identify what transmission elements to focus on, nor does it provide an indication that a specific investment is even required.

Q.35 What conclusions arise from this illustration?

A.35 There are two main conclusions:

1. Changes in Transmission System Losses are far more dependent upon Current than on Resistance. Factors that affect Current relate to the overall operation of the electricity market and the activities of other market participants in Ontario, and fall outside of Hydro One's responsibilities. As such, variations of losses on the transmission system would not inform a transmitter's performance, good or bad.

2. Transmission System Losses are not directly factored into Hydro One's investment planning process. This is because the opportunities to make a material reduction to Resistance are extremely limited. Due to the enormity of the costs required to reduce Resistance (and therefore to reduce losses), Transmission System Losses will never form the basis for identifying and selecting an investment candidate except in very special and limited circumstances.

VII. CONCLUSION

Q.36 Does this conclude Hydro One's additional evidence?

A.36 Yes.

UNDERTAKING – J5.1

Undertaking

To review and confirm whether or not the information requested by Mr. Elson is available; secondly, if it is available, whether it can be produced publicly or must be redacted for purposes of confidentiality; if it is available and/or can be produced publicly, to produce it.

Response

See attached sample excerpt from a transformer tender specification for the transformer loss performance. It should be noted that the estimated lifetime cost of the No Load (i.e. core) and Load Losses are expressed on a $/kW basis for the manufacturer. These values are based on an NPV assessment that considers the transformer lifetime, loading profile and forecast loading over its life, and the average annual energy costs and the discount rate. The manufacturers develop their designs in consideration of these $/kW loss values in conjunction with other performance, safety, environmental and technical requirements. As part their bid, manufacturers submits test values of both No Load and Load Losses. Hydro One evaluates the lifetime cost of the transformer reflecting the cost of energy losses and other costs as part of its bid selection.

2.2.6 Loss Evaluation, Temperature Rise Evaluation, Liquidated Damages

1. The Tenderer shall note that Hydro One will evaluate guaranteed losses (in Canadian dollars) and add this value to the tendered price.
2. The Tenderer shall state the guaranteed no-load loss at the rated voltage and the guaranteed load loss at the base MVA rating.
3. For auto-transformer items, the guarantee load loss shall consider unloaded tertiary winding.
4. All auxiliary losses will be evaluated at the same capitalization as the load loss. Auxiliary loss shall be stated in the proposal.
5. The guarantee no-load loss shall be referenced at the temperature of 20 °C and load loss corrected to a reference temperature of 85 °C.
6. The dollar values per kW assigned to the losses for the purpose of evaluation are as follows:

No- load loss	$ 13,800	at rated voltage
Load loss	$ 5,200	at ONAN rating and rated voltage

7. The above dollar values will also be used for liquidated damages, in the event that the final measured losses exceed those stated in the Tender. Tolerances for losses given in Section 14 of CAN3-C88-M90 shall apply.
8. Should the transformer exceed the guaranteed 65 °C temperature rise during tests and require a de-rating of its capacity, the following penalty shall apply:
   a) If the temperature rise exceeds the guaranteed value by more than 5° C, Hydro One reserves the rights to reject the transformer.
   b) If the temperature rise exceeds the guaranteed value by less than 5 °C, the penalty shall be 3 % of the transformer purchase price for each degree °C by which the temperature rise is exceeded.

who can affect losses hour to hour, day-to-day, or year to year, like Statnett or NGET.

In Ontario, the IESO is responsible for the integrated power system operations and planning, and monitors and collects payments for losses on Ontario's transmission system.

MR. NETTLETON: Mr. Young, why would historical losses not be an appropriate metric to gauge a transmission owner's performance?

MR. YOUNG: As discussed in Exhibit K 2.1, current is the most significant variable affecting transmission losses, and current is dependent on a wide range of factors that are not within the transmission owner's control.

The inherent characteristics of transmission facilities that can affect losses are static. They can only potentially change when investments are made to replace or to add new elements to the system. This also makes it extremely difficult to assess a transmitter's ability to reduce system losses, or its performance in that area.

MR. NETTLETON: Now, Mr. Young, you have referred to the term "static transmission elements", and that it's the activities of other market participants that affect losses and are outside the transmitter's control.

Can you give us an example?

MR. YOUNG: Yes, I can give two examples. First, the more transmission elements that current must flow over, the higher the transmission losses will be. This means that the distance between generation and load centres has a large affect on losses, and Hydro One cannot control generation location or the generation dispatch.

Second, system losses can be affected by loop flows in the systems. If there are prevailing loop flows, meaning higher current flow on transmission elements that flow through Ontario as a result of transactions that take place in other jurisdictions, system losses will be higher.

Because the transmitter cannot control these activities on the power system, measuring transmission losses resulting from them would not be a useful metric to measure the transmission owner's performance.

MR. NETTLETON: So, Mr. Young, what factors are within Hydro One's control? Why can't a meaningful metric be developed to reflect those factors?

MR. YOUNG: Well, it's not practical to disaggregate the aspect of losses that the transmitter can affect from the losses that the transmitter cannot affect.

This is because the loss values are dominated by the sheer volume of activities by other market participants, which continuously change and are again outside the transmitter's control.

Even if for a moment you could disaggregate those aspects, the data would only reflect small changes in losses. This is because the transmission system changes that impact losses and can economically be made within the control of Hydro One, and that is changes that effectively reduce resistance. Those changes that can be made from year to year are extremely small.

If I can, I would like to use an analogy to capture the scale of the numbers that we are talking about. It's not a perfect analogy, but I think it illustrates the same principles.

A transmission owner is much like a road builder. A transmission owner can build a line with lower resistance for better efficiency, and a road builder can pave a road smoother for better fuel economy. The impact of having a rougher or smoother road on fuel economy would be very small.

In contrast, the things that have a big impact on fuel economy are controlled by the users of the roads; you know, what cars they drive, the size of the engines, proper tire inflation, their driving habits, and the number of users, the congestion, and the speed of the cars.

Measuring historical overall fuel economy in the province does not tell the road builder when he has to rebuild the road, or when he has to add a new lane or road. Instead, the road builder only repairs or adds a small percent of the roads each year, and only rebuilds a road when it has degraded to an unsafe or unacceptable level.

Hydro One has historically replaced less than one percent of its line conductors and adds less than 0.3 percent circuit kilometres of new line per year. Measuring the historical fuel economy for the province would not be a good indicator of the road builder's influence on fuel economy.

MR. NETTLETON: Now, Mr. Young, can you comment on Environmental Defence's evidence as they relate to operational recommendations for reducing losses?

MR. YOUNG: Yes. ED makes a number of operational recommendations, including transmission system lulling on a daily basis to optimize system configuration, increasing the voltage of the transmission system, including the value of loss reduction in the planning process, benchmarking the level of transmission losses to other jurisdictions, and taking transformers out of service.

I have already explained why historical transmission losses does not inform the planning process of a transmission owner, and why benchmarking against jurisdictions like NGET or Statnett is not comparable.

With respect to the transmission system modelling, it is unclear what configuration changes Hydro One could do by modelling on a daily basis. In response to Hydro One's interrogatory, ED responded with increasing operational voltages above a nominal voltage, and disconnecting additional transformers during low-load periods to reduce core losses.

With respect to voltage increases, operating to higher system voltages whenever possible is already being done. It's being done by the IESO as a system operator, and not Hydro One as the transmission owner.

Taking transformers out of service to reduce core losses is not done here or anywhere that I am aware of. Doing so would dramatically reduce reliability at all load