ONTARIO GREENHOUSE VEGETABLE GROWERS

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November 06, 2023

Ontario Energy Board (OEB)

RE: Enbridge Gas Inc. application for Leave to Construct the Panhandle Regional Expansion Project (EB-2022-0157)

Pursuant to the OEB's Procedural Order No. 8 dated October 30, 2023, the following is the written evidence of Dr. Robert Andrew Petro, the Energy, Infrastructure and Environment Co-Ordinator for the Ontario Greenhouse Vegetable Growers.

Thank you for the opportunity to provide commentary pertaining to Enbridge Gas Inc.'s application for leave to construct the Panhandle Regional Expansion Project. Ontario Greenhouse Vegetable Growers (OGVG) represents over 165 greenhouse vegetable producers accounting for more than 3,800 acres of fresh and affordable tomatoes, cucumbers, and peppers across Ontario, with over 80% of those producers located in the Leamington Kingsville area. Generating yearly farmgate sales exceeding $1 Billion since 2019, the greenhouse vegetable sector is a critical part of Ontario's exports and economy. The greenhouse vegetable sector has maintained an average year-over-year growth of 5% over the last 15 years and is projected to continue to grow at a rate of 5% per year throughout the decade, with over 2,000 acres planned the Leamington area provided that necessary incremental natural gas supply becomes available.

As noted above the Leamington-Kingsville region accounts for approximately 80% of Ontario's vegetable greenhouse acreage. The climate in the Leamington-Kingsville region is ideal for greenhouse agriculture which is why Leamington-Kingsville is projected to house nearly 2,000 acres of the projected additional 2,500 acres of new greenhouse development across Ontario over the coming decade. The development of the additional acreage will double greenhouse vegetable's contribution to GDP with farmgate sales alone projected to exceed $2 Billion/year by the end of the decade. As presented in this written testimony, the availability of natural gas is critical to Leamington-Kingsville for economic development, food sustainability and greenhouse expansion; without new natural gas capacity the material forecast growth in the greenhouse sector in the Leamington Kingsville area will not occur.

Growing Practices & Energy Requirements:

Modern greenhouse vegetable farms are state-of-the-art food production facilities leveraging and implementing innovative technologies including robotics, machine learning systems, and highly advanced lighting systems. The application of advanced lighting systems, specifically Light Emitting Diode (LED) and High-Pressure Sodium (HPS) lighting systems, has allowed Canadian greenhouses to extend their growing season into the winter months where heating is required to sustain the plants. Heating, used in the spring, summer, and fall to reduce humidity in the crop, is essential in the winter to maintain the greenhouse environment between 21°C and 27°C for optimal crop production. Capitalizing on the efficiency of scale, modern farms are built in 30-to-40-acre blocks with an electrical demand for lighting of approximately 0.5 MW/Acre.

Fundamentally commercial greenhouse farming requires light, water, carbon dioxide (CO_2), and heat as critical inputs to sustain photosynthesis and produce viable fruit in the crop. The output from the crop is proportional to the availability of both light and CO_2. To remain viable, efficient, and productive, greenhouse farms maintain an

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ambient CO_2 concentration of between 1,000-1,300 ppm which improves yield by 20% to 30%[1] and requires up to 250 tonnes of CO_2 per acre per year. Without CO_2 supplementation, the ambient concentration of CO_2 would drop to below 200 ppm within an hour causing irreversible damage to the crop. According to the international Energy Agency (IEA), CO_2 use to enhance the yields of biological processes is one of the preferred uses for CO_2 from CO_2 generating activities. By way of example, in the Netherlands annual consumption of CO_2 is between 5 and 6.3 MtCO2[2] (4.5 and 5.7 million tonnes) across approximately 5,000 hectares (12,000 acres) or at least 375 tonnes per acre per year. Due to increased energy prices and a shortage of natural gas, greenhouse vegetable production in the Netherlands fell by 7.9% in 2022,[3] demonstrating the need for reliable energy and CO_2 supplies and the sensitivity of greenhouse operations to fluctuations in the availability of both.

Greenhouse farms have adapted natural gas usage to fulfill both their heating needs and supplement their demand for CO_2. Sourcing CO_2 from natural gas has been fundamental to unlocking efficient winter farming and reducing the demand for imported liquid CO_2. During the spring, summer, and fall natural gas is burned during the day to supply the crop with CO_2 and the heat is stored in tanks to provide the heat when it is needed. The technological advances in the greenhouse sector including the smart climate systems have further supported greenhouse farms in using natural gas efficiently and maximizing the benefits of natural gas.

Natural gas has further supported greenhouse farming with the adaptation of combined heat and power (cogeneration) providing electricity for lights, heat for greenhouse, and CO_2 to the crop. Farms in Leamington-Kingsville adopted cogeneration due in part to a lack of capacity in the local electrical grid. As a result, throughout Ontario, nearly 90 Megawatts (MW) of electricity are produced by greenhouse operations and supplied to Ontario's energy grid with the CO_2 generated by these engines sequestered by greenhouse operations.

Critically, of the 1400 MW transmission capacity planned for Windsor-Essex by 2031, greenhouse operations are expected to require 600 MW to 750 MW of that incoming capacity without accounting for electrification of production through automation or electrical assets and vehicles. Cogeneration is yet another way natural gas is utilized efficiently within greenhouse operations to support economic growth.

Alternatives:

Investment in the greenhouse sector amounts to millions of dollars per farm per year with the value of a crop climbing to the tens of millions for some greenhouse ranges. Due to the value invested into their crop, growers often use secondary or backup systems to protect their investment. Some have chosen to augment their natural gas with backup systems including diesel, fuel oil, or biomass.

Many growers have investigated geothermal loops and heat pumps as an avenue to heat their greenhouse farms. Despite enhancements in geothermal technology, no system has been able to overcome the geological limitations in the Leamington-Kingsville area which include a high-water table and poor soil conditions requiring lateral systems and significant land. The lack of electrical capacity in the Leamington area, estimated today to be less than 40 MW available, further limits large farms from adopting electricity-based heat pumps and restricts the choice between heating or lighting the crop. However, both electrification in general and heat pumps in particular remain at best a secondary source of heat due to the lack of CO_2 produced from either source. The sourcing and

[1] https://www.iea.org/reports/putting-co2-to-use
[2] https://www.iea.org/reports/putting-co2-to-use
[3] https://www.hortidaily.com/article/9520941/energy-crisis-results-fewer-dutch-greenhouse-tomatoes-and-cucumbers-in-2022/

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supply of CO_2 without onsite generation presents the most significant challenge and risks directly exposing farms to the volatility of liquid CO_2 market which has seen increases of almost 3,000% [4] in some areas of the global market. As CO_2 is a critical input, subjecting farms to the volatility of the CO_2 market presents a competitive disadvantage against existing farms that generate CO_2 onsite from natural gas.

The example of H&A Mastronardi demonstrates the need for CO_2 and commitment to sustainability rather than venting the CO_2 produced by the biomass. According to Ontario's "Greenhouse Gas Emissions Reporting By Facility" [5] 20% of H&A Mastronardi's emissions in 2019 and 2020 originated from biomass while the other 80% originated from natural gas. The choice of growers to utilize biomass as a secondary heating source is due entirely to the low cost of obtaining waste wood that would otherwise be sent to a landfill. The wider use of biomass as a full replacement for natural gas is, however, limited by cost, logistics, and the space required for biomass storage. In the example cited from Dias et al.[6] 50,000 hectares (500 km^2) of land would be needed to produce the biomass needed for just the annual (2016) production of tomatoes in Leamington. Tomatoes are only one-third of the production in Leamington-Kingsville, with peppers and cucumbers each taking up similar acreage. Without accounting for the new crop types being introduced into the region, including strawberries and lettuce amongst others, 150,000 hectares of biomass production would be needed just to fuel existing tomato, cucumber, and pepper operations. By 2031 the required acreage would be projected to be more than twice the 2016 value, meaning that, were biomass adopted as an alternative fuel source, 3,000 km^2 of land, or more than the entire municipality of Chatham-Kent (2,457.90 km^2), would be needed to supply the annual need for biomass to the greenhouse sector in Leamington. The cost of land including the displaced field farming activities, the processing cost, the environmental and monetary transportation cost of the biomass in addition to the more expensive cost of post processing to provide CO_2 to the crop makes biomass unfeasible.

Natural gas has presented the best solution for heating with the added benefit of producing critically needed carbon dioxide for the crop. The heating provided from natural gas amounts to an average of over 5,000 MMBTU per acre per year, or over 1,500 MWh equivalent of energy per acre. The forecast increase in local sustainable production of greenhouse vegetables and the increased local generation of electricity through sustainable cogeneration will become impossible without new natural gas capacity in the region.

Sustainability:

Greenhouse farms have an intense commitment to efficiency and sustainability as both are directly reflected in their ability to operate profitably. Projects OGVG members have supported include carbon capture and release technologies to eliminate all asynchronicities in their deployment of generated CO_2, continuous lighting to provide constant light and CO_2 to allow for more regulated CO_2 uptake, use of greenhouse waste in renewable natural gas processes such as digesters and landfill recapture, and hydrogen blending to reduce CO_2 density of natural gas and facilitate capture and redeployment.

The investigation of renewable hydrogen through the Hydrogen Integrated Greenhouse Horticultural (HIGH) Energy project[7] is a partnership between OGVG, the University of Windsor, and Kruger Energy to reduce natural

[4] https://www.morningadvertiser.co.uk/Article/2022/10/03/Soaring-gas-prices-could-result-in-liquid-CO2-and-beer-shortages
[5] https://data.ontario.ca/dataset/greenhouse-gas-emissions-reporting-by-facility/resource/0996bfd9-ed27-4f78-8ed1-9e024185f10a
[6] Dias, G. M. et al. (2017). Life cycle perspectives on the sustainability of Ontario greenhouse tomato production: Benchmarking and improvement opportunities. Journal of Cleaner Production. 140(2): 831-9. https://doi.org/10.1016/j.jclepro.2016.06.039
[7] https://www.ogvg.com/post/new-joint-venture-to-examine-potential-for-wind-farm-production-to-power-greenhouse-sector

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gas emissions through hydrogen blending and increase renewable energy deployment, through hydrogen blending, in the greenhouse sector. Hydrogen blending of up to 20% will reduce the CO_2 produced by natural gas use without requiring greenhouses to become reliant on CO_2 supply chains which can be prone to shortages and price shocks[8]. A shortage of CO_2 would be devastating to the greenhouse sector, as without a means of generating CO_2 the greenhouse sector would fail.

Conclusion:

Natural gas remains the best, most economically and scientifically viable source of heat and CO_2 for the greenhouse sector in the region serviced by Panhandle transmission system. Without additional natural gas supply greenhouse farm development in the area served by the Panhandle transmission system will cease, sustainable goals in hydrogen blending for the greenhouse sector will not be realized and investment in the greenhouse sector along with the associated benefits will flow to jurisdictions outside of Ontario such as Michigan, Ohio, and North Carolina.

8 https://www.chemanalyst.com/Pricing-data/liquid-carbon-dioxide-1090

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EDUCATION:

2014	Ph.D.	University of Windsor (Physics) Dissertation Title: "Modern Applications of Novel Electroless Plating Techniques" Advisor: Dr. Mordechay Schlesinger
2007	B.Sc.	University of Windsor (Physics & High Technology – Honors)
2003	High School	École Secondaire L'Essor – (French-English Bilingual Diploma)

EMPLOYMENT

1) TECHNICAL EMPLOYMENT

Feb 2021 – Present	**Energy, Infrastructure, and Environment Coordinator, Ontario Greenhouse and Vegetable Growers**
Oct 2020 – Present	**Senior Regulatory Affairs Associate, Tersano Inc.**
Apr 2019 – Present	**Director of Science and Innovation, Prodigie – innovation evolved**
June 2019 – Feb 2020	Chemical Control Center Assistant, University of Windsor
Oct 2018 – Mar 2019	Scientific Advisor, Prodigie – innovation evolved
Oct 2018 – Mar 2019	Business Development Specialist, Mitacs
May 2018 – Oct 2018	Director of Innovation, Prodigie – innovation evolved
Mar 2018 – Oct 2018	Chemical Control Technician, University of Windsor
Nov 2017 – Apr 2018	Compounder, International Nutrient Technologies, Windsor, Canada
Jan 2017 – Apr 2017	Special Projects, University of Windsor
June 2016 – Dec 2016	Project Assistant for Program Development, University of Windsor
Sept 2015 – Dec 2015	Physics Laboratory Coordinator, University of Windsor

2) RESEARCH EMPLOYMENT

Oct 2020 – Present	**R&D Engineer, Tersano Inc.**
Oct 2015 – Dec 2016	Post-Doctoral Fellow, University of Windsor
Nov 2014 – Oct 2015	Visiting Research Scholar, Johns Hopkins University
Aug 2014 – Sept 2015	Post-Doctoral Fellow, University of Windsor
Sept 2008 – July 2014	Research Assistant, Ph.D. Dissertation, University of Windsor

3) TEACHING EMPLOYMENT

a) Instructorships

Jan 2020 – Apr 2020	Sessional Instructor, Introductory Physics II, University of Windsor
Jan 2020 – Apr 2020	Sessional Instructor, Introductory Physics II, University of Windsor
May 2019 – Aug 2019	Sessional Instructor, Introductory Physics II, University of Windsor
Apr 2019 – June 2019	Grade 9 & 10 General Science Teacher, Académie Ste. Cécile International School
Sept 2018 – Dec 2018	Sessional Instructor, Introductory Physics I, University of Windsor
Apr 2018 – Aug 2018	Course Development, Design and Application of Thin Films, University of Windsor

Apr 2017 – Aug 2017	Sessional Instructor, Introductory Physics II, University of Windsor

b) Teaching Assistantships

Jan 2016 – Apr 2016	Lab Instructor, Introductory Physics II, University of Windsor
Jan 2019 – Apr 2019	Lab Instructor, Introductory Physics II, University of Windsor
Sept 2017 – Dec 2017	Lab Instructor, Introductory Physics I, University of Windsor
Jan 2016 – Apr 2016	Lab Instructor, Introductory Physics II, University of Windsor
Jan 2015 – Apr 2015	Lab Instructor, Introductory Physics II, University of Windsor
Jan 2014 – Apr 2014	Lab Instructor, Introductory Physics II, University of Windsor
Sept 2011 – Dec 2011	Lab Instructor, Electromagnetic (EM) Waves, University of Windsor
Sept 2008 – Apr 2012	Lab Instructor for Introductory Physics (for Life Sciences), University of Windsor

4) OTHER EMPLOYMENT

PATENTS

Issued

2014 Mordechay Schlesinger and Robert Petro, Selective Electroless Deposition of Gold onto Silicon, US patent number 8,900,998, Filed: November 19, 2013, Granted: December 2, 2014

Filed

2014 Mordechay Schlesinger and Robert Petro, Single Solution for Electro-Electroless Deposition of Metals, International Filing Number: PCT/CA2014/000472 (USA, Canada, EPO (Europe))

2013 Mordechay Schlesinger and Robert Petro; Process for Electroless Deposition on Magnesium Using a Nickel Hydrate Plating Bath; Filing Number: CA2806047, US 20130216721 [Combined into: High Alkaline Plating process for highly reactive metals, PCT/CA2011/001146]

2011 Mordechay Schlesinger and Robert Petro; High Alkaline Plating process for highly reactive metals; International Filing Number: PCT/CA2011/001146 (USA, Canada, EPO (Europe), Mexico, Brazil, China, Korea, Japan)

PUBLICATIONS & PRESENTATIONS

1) Book Chapters

2013 Petro, R., Schlesinger, M. (2013) Applications of Electrochemistry in Medicine, p1-33, in Modern Aspects of Electrochemistry Volume 56: Applications of Electrochemistry in Medicine (ed M. Schlesinger), Springer US. doi: 10.1007/978-1-4614-6148-7_1

2010 Petro, R., Schlesinger, M. and Song, G.-L. Ionic Liquid Treatments for Enhanced Corrosion Resistance of Magnesium-Based Substrates, p665-686, in Modern Electroplating, Fifth Edition (eds M. Schlesinger and M. Paunovic), John Wiley & Sons, Inc., Hoboken, NJ, USA. doi: 10.1002/9780470602638.ch30

2) Peer-Reviewed Articles

2017 Robert Petro, "Developments in Co(Ni-P) Hybrid Electro-Electroless Deposited (HEED) Alloys and Composites", ECS Transactions, 75(34): 61-66

2015 Robert Petro, Pavel Borodulin, T. E. Schlesinger, and Mordechay Schlesinger, “Liquid Exfoliated Graphene: A Practical Method for Increasing Loading and Producing Thin Films, ECS Journal of Solid State Science and Technology, 5(2): P1-P5

2015 Robert Petro and Mordechay Schlesinger, “Deposition of Cobalt-Nickel Hybrid Electro-Electroless Deposited (HEED) Modulated Multilayers”, Journal of The Electrochemical Society, 162(4): D154-D158

2014 Robert Petro and Mordechay Schlesinger, “Development of Hybrid Electro-Electroless Deposit (HEED) Coatings and Applications”, Journal of The Electrochemical Society, 161(10): D1-D6

2013 Robert Petro and Mordechay Schlesinger, “Direct Electroless Deposition of Ni-P-Zn Films on AZ91D Mg Alloy”, Journal of The Electrochemical Society, 160(9): D349-D353

2012 Robert Petro and Mordechay Schlesinger, “Direct Electroless Deposition of Low Phosphorous Ni-P Films on AZ91D Mg Alloy”, Journal of The Electrochemical Society, 159(7), p. D455-D461

2011 Robert Petro and Mordechay Schlesinger, “Direct Electroless Deposition of Nickel Boron Alloys and Copper on Aluminum Containing Magnesium Alloys”, Electrochemical and Solid-State Letters, 14(4), p.D37-D40

3) Unpublished Manuscripts

2017 Stephanie Frowley, Robert Petro, Chitra Rangan, “Qualitative measurements of electrolyte stability and breakdown conditions”

4) Academic Presentations

2016 R. Petro, “Developments in Hybrid Electro-Electroless Deposition (HEED)”, 230th Meeting of the Electrochemical Society, Honolulu, Hawaii

2015 R. Petro and M. Schlesinger, “Hybrid Electro-Electroless Deposition (HEED)”, 228th Meeting of the Electrochemical Society, Phoenix, Arizona