

<b>TO:</b>	<b>CHAIR AND MEMBERS CIVIC WORKS COMMITTEE MEETING ON APRIL 16, 2019</b>
<b>FROM:</b>	<b>KELLY SCHERR, P.ENG., MBA, FEC MANAGING DIRECTOR - ENVIRONMENTAL &amp; ENGINEERING SERVICES &amp; CITY ENGINEER</b>
<b>SUBJECT</b>	<b>MEMORANDUM OF UNDERSTANDING WITH GREEN SHIELDS ENERGY AS PART OF THE LONDON WASTE TO RESOURCES INNOVATION CENTRE</b>

<b>RECOMMENDATION</b>
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That, on the recommendation of the Managing Director, Environmental & Engineering Services and City Engineer, with the support of the Director, Environment, Fleet and Solid Waste, the attached proposed by-law (Appendix A) **BE INTRODUCED** at the Municipal Council meeting to be held on April 23, 2019 to:

- a) authorize and approve a Memorandum of Understanding with 9003711 Canada Inc. operating as Green Shields Energy ("GSE") with respect to advancing our joint waste to resources (waste management, diversion and/or conversion into products with beneficial uses) objectives with the mutual understanding that the combined expertise, influence and commitment are better applied together to support common goals attached as Schedule "A" to the by-law; and
- b) authorize the Mayor and the City Clerk to execute the Memorandum of Understanding authorized and approved in a), above.

<b>PREVIOUS REPORTS PERTINENT TO THIS MATTER</b>
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Relevant reports that can be found at [www.london.ca](http://www.london.ca) under City Hall (Meetings) include:

- Update and Next Steps: London Waste to Resources Innovation Centre and Green Shields Energy (October 4, 2016 meeting of the Civic Works Committee (CWC), Item #10)
- Preliminary Concept for a London Waste to Resources Innovation Centre (February 3, 2015 meeting of the CWC, Item #4)

<b>STRATEGIC PLAN 2015-2019 AND DEVELOPMENT OF COUNCIL'S 2019-2023 STRATEGIC PLAN</b>
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Municipal Council has recognized the importance of solid waste management, climate change, other related environmental issues and innovation in its previous Strategic Plan (2015-2019) and to "Increase waste reduction, diversion, and resource recovery" and "Increase partnerships that promote collaboration, innovation, and investment" in the development of its 2019-2023 Strategic Plan for London. This work touches on three Areas of Focus:

- Building a Sustainable City
- Growing our Economy
- Leading in Public Service

## BACKGROUND

### PURPOSE

The purpose of this report is to provide Civic Works Committee and Council with a non-binding Memorandum of Understanding (MoU) to be signed by the City of London and Green Shields Energy (GSE). In brief, the MoU sets out the mutual intentions of the City and GSE to advance their joint waste to resources (waste management, diversion and/or conversion into products with beneficial uses) objectives.

### CONTEXT

#### **February 9, 2015 Council Direction - London Waste to Resources Innovation Centre**

At its February 9, 2015 meeting, Council approved and adopted the following recommendation with respect to the London Waste to Resources Innovation Centre:

- a) *the concept of a London Waste to Resources Innovation Centre BE APPROVED IN PRINCIPLE; it being noted that the Centre would build upon the numerous innovative activities that have already occurred to date and are being planned for 2015 and 2016;*
- b) *the Civic Administration BE DIRECTED to:*
  - i) *identify potential partners, projects, resource requirements and funders;*
  - ii) *obtain initial feedback from potential partners; and,*
  - iii) *develop a scope of work for the London Waste to Resources Innovation Centre concept;*
- c) *the Civic Administration BE DIRECTED to report back with a proposed scope of work and funding plan for the London Waste to Resources Innovation Centre.*

#### **Municipal Council's Strategic Plan 2015-2019 (approved March 2015)**

The London Waste to Resources Innovation Centre is listed as a component of London's Strategic Plan 2015-2019 under local, regional and global innovation.

#### **Municipal Council Approval of 60% Waste Diversion Action Plan**

The 60% Waste Diversion Action Plan containing programs and initiatives to be phased in between 2019 and 2022 to achieve 60% waste diversion was approved subject to further financing considerations. The Action Plan includes an update on the progress of the long-term Resource Recovery Strategy that will be completed in 2020.

#### **Development of Municipal Council's Strategic Plan 2019-2023 (as of April 1, 2019, a report before the Strategic Priorities and Policies Committee)**

The London Waste to Resources Innovation Centre is listed as a proposed component of London's Strategic Plan 2019-2023 under Growing Our Economy:

- Outcome 2: London is a leader in Ontario for attracting new jobs and investments
- a) Increase partnerships that promote collaboration, innovation, and investment Growing Our Economy (GOE-06) Expand opportunities and activities through the London Waste to Resources Innovation Centre.

#### **Civic Works Committee Agenda (April 16, 2019)**

An update report and action plan for the London Waste to Resources Innovation Centre between 2018 and 2023.

## Primary Goals of the London Waste to Resources Innovation Centre

The primary goals are to:

- build on the existing foundation of traditional and innovative projects to divert waste from landfill and create value added products from residues and waste;
- create a focal point (location or locations) for the ongoing examination of innovative solutions for waste reduction, resource recovery, energy recovery and/or waste conversion into value-added materials, chemicals, heat and power;
- establish partnerships and collaborations between government, academia and businesses to synergistically build on existing strengths to create opportunities to prevent waste, to create products of value from waste, and to solve existing waste management challenges; and
- be known as an innovative centre of excellence with shared facilities and resources providing leadership, implementing best practices, undertaking leading edge research, providing knowledge and support to industry, while educating and training students, researchers and postdoctoral fellows in the various fields of resource and waste management.

## Direction of the Provincial Government

### Waste Free Ontario Act, 2016

In November 2015, the Minister of the Environment and Climate Change (MOECC) introduced a new legislative framework for managing waste in Ontario under Bill 151, *Waste Free Ontario Act (WFOA)*. Bill 151 received Royal Assent in June 2016 and was proclaimed November 30, 2016.

### Strategy for a Waste-Free Ontario: Building the Circular Economy

MOECC published the final Strategy for a Waste-Free Ontario: Building the Circular Economy in February 2017, a requirement of the WFOA, which outlines a road map for resource recovery and waste reduction for Ontario including setting a vision and interim waste diversion goals for 2020 (30%), 2030 (50%) and 2050 (80%). To fulfil the vision, the Strategy has two visionary goals; a zero waste Ontario; and zero greenhouse gas emissions from the waste sector.

### Preserving and Protecting our Environment for Future Generations: A Made-in-Ontario Environment Plan

The proposed Made-in-Ontario Environment Plan is the Provincial Government's holistic approach to managing all the environmental aspects that it is now responsible for including "Reducing Litter and Waste in Our Communities & Keeping Our Land and Soil Clean". Specifically on page 43, it proposes to:

- "Investigate options to recover resources from waste, such as chemical recycling or thermal treatment, which have an important role – along with reduction, reuse and recycling – in ensuring that the valuable resources in waste do not end up in landfills.
- Encourage increased recycling and new projects or technologies that recover the value of waste (such as hard to recycle materials)".

This theme and direction has been carried into the most recent release from the province, *Reducing Litter and Waste in Our Communities: Discussion Paper* (March 2019) and the section titled *Recover the Value of Resources*.

## Current and Expired MoUs

The City has six MoUs approved by Council:

- Canadian Plastic Industry of Canada (CPIA); approved March 2018 with a current expiry date of March 31, 2020;
- Resource Energy Development of Canada (RediCan); approved March 2018 with a current expiry date of March 31, 2021;
- Try Recycling; approved June 2017 with a current expiry date of December 31, 2019;
- Bio-TechFar Inc; approved June 2017 with a current expiry date of December 31, 2019;
- Tucker Engineering through the Hawthorne Green Key Group; approved June 2017 with a current expiry date of June 30, 2020; and
- University of Western Ontario (Institute of Chemicals and Fuels from Alternative Resources); approved December 2016 with a current expiry date of December 31, 2019.

One MoU has expired:

- Green Shields Energy; expired December 31, 2017. In conversation with GSE and its potential technology partners, the decision to let the previous MoU expire was a function of several matters that have either been resolved or can now be more easily addressed including:
  - A technology dispute dealing with patents and management with the previous technology provider. This dispute was resolved with the formation of a new legal entity called True Energy, the technology provider;
  - End market uncertainty with renewable natural gas (RNG) due the potential acquisition of Union Gas by Enbridge; and
  - A change in Provincial Government in 2018 that has produced a more conducive environment for resource recovery and waste conversation technologies to help significantly reduce the need to send materials to landfill and to further reduce greenhouse gas emissions.

<b>DISCUSSION</b>
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**Step 1 – Memorandum of Understanding – General Arrangement**

The first step in formalizing a working relationship with GSE is to enter into a non-binding MoU. The MoU sets out the short-term objective of collaboration between the City and GSE to undertake testing and develop data/information on the viability of Hydrogen Reduction technology to manage various non-hazardous waste streams including household garbage. This will be done by constructing and operating a pilot scale facility containing a Hydrogen Reduction unit designed for demonstrating the effectiveness of the process on the conversion of various wastes and waste matrices. The facility will process 50 tonnes of material per day and is expected to significantly reduce the volume/weight of the material being processed while generating methane rich syngas commonly referred to as Renewable Natural Gas (RNG).

Complementing the technical processes is the ongoing development of the potential role for this technology to handle non-hazardous materials from the residential, institutional, commercial and industrial sectors and to contribute towards policies and programs established by the various levels of government (Municipal Provincial and Federal) as well as and other Governmental agencies outside of Canada.

The responsibilities of the City are to include:

- Assist with all approvals (e.g., Ministry of the Environment, Conservation & Parks MECP, City of London zoning, etc.)

- Provide land in the special policy area (Waste Management Resource Recovery Area) as a host site for three years with an option to renew for additional years
- Bring services (water, sanitary and hydro) to the location of the pilot scale facility
- Provide access to the boardroom room and education room in the Material Recovery Facility (MRF)
- Participate, when available, in discussions, tours and related activities
- Provide solid waste materials for waste conversion
- Assist with reporting, being available for media interviews and related matters
- Keep London Municipal Council informed

The responsibilities of GSE are to include:

- Obtain all necessary approvals and licenses
- Construct and operate the pilot scale facility and all associated costs including utilities
- Evaluate and report the results of the research and development work
- Provide overview reports quarterly to the City of London highlighting activities undertaken, key non-proprietary results and related matters noting that such reports are subject to the requirements of the *Municipal Freedom of Information and Protection of Privacy Act*

**Step 2 – Formal Agreement for Demonstration Pilot Projects**

The City and GSE work together to develop a formal agreement to undertake the approval, design, construction and testing and develop data/information on the viability of Hydrogen Reduction technology, contracts with funding agencies, contracts with secondary educational institutions, private companies and investors. Any Formal Agreement will follow the same approval processes as this General Arrangement and require Council approval.

**ACKNOWLEDGEMENTS**

This report was prepared with assistance from Mike Losee, Division Manager, Solid Waste Management. This report has followed the template for by-law approval and MoU signing approved by the City Clerk and Legal Services.

PREPARED AND SUBMITTED BY:	RECOMMENDED BY:
JAY STANFORD, M.A., M.P.A. DIRECTOR, ENVIRONMENT, FLEET & SOLID WASTE	KELLY SCHERR, P.ENG., MBA, FEC MANAGING DIRECTOR, ENVIRONMENTAL & ENGINEERING SERVICES & CITY ENGINEER

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Appendix A    A by-law to authorize and approve a Memorandum of Understanding between 9003711 Canada Inc. operating as Green Shields Energy (“GSE”), and The Corporation of the City of London and to authorize the Mayor and the City Clerk to execute the Memorandum of Understanding

                    Schedule A        Memorandum of Understanding

                    Attachment A    Overview of City of London Solid Waste Management Facilities

                    Attachment B    Primer – Hydrogen Reduction

- c Jeff Shields, CEO Green Shields Energy, 1316 Gainsborough Road, London, Ontario N6H 5K8

## Appendix A

Bill No.  
2019

By-law No. A.-

A by-law to authorize and approve a Memorandum of Understanding between 9003711 Canada Inc. operating as Green Shields Energy (“GSE”), and The Corporation of the City of London and to authorize the Mayor and the City Clerk to execute the Memorandum of Understanding.

WHEREAS section 5(3) of the *Municipal Act, 2001*, S.O. 2001, c. 25, as amended, provides that a municipal power shall be exercised by by-law;

AND WHEREAS section 9 of the *Municipal Act, 2001*, S.O. 2001, c. 25, as amended, provides that a municipality has the capacity, rights, powers and privileges of a natural person for the purpose of exercising its authority under this or any other Act;

AND WHEREAS it is deemed appropriate for The Corporation of the City of London (the “City”) to enter into a Memorandum of Understanding with 9003711 Canada Inc. operating as Green Shields Energy (“GSE”), to carry out testing and develop data/information on the viability of proprietary technology on solid waste materials, including organics, plastics, mixed solid waste, commonly known as household garbage. This will be done through research at an off-site location housing a benchscale facility and/or by constructing and operating a pilot-scale facility containing an advanced waste conversion system.

AND WHEREAS it is deemed appropriate to authorize the Mayor and the City Clerk to execute the Memorandum of Understanding on behalf of the City;

NOW THEREFORE the Municipal Council of The Corporation of the City of London enacts as follows:

1. The Memorandum of Understanding between The Corporation of the City of London and 9003711 Canada Inc. operating as GSE, attached as Schedule A to this by-law, is hereby authorized and approved.
2. The Mayor and the City Clerk are hereby authorized to execute the Memorandum of Understanding authorized and approved under section 1 of this by-law.
3. This by-law shall come into force and effect on the day it is passed.

PASSED in Open Council April 23, 2019

Ed Holder  
Mayor

Catharine Saunders  
City Clerk

First Reading – April 23, 2019  
Second Reading – April 23, 2019  
Third Reading – April 23, 2019

## Schedule A

# Memorandum of Understanding

Between

The Corporation of the City of London (“City”)

And

9003711 Canada Inc. operating as Green Shields Energy (“GSE”)

Whereas the City has established a special policy area in the City's Official Plan, referred to as the Waste Management and Resource Recovery Area, that plans for the continued evolution of the W12A Landfill and nearby lands into an “Integrated Waste Management Centre” that utilizes environmentally responsible and sustainable operations and practices and achieves a high standard of compatibility with its environs and neighbours;

Whereas the remaining life expectancy of the W12A Landfill as of January 1, 2019 is approximately five years or less;

Whereas the City wishes to examine, support, conduct research and/or implement projects under the broad classification(s) of resource recovery, energy recovery and/or waste conversion within the special policy area, in other locations in London, or in collaboration with others outside of London as part of its continuous improvement system for solid waste management. The continuous improvement system is described in several public documents including City of London Continuous Improvement System for Waste Management (1997), A Road Map to Maximize Waste Diversion in London (2007) and Road Map 2.0 The Road to Increased Resource Recovery and Zero Waste (2013) and the 60% Waste Diversion Action Plan (2018);

Whereas the City wishes to pursue projects, relationships and partnerships for the purpose of innovation, creativity, best practices and excellence in solid waste management and is proposing to operate, subject to final Municipal Council approval, under a banner known as the London Waste to Resources Innovation Centre (LWRIC);

Whereas Green Shields Energy hereafter known as GSE has a broad range of operational expertise in the management of the conversion of organic feedstocks to a variety of value-added resources;

Whereas GSE, has supported the development of a proprietary technology that has successfully converted a range of materials into energy and inert materials, now wants to determine the viability of this technology on solid waste materials, including organics, plastics, mixed solid waste, commonly known as household garbage; and

Whereas the City and GSE recognize that the current framework direction for waste management and waste diversion in Ontario has been set through the *Waste Free Ontario Act, 2016*, the *Resource Recovery and Circular Economy Act, 2016*, the Strategy for a Waste-Free Ontario: Building the Circular Economy (February 2017), ; The proposed Preserving and Protecting our Environment for Future Generations: A Made-in-Ontario Environment Plan (November 2018); and Reducing Litter and Waste in Our Communities: Discussion Paper (March 2019).

### 1.0 Purpose of the Memorandum

This Memorandum of Understanding (“MoU”) is intended to set out the mutual intentions of the City and GSE to advance their joint waste conversion, resource and energy recovery objectives. The MoU is based upon the mutual understanding that the combined expertise, influence and commitment of the parties are better applied together



to support their common goals. The MoU establishes the non-legally binding framework and set of principles for enhanced and focused coordination and collaboration to support their shared interests in waste conversion and resource and energy recovery.

The parties to this MoU acknowledge that if they wish to jointly carry out specific initiatives that may arise out of this MoU, they will have to engage in further discussion and prepare necessary agreements to define, authorize and execute, among other things, each party's roles and responsibilities, resource allocation and other details.

The MoU is not an exclusive arrangement and does not restrict either party from pursuing their mandates either on their own or in collaboration with any other party.

## **2.0 Short Term Objective**

The short term objective of the collaboration between the City and GSE is to undertake testing and develop data/information on the viability of Hydrogen Reduction technology to manage various non-hazardous waste streams including household garbage.

This will be done by constructing and operating a pilot scale facility containing a Hydrogen Reduction unit designed for demonstrating the effectiveness of the process on the conversion of various wastes and waste matrices. The facility will process 50 tonnes of material per day and is expected to significantly reduce the volume/weight of the material being processed while generating methane rich syngas commonly referred to as Renewable Natural Gas (RNG).

Complementing the technical processes is the ongoing development of the potential role for this technology to handle non-hazardous materials from the residential, institutional, commercial and industrial sectors and to contribute towards policies and programs established by the various levels of government (Municipal Provincial and Federal) as well as other Governmental agencies outside of Canada.

## **3.0 General Arrangement**

This MoU sets out the General Arrangement between the parties that will be the basis for working together.

The responsibilities of the City are to include:

- Assist with all approvals (e.g., Ministry of the Environment, Conservation & Parks MECP, City of London zoning, etc.)
- Provide land in the special policy area (Waste Management Resource Recovery Area) as a host site for three years with an option to renew for additional years
- Bring services (water, sanitary and hydro) to the location of the pilot scale facility
- Provide access to the boardroom room and education room in the Material Recovery Facility (MRF)
- Participate, when available, in discussions, tours and related activities
- Provide solid waste materials for waste conversion
- Assist with reporting, being available for media interviews and related matters
- Keep London Municipal Council informed

The responsibilities of GSE are to include:

- Obtain all necessary approvals and licenses
- Construct and operate the pilot scale facility and all associated costs including utilities
- Evaluate and report the results of the research and development work
- Provide overview reports quarterly to the City of London highlighting activities undertaken, key non-proprietary results and related matters noting that such reports are subject to the requirements of the *Municipal Freedom of Information and Protection of Privacy Act*

#### **4.0 Formal Agreement**

The parties agree to work together to develop a formal agreement to undertake the approval, design, construction and testing and develop data/information on the viability of Hydrogen Reduction technology as outlined above.

The Formal Agreement will follow the same approval processes as this General Arrangement.

#### **5.0 Effective Date and Duration**

This MoU will come into effect upon the date it has been signed by all signatories and will remain in effect until December 31, 2022.

This MoU will be reviewed two months prior to the anniversary date and any agreed to changes added to the MoU. Substantive changes will trigger the approval process for the MoU and this determination is at the sole discretion of the City.

A participant may withdraw from this MoU by providing a sixty (60) written notice to the other parties.

This MoU is subject to approval processes required by each of the parties.

DATED this \_\_\_\_\_ day of \_\_\_\_\_.

IN WITNESS WHEREOF:

THE CORPORATION OF THE CITY OF LONDON

By:

Name: Ed Holder  
Title: Mayor

By:

Name: Catharine Saunders  
Title: City Clerk

I/We have authority to bind the City.

GREEN SHIELDS ENERGY

By:

Name: Jeffrey Shields  
Title: President & CEO (Founder),

I/We have authority to bind the corporation.

## ATTACHMENT A

### OVERVIEW OF CITY OF LONDON WASTE MANAGEMENT FACILITIES ([www.london.ca](http://www.london.ca))

The City contributes to the health of the environment and its citizens through appropriate collection and management of garbage, recyclables, yard materials, household special waste, and other designated waste materials. This involves providing pick-up and drop-off services within London, processing and creating products of value from compostable/recyclable/reusable materials; and disposing of garbage in an environmentally responsible manner, including the ongoing monitoring and management of closed landfills and other sites producing methane.

To support these services the City owns and operates an array of Solid Waste diversion and disposal assets valued at over \$64 Million. These range from public waste and recycling bins, to drop off depots and one active landfill (W12A) and many closed landfill sites.

The City also owns a centralized Material Recovery Facility (MRF) which provides recycling services to London and several neighbouring communities. The MRF was newly constructed in 2011 and is operated and maintained by an outside contractor.

Drop off locations (Community EnviroDepots) are provided for special wastes including household special waste, yard materials, electronics, scrap metal, tires, roofing, etc. Solid Waste is responsible for maintaining these assets in serviceable condition between replacement cycles, ensuring compliance with Provincial regulations and maintaining the continuity of solid waste services to the citizens of London and other customers.

General household waste is primarily collected by the City while recycling pick-up and processing services are contracted out. The City owns and operates a fleet of garbage truck.

The W12A Landfill consists of a number of assets including landfill cells, buildings, leachate and gas collection systems and stormwater maintenance ponds. This facility operates within its Operation Plan, with additional disposal cells being brought online to accommodate waste in accordance with its Environmental Compliance Approval. Based on projected use, the current landfill will reach capacity in about 2023, at which point it will require an expansion (or other long term disposal solution) to provide the city with the space needed to meet its future needs.

The W12A buildings (inc. Site Works & Equipment) includes the roads, curbs and landscaping as well as the administration, maintenance and scale house buildings. The W12A Leachate Collection System collects and conveys leachate for treatment. This system is capable of meeting the current City's needs and is expanded as new disposal cells are constructed. The Landfill Gas Collection System collects and conveys landfill gas to the on-site landfill gas flare for destruction. This system is capable of meeting current City's needs and is expanded as new disposal cells are constructed.

On-site W12A Stormwater Management Ponds and site drainage infrastructure collect and treat surface runoff from snow and rain that impact the site. Maintenance occurs on a planned basis, with investments identified through regular inspections.

Any expansion or examination of alternatives will be undertaken as per the requirements of the Environmental Assessment Act.

Buffer land is comprised of City owned land adjacent or near the W12A Landfill that has been acquired to provide an appropriate buffer from existing operations and to provide buffering for possible future landfill expansion and resource recovery facilities. It is expected that additional land will be acquired for these purposes over the next several years.

## **ATTACHMENT B**

### **PRIMER – HYDROGEN REDUCTION (details provided by Green Shields Energy)**

#### **High Level Overview of Hydrogen Reduction Technology**

Hydrogen Reduction is built on a premise that in essence all organic molecules can be reduced, as they are enzymatically in nature, to form methane gas if there is an excess of hydrogen donors or electrons present. In chemistry this is best accomplished in a gas phase. In organic chemistry, gas phase chemistry is also known as plasma chemistry. All organic chemicals are known to volatilize at 440 degrees Celsius.

Hydrogen Reduction does not allow condensation reactions which form dangerous compounds such as polyaromatic hydrocarbons (PAHs) some of which are the carcinogens in cigarette smoke and the well-known environmental problems Dioxins and Furans. These chemicals are destroyed in Gas Phase Reduction and cannot form.

Condensation reactions occur when aromatic hydrocarbons or fragments of aromatic hydrocarbons are allowed to cool in an oxidizing atmosphere such as the scrubber in an energy from waste (EFW) facility. They form on the surfaces of particulates which is why EFW ash and fly ash is a problem. They also are well known to form in coal gasification forming coal tar. Other simple gasification techniques also form tar for the same reasons. However if the aromatic and partial aromatic molecules are eliminated by completely mixing every molecule with enough electrons to saturate all of the carbon bonds forming methane, there is no possibility of tar formation. This is the theory and practice of Hydrogen Reduction. Excess hydrogen gas which is the ideal reducing agent is present at every stage of the process. In the end 80% of the hydrogen is removed from the gas stream and recycled back into the reaction leaving 20% in the fuel gas.

Hydrogen is produced from the methane formed through catalyzing the water shift reaction with metal catalysts that are imbedded in the walls of the reactor. This is why moisture is left in the waste and in some cases steam is added at various points in the reaction. The method is well described in the new Canadian patent which has been published.

In Hydrogen Reduction the gas formed from all runs as been continuously analyzed and shown to be a very clean burning gas comprised of methane with about 20% hydrogen, 10% CO and 5% CO<sub>2</sub>. Regulatory analysis has shown that benzene and monochlorobenzene have been below ppm levels as measure on a continuous basis.

The combustion power of this gas is 92% of the combustion power of natural gas. The content of hydrogen at 20% has been shown to reduce the greenhouse gas production or CO<sub>2</sub> by 50% after combustion.

#### **Hydrogen Reduction Has Been Demonstrated to Destroy or Convert Many Different Non-hazardous and Hazardous Materials**

Hydrogen Reduction is the result of twenty years of development beginning with the chain of events that began when Dr. Douglas J Hallett (Natural Energy Systems Inc.) invented a non-incineration process for the destruction of PCBs and other hazardous organic waste. Dr. Hallett went on to create a company that moved his patented invention from lab-scale, to pilot scale, to a commercially viable venture. In 1986 ELI Eco Logic was established. This company went on to build processing plants in Canada, the USA, Australia and Japan. Eli Eco Logic was taken public on the Toronto Stock Exchange in 1994.

The first pilot scale demonstration of the technology occurred in 1991 and involved the remediation of coal tar contaminated sediment from a “hot-spot” in Hamilton Harbour. This project received both provincial and federal support from both Environmental Canada and the Department of Defence (DoD).

The USEPA created a report through their Cincinnati lab and this then became the record of verification to match vendor claims as to efficacy. This was laborious and time consuming, but ultimately gave Eco Logic the USEPA “gold seal” of approval.

In 1994, Eco Logic was awarded the contract to build a plant for General Motors in St. Catharines, Ontario Canada.

The successful operation of plants conducting real hazardous waste destruction led to extensive evaluation by the US Army and various prime contractors within the US Defense arena for future work on various chemical inventories and wastes within their domain, domestically and internationally. Eco Logic did extensive testing with the US Army and proved that the GPR process could successfully and safely destroy chemical warfare agents, rockets, suits and packaging waste associated with these programs.

Hydrogen Reduction plants successfully treated many different types of organic wastes including chemical warfare agents, explosives, pesticides, brominated fire retardants, CFC refrigerants, HCB, and dioxins. The technology is proven suitable for the destruction of organic wastes in all matrices including soil, sediment, sludge, high-strength oils, tar, watery wastes, wood wastes, and bulk solids such as electrical transformers and capacitors, equipment casings, and drums of crystalline chemical.

Wastes that have not been thoroughly tested include mixed solid waste (household garbage), source separated organics (Green Bin) materials, mixed plastic waste and shredder fluff from automotive industry.

According to GSE, the technology has been found acceptable by NGOs such as Greenpeace and the Sierra Club as well as regulators in Canada, the U.S.A., Australia, and Japan. A paper written by Pat Costner, Senior Science Advisor for Greenpeace International dated 9 June 2004 states “Greenpeace still finds that, among those technologies regarded as commercially available, gas phase chemical reduction (GPCR) remains the only technology that meets the 1998 Greenpeace criteria.”