



SUSTAINABLE DEVELOPMENT
TECHNOLOGY CANADA™

Partnering for real results.

Annual Report Supplement 2015

Our companies' successes are our successes.

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Sustainable Development Technology Canada Annual Report Supplement 2015

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Introduction

In accordance with the terms and conditions of both Funding Agreement Five pertaining to the Sustainable Development Technology Fund (SD Tech Fund™) between Sustainable Development Technology Canada (SDTC) and the Government of Canada, executed December 10, 2014, and the Funding Agreement pertaining to the Next-Generation Biofuels Fund (NextGen Biofuels Fund™) between the same parties executed September 4, 2007, SDTC is required to publish an Annual Report Supplement to provide specific additional details of projects funded by SDTC. Within this supplement, SDTC provides the required information relating to both Funds in 2015.

This Annual Report Supplement, which complements the SDTC Annual Report, is tabled in Parliament along with the Annual Report and the Corporate Plan Executive Summary by the Minister of Innovation, Science and Economic Development Canada. These documents are made available to the public on SDTC's website.

Purpose and Selection Criteria of Each Fund

Each Fund has a unique purpose and set of criteria for qualifying, assessing and approving projects. This is summarized in this report, at the beginning of the respective sections, for the SD Tech Fund™ and the NextGen Biofuels Fund™.

Conflict of Interest and Non-Disclosure Requirements for SDTC's Funding Allocation Process for Both Funds

All due diligence and decision-making processes at SDTC require that the individuals involved are subject to conflict of interest guidelines and non-disclosure agreements. This is applied consistently whether the individuals are experts reviewing applications or part of the SDTC organization. It should be noted that Directors of the Board are also subject to conflict of interest guidelines that require Directors to declare potential conflicts of interest and refrain from participating in any discussion regarding matters that could give rise to a conflict of interest.

Section 1: Index of Portfolio Companies Whose Project was Announced, Completed, or Reported Market Impacts in 2015

This section includes an index of SDTC portfolio companies for which the project was announced, completed or reported market impacts in 2015.

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Section 2: SD Tech Fund™ – Introduction

Purpose

The purpose of the SD Tech Fund™ is to:

- fund the development and demonstration of new sustainable development technologies related to climate change, clean air, clean water, and clean soil in order to make progress towards sustainable development;
- foster and encourage innovative collaboration and partnering amongst diverse persons in the private sector and in academic and not-for profit organizations to channel and strengthen the Canadian capacity to develop and demonstrate sustainable development technologies with respect to climate change, clean air, clean water, and clean soil; and
- ensure timely diffusion by funded recipients of new sustainable development technologies in relevant market sectors throughout Canada.

Funding provided by SDTC is a grant provided to Eligible Recipients, subject to the successful completion of contracted milestones.

Eligible Projects

To be eligible, a project must be primarily carried on in Canada to develop and demonstrate new technologies to promote sustainable development, such as:

- technologies related to energy end-use technologies, such as transportation and building technologies, and technologies to reduce ground level ozone;
- technologies related to the hydrogen economy, such as mobile and stationary fuel cells, the production, distribution and storage of hydrogen as well as transition fuels and related technologies;
- technologies related to the sustainable production of fossil fuels (“clean fossil fuel technologies”), such as the efficient combustion or conversion of fossil fuels (including advanced coal gasification), CO₂ capture and storage, more efficient technologies for surface and in-situ oil sands production, and access to frontier and unconventional natural gas resources;
- renewable energy technologies, including biomass, solar, wind, wave and tidal technologies;
- Greenhouse Gas emissions reduction technologies related to areas other than energy production and use, including technologies to reduce CO₂ in cement manufacturing;
- air quality improvement technologies, including toxic substance recovery systems, particulate control technologies and acid rain technologies;
- enabling or cross-cutting technologies, including sensors and controls, closed loop process waste, or air, water or soil treatment technologies, and process technologies for the purpose of increasing energy efficiency;
- water quality and quantity improvement technologies, including, the conservation of water and the disinfection and the mitigation or abatement of contaminants in water, sewage or sludges generated in the treatment of wastewater or potable water; including associated equipment for detection, quantification, analysis and calibration;
- waste management technologies, including those designed to prevent, reduce, or eliminate solid waste generation or discharge, as well as materials recovery processes, composting, thermal treatment, and biotechnology-based systems, and associated equipment for detection, quantification, analysis, and calibration; or
- soil quality improvement technologies, including the remediation of contaminants in soil and sediments, through containment, removal, recovery, reduced bio-availability, and destruction methods applied either in-situ or ex-situ using physical, chemical, thermal or biological processes, and associated equipment for detection, quantification, analysis, and calibration.

Funding Criteria

The Foundation must only award funding to eligible recipients who demonstrate that:

- the proposed project is technically sound and will, in the opinion of the Board, result in the development or demonstration of new sustainable development technologies;
- the Eligible Recipient brings together the necessary technical, financial and management capacity to successfully undertake the Eligible Project in a collaborative and innovative manner;
- the funding by the Foundation is necessary to ensure that the Eligible Project proceeds within the scope, with the timing or at the location necessary to ensure that significant broad benefits accrue to Canadians nationally or regionally; and
- the Eligible Recipient has provided a description and assumptions for the timely diffusion and deployment in relevant market sectors of the new sustainable development technology resulting from the proposed Eligible Project and any related incremental intellectual property.

More detail on the funding process can be found in the Funds section of the SDTC website at: www.sdtec.ca

Section 3: SD Tech Fund™ – Projects Announced in 2015

This section of the report provides a brief description for each active project announced for funding in 2015.

Alliance Magnesium Inc.

Environmental Benefits: Climate Change / Clean Soil

Total Project Value: Magnesium could be used in a variety of applications where other heavier metals like steel or aluminum are traditionally used. Alliance Magnesium is developing a novel technology that combines aspects of hydrometallurgy and electrolysis to produce magnesium metal from tailings left over by mining activity. As compared to the incumbent magnesium extraction method, Alliance's process will reduce greenhouse gas (GHG) emissions, conserve water and reduce the amount of tailings. This project will demonstrate a pilot plant in Asbestos, Quebec.

SDTC Funding: \$3,000,000

Leveraged Funding: \$6,480,585

Consortium Members:
Alliance Magnesium Inc.
INRS (Institut national de recherche scientifique)
SENECA

ARDA Power Inc.

Environmental Benefits: Climate Change / Clean Air

Total Project Value: Power comes in two forms: alternating current (AC) and direct current (DC), each having its own applications and benefits. While the predominant form of electricity usage today is AC, both renewable sources including solar and fuel cells, and an increasing number of loads including LED lighting, high efficiency HVAC, data centers and electric vehicles are DC. In addition the distributed nature of these sources and loads requires increased use of distributed storage, such as lithium and flow batteries, that are also DC. The future interconnection of these DC sources, loads and storage will inevitably involve DC microgrids, where the costs, complexity and losses associated with AC grid connections are eliminated. ARDA Power is developing an innovative technology designed for commercial and industrial sites that can benefit from the use of flexible and scalable DC microgrids. Compared to other DC microgrid technologies, the plug-and-play nature of ARDA's solution will result in a significant reduction of non-recurring engineering costs required for the design of a new system while preserving all of the cost and efficiency benefits of DC. This project will provide a proof-of-concept for the ARDA DC Microgrid system, demonstrating its plug-and-play nature via the use of standardized components, as well as its efficiency, its resiliency - in the form of back-up generation and extended battery storage, and its ability to shift AC grid load and operate on a stand-alone basis in the event of conventional grid failure.

SDTC Funding: \$400,000

Leveraged Funding: \$648,542

Consortium Members:
ARDA Power Inc.
Etratech Inc.
Gildemeister Energy Storage GmbH
Swan Creek Energy LL

ASE Smart Energy Inc.

Environmental Benefits: Climate Change

Total Project Value: Ottawa-based ASE Smart Energy Inc. (ASE) is a leading manufacturer of open smart home energy and comfort management solutions for the residential and hospitality markets. ASE provides scalable, fully wireless, easy-to-operate and cost-effective virtual multi-zone solutions that improve comfort while minimizing energy consumption. RetroSave, the ASE's patented technology system interoperates seamlessly with any COTS in-home HVAC appliances and thermostats. ASE solutions enable the collection and analysis of a building's environmental data and its energy-usage patterns. Collected data can be used to help utilities to more effectively cope with peak loads through their demand-side management programs. Government-led energy conservation programs can also benefit from the mass deployment of ASE solutions. HVAC service providers can take advantage of the RetroSAVE capabilities to better manage and upsell their customer base with new services that will cut down or even eliminate HVAC system downtime. ASE-developed hospitality controllers and sensors are already installed in thousands of hotel rooms throughout North America while residential RetroSave systems for buildings with Central Forced Air (CFA) are in commercial trials in several major Ontario cities.

SDTC Funding: \$300,000

Leveraged Funding: \$409,688

Consortium Members:
ASE Smart Energy Inc.
Hydro Quebec IREQ

Avalon Rare Metals Inc.

Environmental Benefits: Climate Change / Clean Air / Clean Soil

Total Project Value: Rare earth elements are a fundamental ingredient in many wide-ranging existing and developing clean and green technologies, but the processes to obtain these necessary ingredients, like with any resource extraction, can come at a cost to the environment. Avalon Rare Metals has developed an efficient, environmentally responsible and yet economically viable method for extracting rare earths from an ore body in Canada's Northwest Territories that is the most advanced large heavy rare earth project in the world outside of China and is strongly positioned to become a sustainable supplier for the international marketplace. Recently, Avalon has greatly improved the efficiency of recovering these rare earths but the processes involved rely on a number of expensive bulk chemicals. By introducing further technologies Avalon has also been able to recover and recycle significant quantities of three of the major chemicals used in the process, thereby reducing greenhouse gas (GHG) emissions, lowering volumes of solid tailings and improving waste water quality. The project will soon be demonstrated by a pilot program to be conducted at the Saskatchewan Research Council.

\$3,980,697

SDTC Funding:
\$1,313,630

Leveraged Funding:
\$2,667,067

Consortium Members:
Avalon Rare Metals Inc.
Solvay S.A.

BBCP Conductor Inc.

Environmental Benefits: Climate Change / Clean Air

Total Project Value: It is estimated that between 5 and 10 percent of electricity generated in developed countries never reaches the consumer, being lost as heat due to the resistance of the cables and wires. Ever since the discovery of the extremely low resistance of carbon nanotubes, researchers have speculated that adding them to the aluminum and copper used in the distribution of electricity would lower the resistance of the wire, holding out the promise of lower grid losses, lower energy losses and reducing wastage. There were already good indications that a nanotube-metal alloy would be stronger, which is also important to the electrical industry. Until now, efforts to use nanotubes to both strengthen wires while decreasing resistivity have been largely unsuccessful. BBCP Conductor has developed a unique method to accomplish these goals: their aluminium wires are both less resistive and stronger than conventional aluminium electrical wires. The consortium partners will be using BBCP wire in a variety of grid related products to validate the expected increase in performance.

\$11,410,000

SDTC Funding:
\$3,660,000

Leveraged Funding:
\$7,750,000

Consortium Members:
BBCP Conductor Inc.
Hammond Power Solutions
Partner Technologies Inc.
Valard Construction LP
Nexans Canada Inc.
Raymor Industries Inc.

CelluForce Inc.

Environmental Benefits: Climate Change / Clean Water

Total Project Value: This project will further improve and optimize the process developed by CelluForce to extract nanocrystalline cellulose (CelluForce NCC™) from dry wood pulp. CelluForce NCC™ (NCC) is the primary building block found in cellulosic biomass such as trees. Measured in units as small as nanometres, these tiny structures nonetheless have strength properties comparable to steel. NCC is a versatile material that will have uses in a variety of industrial sectors. In particular, NCC is touted as having the potential to significantly advance the oil-and-gas industry. Suspension methods for extracting oil out of the ground – are limited as to where they can be applied. Under some conditions, traditional suspensions break down: valuable resources fall out of suspension and do not achieve their function. When NCC is added to the suspensions, they remain cohesive even under extreme conditions. Moreover, the addition of NCC reduces the volume of water and pressure needed to carry out the extraction. The enhanced characteristics that NCC imparts to the suspensions should provide opportunities for extracting resources in areas where that is not currently possible and to do so with a lower environmental footprint. Other objectives of the project are to develop additional applications for the oil-and-gas industry which include cementing using this renewable forestry resource.

\$12,943,101

SDTC Funding:
\$4,004,254

Leveraged Funding:
\$8,938,847

Consortium Members:
CelluForce Inc.
Schlumberger Technology
Corporation

Cellufuel Inc.**Environmental Benefits: Climate Change**

Total Project Value: A drop-in biofuel – made from biomass that is chemically indistinguishable from petroleum-based fuel and compatible with currently used fuel infrastructure and engines – has been difficult to produce. Cellufuel’s catalytic depolymerisation technology converts wood into renewable diesel that meets the quality of petroleum diesel. This project will build a demonstration scale plant at a former newsprint mill, demonstrating the commercial viability of the process including the production cost and product quality.

\$6,523,312

SDTC Funding:

\$2,152,693

Leveraged Funding:

\$4,370,619

Consortium Members:
Cellufuel Inc.
Boralex Inc.

CHAR Technologies Inc.**Environmental Benefits: Climate Change / Clean Air**

Total Project Value: Biogas is generated in anaerobic digesters and landfills but contaminants such as hydrogen sulfide (H₂S) must be removed to prevent damage to engines and pipelines. Worldwide, it is estimated that over \$1 billion is spent annually on removing H₂S from biogas before it can be used as renewable natural gas for heating or for the production of electricity. Currently-available products for scrubbing can be expensive and need to be landfilled after use. Enter SulfaCHAR™, a zero-waste and cost-effective way of purifying biogas – while also transforming the H₂S into a valuable sulfur-rich fertilizer that increases crop yields. This project will focus first on designing and building a SulfaCHAR™ production facility, then on using the SulfaCHAR™ scrubbing units to remove H₂S from biogas, and testing spent SulfaCHAR™ as an agricultural fertilizer.

\$2,403,402

SDTC Funding:

\$750,000

Leveraged Funding:

\$1,653,402

Consortium Members:
CHAR Technologies Inc.
Kentech Automation Inc.
Boreal Agrominerals Inc.
The Grober Group Inc.

CO2 Solutions Inc.**Environmental Benefits: Climate Change**

Total Project Value: Conventional amine-based carbon dioxide (CO₂) capture technologies that reduce emissions are costly and toxic. CO₂ Solutions’ enzymatic and environmentally benign technology lowers costs by over half by greater energy efficiency. This demonstration project represents an important scale-up step for this technology as it approaches commercialization. As a result of it, the technology will be made applicable to broad range of commercial CO₂ capture markets, most notably for Enhanced Oil Recovery (EOR) and Carbon Capture and Sequestration (CCS).

\$7,400,000

SDTC Funding:

\$2,442,000

Leveraged Funding:

\$4,958,000

Consortium Members:
CO₂ Solutions Inc.
Resolute Forest Products Inc.
Serres Toundra Inc.

Comet Biorefining Inc.**Environmental Benefits: Climate Change / Clean Water**

Total Project Value: Bio-based products can potentially replace petro-based products in a range of industries, improving sustainability through the reduction of greenhouse gas emissions. Comet Biorefining’s proprietary technology converts non-food biomass, such as agricultural and forest material, into high-purity dextrose sugar. The sugar can be transformed into a range of renewable chemicals and biomaterials and valuable by-products from the process can be used for animal nutrition and performance chemicals. Involving industry leaders across the supply chain, such as SDTC-funded BioAmber, this project will build a 200 tonnes/day demonstration facility to test the technology and develop upstream and downstream partnerships for large-scale commercialization.

\$34,712,338

SDTC Funding:

\$10,890,000

Leveraged Funding:

\$23,822,338

Consortium Members:
Comet Biorefining Inc.
BioAmber Inc.
Domtar
UPM
Sofinnova Partners

CrossChasm Technologies Inc.

Environmental Benefits: Climate Change / Clean Air

Total Project Value: \$1,208,556
SDTC Funding: \$430,000
Leveraged Funding: \$778,556

The number of plug-in electric vehicles (PEVs) in the United States is forecast to grow from approximately 296,000 in 2014 to more than 2.7 million in 2023. The need to charge this increasing number of PEVs is putting pressure on electricity generation and distribution during peak power demand periods of the day. This pressure can be reduced if the PEVs are enrolled in a smart-charging program. Smart-charging means using real-time grid conditions to charge electrical vehicles efficiently: knowing when to draw on the conventional grid, when to involve renewable energy, and more. An obstacle to smart-charging is that each vehicle manufacturer has its own system for tracking and logging a PEV fleet's usage and need for re-charging; having vehicle-side data across models and manufacturers is necessary. CrossChasm's FleetCarma C5 logger is able to read proprietary signals from 24 different electric vehicle models, including all PEVs sold in North America. It will combine the vehicle's current battery state-of-charge with the owner's charging preferences to determine the optimal charging schedule for the EV owner and signal to the grid operator the availability of the charger for demand response. From a commercialization standpoint, the major outcome of this project is the validation of the FleetCarma Smart Charging System, and the associated benefits of knowing and predicting how to accommodate the energy needs of a growing PEV market.

Consortium Members:
 CrossChasm Technologies Inc.
 Siemens
 Oakville Hydro Electricity
 Distribution Inc.
 NB Power
 Burlington Hydro Inc.
 BC Hydro
 The University of British
 Columbia

David Bromley Engineering Ltd.

Environmental Benefits: Climate Change / Clean Air

Total Project Value: \$9,725,000
SDTC Funding: \$3,225,000
Leveraged Funding: \$6,500,000

The oil and gas industry is working to reduce water use – but water is critical to the extraction of resources. The industry currently uses treatment processes that filter water through membranes and use high levels of chemicals and energy to produce filtered, clean effluent water. Nanofiltration technology could change that. Filtration is performed using a membrane that has a unique replaceable membrane layer technology. The replaceable membrane layer is a powder that causes the smallest particles in the water to separate from water and attach to the powder. Once the powder membrane layer is "full", it is replaced with a new layer. This demonstration project will use three key wastewater streams from an oilsands operation (evaporator blow down, SAGD and fractured shale flow back waters) and will provide the basis for full-scale commercialization in oil-and-gas water treatment applications. This method of nanofiltration could reduce the use of energy by 65 percent and chemicals by 86 percent, resulting in 41 percent lower capital costs and 33 percent lower operating costs.

Consortium Members:
 David Bromley Engineering Ltd.
 AH Lundberg Systems Ltd.
 PurLucid Treatment Solutions Inc.

DMF Medical Incorporated

Environmental Benefits: Climate Change / Clean Air

Total Project Value: \$1,635,575
SDTC Funding: \$686,575
Leveraged Funding: \$949,000

For many surgical procedures, general anesthesia is required to keep patients sedated. General anesthesia however, requires the use of vapors that are significant contributors to greenhouse gases (GHG). Current chemical absorbers used to safely deliver anesthesia require the release of a portion of these harmful vapors into the atmosphere. DMF Medical has developed a next-generation chemical-free solution to address this issue. This solution significantly reduces GHG emissions, while providing best-in-class clinical outcomes. The result is a reduction in the use of costly anesthetic vapor, detrimental emissions, and the elimination of hazardous chemical waste. The benefits include reduced operating costs, improved environmental footprint and better clinical outcomes. This project, through product optimization and in-patient trials, will demonstrate these improved environmental benefits.

Consortium Members:
 DMF Medical Inc.
 Capital District Health Association
 Department of Anesthesia
 Pain Management and
 Perioperative Medicine
 3M
 University of Alberta
 Department of Anesthesiology
 and Pain Medicine
 Brain Repair Centre

Field Upgrading Ltd.

Environmental Benefits: Climate Change / Clean Air

Total Project Value: \$22,387,789
SDTC Funding: \$5,150,000
Leveraged Funding: \$17,237,789

Currently, over one million barrels per day of bitumen are blended with diluent in order to move it through pipelines throughout Canada and to the United States for upgrading and refining. Diluent is energy-intensive to produce and transport to the oilfields for use. There exists a huge opportunity to partially upgrade the bitumen in Canada before sending it on for refining. This project will demonstrate Field Upgrading's desulfurization and upgrading technology (DSU), an innovative partial upgrading technology that uses sodium to selectively remove sulfur and other impurities from the bitumen, producing the necessary upgraded bitumen. The reactivity of the sodium eliminates the need for many conventional upgrader process units by combining sulfur removal, metals precipitation and upgrading in one step. The DSU process reduces GHG life-cycle emissions by over six percent when compared with conventional upgraders. In addition, the technology completely eliminates the emission of sulphur oxides from the upgrading process. This technology could reduce capital costs by 50 percent and operating costs by 30 percent when compared with conventional upgraders. Field Upgrading has formed an Advisory Committee to obtain the advice and experience of key energy industry participants during the pilot project. The Advisory Committee comprises representatives from Suncor, Cenovus, Alberta Petroleum Marketing Commission, as well as two other major oil and gas companies, and Sterling Fuels who is providing marine industry perspective. Both SDTC and the Climate Change and Emissions Management Corporation (CCEMC) have also provided technical representation.

Consortium Members:
 Field Upgrading Ltd.
 Aux Sable Canada Ltd.

FORGE Hydrocarbons Corporation

Environmental Benefits: Climate Change

Total Project Value: \$12,732,770
SDTC Funding: \$4,201,814
Leveraged Funding: \$8,530,956

National biofuels mandates are a good way to get biofuels in the tanks of cars all over the country – but to date, petroleum companies have complied with these mandates by blending in green fuels such as ethanol and biodiesel. Biofuels developers are still trying to pursue a true drop-in biofuel: that is, a fuel, made from biomass, that is chemically indistinguishable from petroleum-based fuel, and therefore directly compatible with currently used fuel infrastructure and engines. FORGE Hydrocarbons Corp. is developing a technology that transforms low-value fats, oils and greases into fuel. The objective of this project is to continue the accomplishments of the 200,000 litre per year pilot plant, which was supported by investments from Western Economic Development Canada and Alberta Livestock and Meat Agency Ltd. with the construction of a pre-commercial demonstration plant. The first of its kind in Canada, this lipid to hydrocarbon plant will produce renewable liquid hydrocarbons with a production capacity of 19 million litres per year.

Consortium Members:
 FORGE Hydrocarbons Corporation
 BIOX Corporation
 IGPC Ethanol Inc.

Fractal Systems Inc.

Environmental Benefits: Climate Change

Total Project Value: \$11,471,324
SDTC Funding: \$3,700,000
Leveraged Funding: \$7,771,324

Thick and sticky, bitumen must be blended with a diluent, resulting in a product known as "dilbit", before it can be transported through Canada's pipeline system. Producing dilbit can be expensive and uses up capacity on Canada's already constrained pipeline infrastructure, which may hinder the movement of additional products to market. Fractal Systems has developed a partial upgrading technology called Enhanced JetShear™ that can reduce the amount of diluent that must be blended with bitumen by up to 60% in order to meet pipeline specifications. The JetShear™ technology is unique in that it focuses on reducing the bitumen viscosity, rather than changing the chemical composition of the bitumen itself, thereby allowing the same amount of product to be transported for a much lower cost. This project will focus on further improving the JetShear™ technology such that an upgraded dilbit can be produced which is free of olefins and has lower acidity levels, two components of the current dilbit product that are considered impurities.

Consortium Members:
 Fractal Systems Inc.
 Cenovus FCCL Ltd as Operator of
 FCCL Partnership

GaN Systems Inc.

Environmental Benefits: Climate Change / Clean Air

Total Project Value: \$6,630,222
SDTC Funding: \$2,187,971
Leveraged Funding: \$4,442,251

Each electric vehicle comes with a charger to connect its battery to a power grid. This project demonstrates a new technology that maximizes the efficiency of the charger and reduces the vehicle's weight (if installed on-board) which is essential to maximizing the range of the vehicle and lowering vehicle operating costs. GaN Systems and Delta-Q Technologies are working on a battery charger for industrial electric vehicles that uses a breakthrough material, gallium nitride, for the power conversion step. Compared to silicon, gallium nitride operates at higher frequency and at much greater efficiency. These attributes lead to significant reduction in the generation of wasted heat during the power conversion process. This technology can cut power losses incurred today during the charging of a battery in half with a corresponding reduction in greenhouse gasses.

Consortium Members:
 GaN Systems Inc.
 Delta-Q Technologies

General Fusion Inc.

Environmental Benefits: Climate Change / Clean Air

Total Project Value: \$38,971,362
SDTC Funding: \$12,748,560
Leveraged Funding: \$26,222,802

General Fusion is developing fusion energy, a potentially transformational technology for the energy industry: a safe, limitless, clean, emission-free, and cost-effective alternative for power generation. General Fusion's proprietary Magnetized Target Fusion (MTF) technology represents the fastest, most practical, and lowest-cost path to commercial fusion power. This project will construct and demonstrate, at power plant scale, the primary subsystems and physics underpinning General Fusion's technology. Simulation models will be tuned and used to complete the design of the world's first full-scale fusion energy system using commercially-viable technology. This verification of the technical and economic viability of General Fusion's MTF technology will be a major milestone for this game-changing technology.

Consortium Members:
 General Fusion Inc.
 Hatch Ltd.
 McGill University

Grafoid Inc.

Environmental Benefits: Climate Change / Clean Air

Total Project Value: \$25,069,276
SDTC Funding: \$8,120,646
Leveraged Funding: \$16,948,630

At one atom thin, graphene is lighter and stronger than steel, more electrically conductive than copper or silver, and is much sought after for its unique ability to store either hydrogen or electrons. In fact, its discovery in 2004 led to a 2010 Nobel Prize in Physics. In short, this is an impressive natural material derived from crystalline graphite with applications in medicine, electronics, and energy storage, power generation (such as fuel cells or solar cells), aerospace, computer chips, next-generation transportation, construction materials – and more. So why is this nanomaterial not where it needs to be? Simply because it is expensive to produce, largely owing to the high temperatures needed to produce it. Grafoid has developed a novel low-cost, environmentally sustainable method that produces high-quality MesoGraf™ graphene at room temperature, enabling a 90 percent reduction in the amount of energy used as compared to the market dominant method. Furthermore, the process optimizes the reuse of reagents with the net reduction in wastewater production.

Consortium Members:
 Grafoid Inc.
 Graphite Zero Pte Ltd.
 General Sports and Entertainment LLC
 Calevia Inc.
 Focus Graphite Inc.
 Grafwire Inc.
 Alcoa Inc.
 Graflow Inc.

Hydrogenics Corporation

Environmental Benefits: Climate Change

Total Project Value: \$7,625,890
SDTC Funding: \$2,500,000
Leveraged Funding: \$5,125,890

Renewable energies enhance power supply with greener options, but storing them reliably, allowing for them to be wholly integrated, continues to be a challenge. Hydrogenics' technology converts surplus renewable electricity into hydrogen gas. This renewable hydrogen can then be injected, stored, and transported in North America's existing, and extensive, natural gas pipeline systems. With existing, high efficiency, natural gas-fired generators, this stored renewable energy can then be brought back to the electricity grid as dispatchable, renewable power – where and when it is needed most. This project will build a power-to-gas demonstration plant that converts electricity into hydrogen. At 5MW, the plant will be the largest power-to-gas demonstration project in North America, and will form the building block for future utility-scale deployments.

Consortium Members:
 Hydrogenics Corporation
 Enbridge Inc.

Imtex Membranes Corp.

Environmental Benefits: Climate Change / Clean Air

Total Project Value: \$10,112,395
SDTC Funding: \$3,336,960
Leveraged Funding: \$6,775,435

Olefins are products derived from petroleum and natural gas that are used in plastics all over the world. Purified olefins are produced by separating them from other hydrocarbon components – this separation process is currently the most energy-intensive step in the olefin production process. Imtex Membranes' membrane technology, which allows specific olefins to pass through while restricting other gases, could change that by being dramatically more energy efficient, reducing GHGs and air contaminants by up to 90 percent compared to the currently used technology. The project will demonstrate the technology under industrial conditions, exposing it for several months of operation and in different volumes over the life of the project.

Consortium Members:
 Imtex Membrane Corp.
 Borealis AG
 Monteco Ltd.

Ionada Incorporated

Environmental Benefits: Climate Change / Clean Air

Total Project Value: \$4,881,762
SDTC Funding: \$1,394,495
Leveraged Funding: \$3,487,267

The International Maritime Organization (IMO) has imposed global emissions regulations upon the shipping industry, necessitating reduced emissions of sulphur oxides by 2015. This presents a problem for Canada's marine industry, which, according to Transport Canada, is expected to contribute 98 percent of all sulphur oxides released into the atmosphere by the transport industry, far exceeding other modes of transportation including air, rail, and trucking. Ship operators face a choice: switch to expensive lower-sulphur fuel alternatives, or use currently-available heavy fuel oil and install a scrubber on their vessel to clean the exhaust and remove the sulphur oxides. Scrubbing is the most cost-effective means for the industry, but some scrubbers have proven very difficult and expensive to install or retrofit into existing vessels. Enter Ionada's Ionic Capture Technology (ICT), a marine scrubber that removes sulphur oxides through the use of dry membrane gas separation and salt water or ionic liquids. The technology has the added benefit of being 30 percent more energy efficient than widely-available devices and 50 percent smaller avoiding onboard chemical, waste or water storage requirements, and it has a less complex configuration which makes it easier and more cost effective to retrofit shipping vessels.

Consortium Members:
 Ionada Incorporated
 Canadian Steamship Lines Inc.
 Ryerson University

Kelvin Storage Canada Inc.

Environmental Benefits: Climate Change / Clean Air

Total Project Value: \$8,828,573
SDTC Funding: \$2,830,936
Leveraged Funding: \$5,997,637

Industries and power generators worldwide, including and notably Alberta's bitumen producers, are under considerable pressure to reduce greenhouse gas emissions ("GHG") caused by burning fossil fuels. Their challenge is how to do that economically with minimal technical risk. To accomplish this, Kelvin Storage has developed the Thermal Matrix Energy Storage (TMES) system – a system that uses electricity to heat an insulated graphite core, where this energy is stored in the form of thermal energy. This technology can store gigawatt-hours of off-peak electrical energy that can then be delivered in the form of high-quality thermal energy ("CleanHeat") to industry in a safe, efficient and cost-effective manner. TMES will allow large fossil-fueled generation and industrial facilities worldwide – including power generation plants, oil and gas production facilities (especially oil sands operators), industrial thermal facilities (in a multitude of industries), district heating plants, and numerous other applications – a simple, cost-effective, safe, and efficient way to dramatically reduce their use of fossil fuels such as coal, natural gas and oil while allowing them to operate more efficiently, reducing their emissions accordingly. Additionally, TMES provides new markets for off-peak renewable generation, allowing the amount of renewable energy from wind, run-of-river hydro, solar and biomass to increase and the grid to operate more efficiently. This project will see a pilot 10 MWh unit used at a central heating plant in the GTA.

Consortium Members:
 Kelvin Storage Canada Inc.
 Kelvin Storage Inc.
 Greater Toronto Airport Authority
 Kinectrics
 SNC-Lavalin

Liquid Light (Canada) Inc.

Environmental Benefits: Climate Change

Total Project Value: \$28,816,613	Imagine if carbon dioxide (CO ₂) were no longer emitted into the atmosphere and was instead being used to produce goods. That's the idea behind Liquid Light's technology. The company has developed a process that uses waste CO ₂ to produce everyday chemicals that find their way into consumer goods like textiles and plastics. The core technology uses electrochemistry to convert CO ₂ into a variety of chemicals. The technology will promote carbon capture technologies by creating a demand for CO ₂ , and can achieve cost savings of up to 25 percent as compared to petroleum-based products of the same nature. The project will demonstrate the process using CO ₂ sourced from industrial waste streams, such as refineries and bio-ethanol plants.
SDTC Funding: \$8,585,597	
Leveraged Funding: \$20,231,016	

Consortium Members:
Liquid Light (Canada) Inc.
BP Alternative Energy
International Ltd. (BPAEIL)

Loop Energy Inc.

Environmental Benefits: Climate Change / Clean Air

Total Project Value: \$22,680,126	It will be impossible to reach international emission reduction goals without implementing solutions for heavy duty trucking, which represents four percent of total vehicles in North America yet accounts for twenty percent of the fuel consumed, translating into the lion's share of emissions in the transportation industry. Loop Energy Inc. will produce a heavy duty Class 8 truck that delivers zero emissions with performance and attributes that operators' demand. The Loop system combines an EV battery with a hydrogen fuel cell designed around their patented e-Flow technology to deliver superior performance to diesel engines at a lower total cost of ownership. Battery power alone is inadequate due to its limited range. This project will first develop the Loop powertrain and then demonstrate it in real-world testing with consortium partners.
SDTC Funding: \$7,500,000	
Leveraged Funding: \$15,180,126	

Consortium Members:
Loop Energy Inc.
Peterbilt Motors Company

May-Ruben Thermal Solutions

Environmental Benefits: Climate Change / Clean Air

Total Project Value: \$2,522,802	Heating and cooling account for as much as 72 percent of the commercial building sector's total energy use – however, the tools used to heat and cool are very inefficient, producing significant amounts of waste heat. One way to increase energy efficiency is to combine heating and cooling with energy production, so that waste heat can be converted into energy in a single unit – a combined cooling, heating and power (CCHP) plant. May-Ruben Thermal Solutions is working on a technology (a binary fluid ejector) that integrates and enables these efficient CCHP plants, which result in lower operating and maintenance costs, while enabling energy savings of up to 60 percent. This project will scale up the technology from its current size to a commercial scale prototype.
SDTC Funding: \$832,000	
Leveraged Funding: \$1,690,802	

Consortium Members:
May-Ruben Thermal Solutions Inc.
Chemours Company
Ecologix Heating Technologies
Gas Technology Institute (GTI)
University of Calgary

Miovision Technologies Inc.

Environmental Benefits: Climate Change / Clean Air

Total Project Value: \$7,355,499	Cars in urban centres spend as much as a quarter of their time idling at intersections, wasting fuel and emitting GHGs. Current solutions use rule-based functions and pre-defined scripts for a given set of traffic conditions (timers, recognition of peak usage) to flow vehicles through a given intersection. Miovision's adaptive traffic signal control system "watches" an intersection using a set of integrated technologies, including wireless connectivity, cloud-based computing, and a single 360° camera. The system is capable of learning and analyzing real-time conditions, as often as 10 times per minute, causing the traffic lights to change in order to optimize traffic flow and reduce idling. The technology could reduce travel time – and related fuel need and environmental impacts – by over 20 percent.
SDTC Funding: \$1,400,000	
Leveraged Funding: \$5,955,499	

Consortium Members:
Miovision Technologies Inc.
Region of Waterloo

Nano One Materials Corp.

Environmental Benefits: Climate Change / Clean Air

Total Project Value: One of the largest barriers to full-scale electric vehicle adoption is cost – and batteries are largely responsible for that. Nano One Materials Corp. is developing a battery materials production process that improves the energy storing performance and cost of materials used in lithium ion batteries. The technology produces longer lasting materials, simplifies manufacturing, uses lower cost feedstock, brings production costs down by as much as 50 percent and uses less energy in the process. Nano One has been granted key patents covering methods and applications of its technology and has others in the queue. This project includes the construction of a pilot plant, then operating that plant to refine the process to the point that Nano One will be able to demonstrate and license its technology for commercial-scale facilities.

\$6,323,342

SDTC Funding:
\$2,081,297

Leveraged Funding:
\$4,242,045

Consortium Members:
Nano One Materials Corp.
BC Research Institute

Doodle Labs Inc.

Environmental Benefits: Climate Change / Clean Air

Total Project Value: Lighting uses 15–20 percent of electricity generated worldwide, making efficient lightbulbs a key tool for reducing energy consumption. Doodle created the world's most energy efficient lightbulb and it's taking it even further by connecting it to a low-cost intelligent control platform. The platform allows users to customise lighting based on other conditions, like available sunlight or desired lighting aesthetics. The combined features of high efficiency lighting and great light quality meet the needs of users in the merchant and hospitality sectors, where the systems can eventually displace inefficient halogen lighting.

\$8,777,771

SDTC Funding:
\$2,879,925

Leveraged Funding:
\$5,897,846

Consortium Members:
Doodle Labs Inc.
Nanoleaf Ltd.
MaRS Cleantech
Mercatto Restaurant Group
National Research Council of Canada
Impact Centre
University of Toronto

Netlift Transport Social Inc.

Environmental Benefits: Climate Change / Clean Air

Total Project Value: Carpooling could be a meaningful tool to take cars off the road and reduce related GHGs and air pollution – but it's not always flexible for commuters. Mass transit has the same potential for the environment and is more flexible – but can be impractical. Netlift's technology combines the best of both worlds: Netlift is a platform that can recommend a combination of carpooling and mass transit to get commuters to their destination in the way that suits them best – depending on where they want to start and end, their willingness to walk, and other factors. Their algorithm (and its cell-phone app) optimizes journeys involving both private vehicles and public transit, to offer rides that approach the flexibility of driving, but at a fraction of its cost. With this project, Netlift seeks to refine its tool by market testing it in test region (Montreal).

\$941,605

SDTC Funding:
\$448,000

Leveraged Funding:
\$493,605

Consortium Members:
Netlift Transport Social Inc.
Réseau de transport de Longueuil
Société de transport de Laval
Société de transport de Montréal

NextGrid Inc.

Environmental Benefits: Climate Change

Total Project Value: Businesses and consumers in North America depend on a patchwork of local providers to deliver electricity through what has become commonly known as the "grid". This centralized model of delivering electricity to consumers is broken and the American Society of Engineers estimates that a \$673-billion investment by 2020 will be required to fix the national grid in the United States. The result of this investment will be a steady increase in the price of electricity for consumers for years to come. To combat rising electricity prices, NextGrid Inc. proposes to decentralize electricity production. NextGrid's combined heat and power (CHP) system is a revolutionary platform (patent pending) that uses a micro-steam turbine to generate heat and electricity; the generators are the most fuel-efficient in the world with up to 95 percent of all fuel used converted to heat and/or electricity. NextGrid's CHP technology can substantially lower our carbon footprint, with NOx emissions at an industry leading 0–3 PPM and a predicted 47 percent reduction in GHG emissions when compared to incumbent technologies.

\$753,306

SDTC Funding:
\$300,000

Leveraged Funding:
\$453,306

Consortium Members:
NextGrid Inc.
OZZ Energy Corporation (OZZ Electric Inc.)

Nsolv Corporation

Environmental Benefits: Climate Change / Clean Air / Clean Water

Total Project Value: \$84,311,075
SDTC Funding: \$13,000,000
Leveraged Funding: \$71,311,075

Nsolv has developed a cleaner solution to the environmental and economic challenges of heavy oil production. It produces a higher quality oil product while significantly reducing energy inputs and greenhouse gas emissions. Proven technologies such as Nsolv's can lead a transformation in the oil and gas industry, which is what is needed for Canada to meet its climate change goals. The Nsolv technology is a made-in-Canada, patented process that uses a warm solvent rather than water for heavy oil extraction. This significantly reduces greenhouse gas emissions, about 3/4 compared to traditional extraction methods. The technology was developed with previous support from SDTC, and has met with success in the field via the B.E.S.T. (Bitumen Extraction Solvent Technology) pilot project in the Athabasca oil sands region. The next crucial step for Nsolv is the commercialization of the solvent technology, which begins with the development of a Commercial Demonstration Facility. This facility will be a 15 times scale-up of the pilot project and is expected to produce 2,500 barrels per day of cleaner and more valuable Canadian oil.

Consortium Members:
 Nsolv will partner with a major heavy oil producer on the Commercial Demonstration Facility

OpenHydro Technology Canada Ltd.

Environmental Benefits: Climate Change / Clean Air

Total Project Value: \$33,585,949
SDTC Funding: \$6,352,500
Leveraged Funding: \$27,233,449

At over 16 metres, the Bay of Fundy has the highest tidal range in the world. This unique site has also the potential to supply thousands of homes with clean and renewable energy, if the unequalled power of the tides could be harnessed. The conditions found in the Bay of Fundy are demonstrably harsher than other tidal sites around the world, representing a significant engineering challenge in developing devices to turn that energy into electricity in a cost effective manner. OpenHydro will deploy a 4-MW array (two 2-mw turbines) at the FORCE facility in the Bay of Fundy, simulating the cost and performance of a commercial tidal farm. The project will demonstrate and validate turbine spacing effects, control strategies, connectivity and cabling installation needed to sustain the operation of a tidal turbine array. Designed for the harsh conditions of the Bay of Fundy, each OpenHydro turbine is comprised of an outer fixed rim (stator) and an inner single-piece rotating disc (rotor) mounted on a subsea gravity base that is simply placed on the seabed. Each unit is expected to produce 2MW at a cost of 14.7 cents per kWh by 2020.

Consortium Members:
 OpenHydro Technology Canada Ltd.
 Emera Inc.
 Cape Sharp Tidal Venture Ltd.
 OpenHydro Group Ltd.
 OpenHydro Technology Ltd.

OTI Lumionics Inc.

Environmental Benefits: Climate Change / Clean Air

Total Project Value: \$17,006,025
SDTC Funding: \$5,668,675
Leveraged Funding: \$11,337,350

Organic LED lighting – OLED lighting – is a market in its infancy, but the potential is staggering. In fact, most industry analysts project the market to grow to more than a billion USD in sales by 2020. OLEDs are thin, lightweight, and flexible light sources that illuminate an area more efficiently than other sources, including LEDs. However, the cost to produce OLEDs today is too high. OTI will lead a project to engineer and install an operational OLED pilot production line capable of producing high volumes of OLED lighting panels. The line will demonstrate the economic and technical viability of OTI's production technologies.

Consortium Members:
 OTI Lumionics Inc.
 Dr. Reddys
 Teknion Laboratories Canada Inc.
 TE Connectivity Ltd.
 NSG Group
 Province of Ontario

Polar Sapphire Ltd.

Environmental Benefits: Climate Change / Clean Air

Total Project Value: \$7,837,919
SDTC Funding: \$2,650,000
Leveraged Funding: \$5,187,919

Sapphire, which is harder than any other natural material with the exception of diamond, is already used to make high-strength glass for windows in pressure vessels and scientific instruments. The cost of sapphire glass however has prevented its wider use in applications such as consumer electronics. This cost constraint could change with the development of a new process to make high purity alumina which is then used in the production of synthetic sapphire. The Polar Sapphire process significantly reduces the energy required to produce the high purity alumina. The environmental impact of using this alumina for conversion into sapphire could significantly reduce GHG and air pollution particulates in Canada and around the world.

Consortium Members:
 Polar Sapphire Ltd.
 Jaco Corporation Ltd.
 McMaster University

Pyrowave Inc.

Environmental Benefits: Climate Change / Clean Soil

Total Project Value: \$3,130,327
SDTC Funding: \$1,048,474
Leveraged Funding: \$2,081,853

Recycling is a major component of environmental responsibility, yet the costs to haul, store, sort and process plastics are enormous. Pyrowave's technology uses a patented technology that breaks down plastics using high heat produced by microwaves. This technology is packaged in small, modular units directly onsite at recycling facilities and at producers of plastic waste. This convenient and mobile approach will enhance the rate and range of recyclable materials, and will produce higher-value end products from waste plastics – products such as wax, oil and styrene monomer. The result is a technology that reduces waste landfilling, waste incineration and waste hauling via a net positive energy process. This project will produce a proven commercial-scale application of the technology.

Consortium Members:
 Pyrowave Inc.
 City of Montreal
 GreenCentre Canada
 Total Petrochemical and Refining

QD Solar Inc.

Environmental Benefits: Climate Change / Clean Air

Total Project Value: \$8,065,050
SDTC Funding: \$2,550,000
Leveraged Funding: \$5,515,050

A large portion of the available energy in sunlight that hits conventional solar panels is wasted because the silicon solar cells utilized in these panels cannot capture the sun's infrared light energy. QD Solar's solar cells use nano-engineered low-cost materials which are able to absorb infrared light. Implementation of QD Solar's technology into solar panels in combination with conventional solar cells boosts the overall power generation by 20 percent. This project will advance the development of QD Solar's solar cells, and develop and scale up the manufacturing processes needed to economically bring this technology to market.

Consortium Members:
 QD Solar Inc.
 Celestica Inc.
 University of Toronto

Quantiam Technologies Inc.

Environmental Benefits: Climate Change / Clean Air

Total Project Value: \$16,230,148
SDTC Funding: \$4,250,000
Leveraged Funding: \$11,980,148

Hydrocarbons must be heated to extremely high temperatures to produce a petrochemical product called olefins, which can be made from shale gas constituents and find their way into everyday use in plastics and other products. But when heated to that degree, hydrocarbons create an unwanted side-product called coke – which plugs up the furnace tubes used in their production, and interferes with the energy efficiency and profitability of the operation. With SDTC support, Quantiam has already commercialized a product that helps a segment of the industry: an anti-coking furnace coating technology. But with shale gas now revolutionizing the global petrochemical sector with high growth in North America, the demand persists for greater performance under even higher temperatures. Quantiam is pursuing another project with SDTC that will see its technology applied to even higher temperatures and operating severities. The end result will be a reduction of overall energy requirements and GHG emissions by as much as 14 percent.

Consortium Members:
 Quantiam Technologies Inc.
 BASF Qtech Inc.
 BASF SE

Quest Rare Minerals Ltd.

Environmental Benefits: Climate Change / Clean Air / Clean Soil

Total Project Value: \$14,953,041
SDTC Funding: \$4,934,504
Leveraged Funding: \$10,018,537

Rare earth minerals are a key component of many clean technologies, including energy efficient electric motors, light-emitting diode (LED) lights and wind turbines. However, current methods used to mine and process rare earth minerals have repercussions on the natural environment. Quest Rare Minerals has developed a sustainable, energy-efficient process to extract rare earths from mined ore and recycled fluorescent light bulbs. The consortium will demonstrate a novel technology that uses chemical reactions to extract rare earth from granitic ore while minimizing the extraction of unwanted elements – all while producing fewer greenhouse gas (GHG) emissions and tailings waste than the current process. The project will scale up the bench scale process to the pilot stage with subsequent commercial production planned at Becancour, Quebec.

Consortium Members:
 Quest Rare Minerals Ltd.
 Helmholtz Institute Freiburg for
 Resource Technology
 RediMet LLC

Questor Technology Inc.

Environmental Benefits: Climate Change / Clean Air

Total Project Value: Industrial plants, including petroleum refineries, natural gas processing plants or chemical plants, burn off flammable waste gases that are produced by everyday operations. Called natural gas flaring, this process burns off approximately 140B m³/y globally – an amount equivalent to Canada’s total gas production. Imagine if that natural gas, now burned into the atmosphere with an environmental impact, was instead harnessed to produce heat and energy. Questor and its consortium are developing HeatQuest, a packaged solution that will achieve a robust conversion of waste heat to combined heat and power (CHP). HeatQuest will capture waste heat from incinerators and other heat sources using high efficiency heat exchangers and thermal conversion devices that convert heat to electricity. The HeatQuest technology applies to many industries such as oil and gas, mining, chemical processes, wastewater treatment, agriculture and landfill management. The HeatQuest is intended to be a cost competitive unit for less than 100 kWe heat sources that increases the conversion efficiency at a forty percent cost reduction over existing alternative technologies.

\$5,576,703

SDTC Funding:

\$1,977,878

Leveraged Funding:

\$3,598,825

Consortium Members:

Questor Technology Inc.
Journey Energy Inc.
University of Toronto
ClearPower Systems Inc.

Ranovus Inc.

Environmental Benefits: Climate Change / Clean Air

Total Project Value: When users post photos or update statuses on major social networks, or when they use the “cloud” to back up their data, it creates digital traffic within data centres around the world. The energy required for data centres is huge – accounting for two percent of the world’s electricity consumption, and 1.5 percent of the global carbon footprint – and it continues to grow at a rapid rate. Today, there are no power-efficient, cost-effective and scalable solutions to support impending future bandwidth requirements. Ranovus brings together technologies, including a state-of-the-art quantum dot laser and silicon photonics, to streamline the way data flows through a data centre. The resulting 100 Gb/s transceiver module can be integrated in a data centre, reducing its cost of doing business eight-fold and its power consumption four-fold.

\$14,503,317

SDTC Funding:

\$4,250,000

Leveraged Funding:

\$10,253,317

Consortium Members:

Ranovus Inc.
National Research Council
Canada

Ronin8 Technologies Ltd.

Environmental Benefits: Climate Change

Total Project Value: Every year, between 20 and 50 million metric tonnes of electronic waste are generated globally. The U.S. alone discards 14 to 20 million personal computers every year with 80 percent of “recycled” e-waste sent to developing countries where the plastic components are burned to extract metals, releasing toxic chemicals into the atmosphere. Ronin8’s proprietary technology recovers high-value metals from e-waste, particularly printed circuit boards (PrCBs), using a combination of electromagnets, water and sonic vibrations. In the process, circuit boards are disassembled and ground. Ronin8’s powerful, low-frequency sonic reactor then separates metals from non-metals in a closed-loop environment. Non-metals are recycled to make environmentally friendly products while valuable metals are recovered and sorted. All of the process materials (water and solvents) are then cycled back and used for the next batch of e-waste. Ronin8’s technology has considerable cost and environmental advantages over the incumbent technology (i.e., smelters) and offers a sustainable, economically viable solution—the recovered highly pure metal streams are expected to generate \$14 of revenue per kilogram of PrCB input—for e-waste management.

\$1,484,313

SDTC Funding:

\$300,000

Leveraged Funding:

\$1,184,313

Consortium Members:

Ronin8 Technologies Ltd.
Provectus Engineered Materials
Sacré-Davey Engineering Inc.

Sherbrooke OEM Ltd.**Environmental Benefits: Climate Change / Clean Soil**

Total Project Value: \$4,025,000	Most of recycled plastics are optically sorted using near-infrared technology to identify plastics by category. However because the color black absorbs lights, black plastics don't respond well to this technology – making these products almost impossible to be identified and sorted. As black plastic makes up 20 percent of total plastic waste streams, a solution must be found to prevent these products from going to the landfill or incineration. Sherbrooke OEM's innovative optical sorting unit will be able to identify and separate different polymers and material without color distinction, applying this process to all plastics including blacks. This project will see the design, construction and demonstration of an industrial scale system.
SDTC Funding: \$1,275,000	
Leveraged Funding: \$2,750,000	

Consortium Members:
Sherbrooke OEM Ltd
Eagle Vizion Inc.
Plastimum s.e.n.c.
Valoris

Sigma Devtech Inc.**Environmental Benefits: Climate Change / Clean Soil**

Total Project Value: \$10,490,130	Biodegradable plastic is often touted as a solution to address the mountains of plastic that end up in landfills – but it is currently produced in small quantities and at a high price. Sigma Devtech intends to overcome these problems using a novel solvent-free proprietary technology that produces a type of bioplastic from pulp mill effluent sludge. The project will be demonstrated at a Resolute Forest Product's pulp mill in Quebec and result in the first-ever factory to produce bioplastic from this type of renewable waste. Environmental considerations include decreased use of fossil derived plastic and an opportunity for the forestry industry to add value to its waste streams.
SDTC Funding: \$3,100,000	
Leveraged Funding: \$7,390,130	

Consortium Members:
Sigma Devtech Inc.
Private Parter

Sigma Energy Storage Inc.**Environmental Benefits: Climate Change / Clean Air**

Total Project Value: \$7,382,023	Renewable power has the potential to reduce the use of diesel, which in turn reduces greenhouse gas emissions, but by nature it is generated in fits and bursts depending on wind, tide, water flow or sunlight. Technologies that enable this intermittent power to be stored and made available when needed allow renewable energy to be better integrated into the conventional grid. Sigma Energy Storage has developed and designed a portable and climate-resistant Compressed Air Energy Storage (CAES) system that integrates a proprietary thermal recovery system to store energy and distribute it easily and efficiently through the use of a specially-formulated thermal fluid that includes nanotechnology. The project follows Sigma's successful production of a small-scale alpha prototype and features the production and use of a full-scale 500 kW / 2 MWh beta prototype, which can ultimately be scaled up or down as needed for various applications.
SDTC Funding: \$2,436,068	
Leveraged Funding: \$4,945,955	

Consortium Members:
Sigma Energy Storage Inc.
BC Hydro
Beacon 406
Canmet Energy
Hatch Ltd.
Hydro-Québec (IREQ)
Hydro-Sherbrooke
TechnoCentre Éolien

Smart Pipe Company Canada Inc.**Environmental Benefits: Climate Change**

Total Project Value: \$7,162,756	Transmission pipelines are the large-diameter, high-volume energy highways that transport oil and natural gas over long distances between refining, processing, storage and distribution facilities. These pipelines are very safe, but when problems start to appear, sections of pipe may need to be replaced to ensure pipeline integrity and prevent failure. The traditional way to do this is simply to dig and replace with new steel pipe – but that is not so simple when it disrupts communities, damages the environment or stops the flow of a major pipeline artery. Smartpipe® is an alternative to traditional pipeline replacement. It is a self-monitoring composite pipe, with on-board fiber optic and communications systems, that can replace a corroded or compromised pipeline from the inside, without the need to excavate the entire pipeline. The Smartpipe® system is manufactured at the project site using a patented portable factory that allows for very long lengths to be simultaneously manufactured and installed, reducing expensive construction costs, downtime and the above-ground disruption that typically accompanies pipeline replacement. The degraded steel pipeline is replaced with a non-corroding composite Smartpipe® that is monitored 24-7 for leaks, ground movement and approaching third-party intrusion, identifying the nature and location of the problem within one meter. Smart Pipe Company Canada currently offers its pipeline system in smaller diameters; this project will apply its technology to the larger-diameter pipelines used by oilsands producers.
SDTC Funding: \$2,363,709	
Leveraged Funding: \$4,799,047	

Consortium Members:
Smart Pipe Company Canada Inc.
Enbridge Gas Distribution Inc.

SWITCH Materials Inc.

Environmental Benefits: Climate Change / Clean Air

Total Project Value: Vehicle manufacturers are eager to produce cars that use energy wisely in a number of ways, from fuel efficiency to battery efficiency and beyond. One way is to reduce heat and glare in vehicle cabins – a move that would then reduce the resulting need for interior cooling. SWITCH Materials will develop and commercialize energy-efficient switchable glazing for car windows: a hybrid photo-electrochromic window technology that automatically darkens when sunlight hits it. The windows can be switched back to the light state by the user to allow more light into the cabin. By blocking heat and light whether the vehicle is in use or parked, SWITCH windows reduce air-conditioning requirements and vehicle cool-down time, saving energy and reducing emissions in traditional vehicles, and improving the driving range of electric vehicles. By developing and demonstrating the technology in partnership with automotive manufacturers and supply chain partners, the project will accelerate deployment of energy-saving smart windows that will help vehicle manufacturers meet tough new fuel efficiency requirements by 2017.

\$10,313,892

SDTC Funding:
\$2,500,000

Leveraged Funding:
\$7,813,892

Consortium Members:
SWITCH Materials Inc.
General Motors Company
BASF New Business GmbH
Guardian Glass Automotive

Syscor Controls & Automation Inc.

Environmental Benefits: / Clean Soil

Total Project Value: Every day, three million barrels of crude oil are transported through Canada's pipelines to domestic and foreign markets. While pipelines are the safest and most environmentally friendly way of transporting oil over long distances, leaks do occur – so high reliability leak detection systems with low false alarm rates can play a vital role in quickly identifying and addressing any such problems. Syscor Controls & Automation is developing a leak detection sensor cable designed to retrofit existing pipelines. Highly sensitive and easy to install, the technology will enable early and accurate detection of leaks, allowing operators to respond quickly.

\$4,878,413

SDTC Funding:
\$1,626,138

Leveraged Funding:
\$3,252,275

Consortium Members:
Syscor Controls & Automation Inc.
Pipeline Research Council International
Enbridge
Colonial Pipeline Company

Teck Resources Limited

Environmental Benefits: Climate Change / Clean Air / Clean Water / Clean Soil

Total Project Value: Smelting of copper concentrates containing arsenic forms potentially hazardous, arsenic containing by-products. Large copper resources containing arsenic risk being under-explored and undeveloped due to safety, environmental, and technical challenges posed by arsenic during the copper recovery process. Further, 10% of all copper concentrates produced in 2014 had >0.2 percent arsenic, which currently are limited in where they can be processed due to import restrictions by various countries and regions. These restrictions are similar to an outright ban on the import of copper concentrates into China with >0.5 percent arsenic, which has the potential to be further reduced as environmental and societal pressures on current resource development practices increase. Teck Resources Limited ("Teck") and Aurubis AG ("Aurubis") are developing a technology that uses a hydrometallurgical process to refine arsenic-bearing copper concentrates, a product of the mining and concentration process, which avoids smelting altogether, and results in no untreated or harmful effluent streams or emissions. This project will complete pilot level testing for refining concentrates containing up to 12 percent arsenic with a reduction of up to 40 percent in energy consumption and 81 percent in fresh water consumption versus smelting. This will help fulfill the world's growing copper consumption needs in an environmentally sound and sustainable manner.

\$8,101,977

SDTC Funding:
\$2,673,652

Leveraged Funding:
\$5,428,325

Consortium Members:
Teck Resources Limited
Aurubis AG

Terramera Inc.

Environmental Benefits: Climate Change / Clean Air / Clean Water / Clean Soil

Total Project Value: \$5,930,386
SDTC Funding: \$1,984,581
Leveraged Funding: \$3,945,805

The use of synthetic pesticides, such as methyl bromide, are being phased out in North America because of their negative environmental impacts. The use of pesticides to control target pest populations on a farm in order to improve the yield of small-fruit crops and ornamentals is necessary to a successful agricultural operation. Without the use of pesticides, insect pests and diseases would attack and compromise a farmer's crop. Terramera is developing a Neem-oil based biopesticide which is expected to fill the gap being created as the currently-used synthetic pesticides are phased-out. Neem oil, derived from South Asia's neem tree, has long been applauded for its natural pest-controlling characteristics. Neem oil alone has a short shelf-life and is unstable. Terramera has developed a formulation incorporating components such as stabilizers and adjuvants that extend its shelf life and enhance the mode of action against target pests. With this project, Terramera will establish the application rates and confirm the efficacy of its biopesticide in field trials.

Consortium Members:
 Terramera Inc.
 Institute for Sustainable Horticulture
 Kwantlen Polytechnic University
 Kalala Organic Estate Winery
 BC Landscape & Nursery Association
 U.S. Department of Agriculture
 Agricultural Research Service
 Plant Sciences Inc.
 Evonik Goldschmidt Corporation
 Flowers Canada Growers

Terrestrial Energy Inc.

Environmental Benefits: Climate Change / Clean Air

Total Project Value: \$17,223,223
SDTC Funding: \$5,739,167
Leveraged Funding: \$11,484,056

The emerging energy priority, in Canada and globally, is for the development of clean, dependable and economic energy sources that replace fossil fuel combustion in industrial heat and electrical power provision, both on- and off-grid. Terrestrial Energy Inc. is developing a new form of nuclear energy to address this priority – the Integral Molten Salt Reactor (IMSR). The IMSR is an advanced nuclear reactor that uses a liquid fuel – nuclear fuel dissolved in molten salt. This liquid nuclear fuel method is entirely different from that used in conventional nuclear reactors, which all use the traditional solid fuel approach. With a liquid nuclear fuel, IMSR achieves high passive safety (for example, it cannot melt down); it is more fuel efficient, more waste efficient and could in the future consume virtually all of its own long-lived waste as well as that of other reactors. Importantly, it is cost-competitive with fossil-fueled power plants. Furthermore, the IMSR has a much broader set of industrial applications due to its high operating temperatures and small modular format. It can service remote off-grid communities as well as large-scale power grids. It can provide heat to industry – desalination plants, for example, or to chemical plants, for the production of hydrogen or fertilizers. This SDTC-supported project will consist of two phases: the construction of an operational, non-nuclear, IMSR core-unit system, and the continuation of laboratory studies to inform reactor component and material selection for the subsequent fully nuclear demonstration plant. Construction of the nuclear operation will incorporate the data and experience derived from this SDTC project.

Consortium Members:
 2 Private Partners

Thetis Environmental Inc.

Environmental Benefits: Climate Change / Clean Air / Clean Water

Total Project Value: \$2,976,043
SDTC Funding: \$1,100,000
Leveraged Funding: \$1,876,043

Water used in many industries can be filtered and re-used – provided that the filtering technology can efficiently operate at high temperatures and produce a clean stream. Polymeric membranes have been proven very reliable for many years, but their inability to handle high temperatures prevented their adoption in demanding applications. Thetis Environmental is developing a new line of highly efficient membrane filtration systems operating at ambient and high temperatures. This new technology is capable of removing soluble oils and smaller impurities compared to incumbent technologies while maintaining a high productivity during continuous service. This project will first see the construction of a pilot plant to produce the membranes followed by the demonstration of those membranes under three different applications (industrial waste water de-oiling, high temperature liquid/solids separation like thermophilic anaerobic processes and oil-and-gas produced water).

Consortium Members:
 Thetis Environmental Technologies
 CUT Membranes
 Aslan
 Kemira Chemicals
 The Stover Group

West Fraser Mills Ltd.

Environmental Benefits: Climate Change / Clean Air

Total Project Value:
\$18,581,707

SDTC Funding:
\$6,100,000

Leveraged Funding:
\$12,481,707

Lignin is the natural glue that holds wood together – necessary for a growing tree, but a waste product for a kraft pulp mill. If processed properly however, lignin can displace petroleum-derived resins used in a variety of applications, specifically in the manufacture of plywood. West Fraser Mills will use FPIinnovations' patented LignoForce™ process to recover lignin from black liquor, the solution containing dissolved lignin, hemicelluloses and chemicals following the pulping process. With performance equal to conventional petroleum-based resin, the use of lignin will result in substantially reduced production costs, as well as reduced greenhouse gas emissions. This project will see the construction of Canada's first LignoForce™ commercial demonstration lignin recovery plant, and the consortium will work to identify new applications for lignin and ultimately grow the market.

Consortium Members:

West Fraser Mills Ltd.
Hinton Pulp –
West Fraser Mills Ltd.
FPIinnovations

Section 4: SD Tech Fund™ – Projects Completed or Reporting Market Impacts in 2015

This section provides a summary of projects completed, or reporting on Market Impacts, in 2015.

For each completed project, the project results have been highlighted and an evaluation of the Project Impact has been included within this section. Post-project reporting continues past project completion so as to understand the evolution of the technologies and the Market Impact of each funded project. Such Market Impacts are reported two years after project completion and the relevant project updates are included in this report.

It is important to recognize that SDTC funding is focused on the development and demonstration of new technologies. In so doing, projects progress from early development along the innovation chain towards commercialization. This staged approach to innovation results in some successful projects requiring further development and/or demonstration before reaching commercialization. Understanding that the purpose of the fund is to assist with de-risking of technology, it is to be expected that a number of projects may not succeed either from a technological or economical perspective.

Reports are accurate as of the date of presentation of the report regarding impact on the market.

A full listing of all completed projects can be found in the Results section of SDTC's website under Projects.

Développement Effenco Inc.

Round 11-2007A

Sector:

Transportation

Project Completion Date:

March 2013

Market Impact Report Due:

March 2015

Total Project Value:

\$3,801,799

SDTC Funding:

\$1,074,955

Leveraged Funding:

\$2,726,844

Consortium Members:

Développement Effenco Inc.

Gadreau Environnement

Waste Management Québec

Agence de l'efficacité énergétique
du Québec

Veolia Environmental Services

Environmental Benefits:

(primary benefit bolded)

Climate Change

Clean Air

Project Title:

Hybrid Refuse Truck

Project Description:

Développement Effenco Inc. (Effenco) and its partners completed the development and demonstration of a hybrid hydraulic regenerative braking system for refuse trucks, the Torque-Assist Hybrid System. Using a hydraulic pump, the system regenerates kinetic energy while the truck is braking. This energy is stored in a hydraulic accumulator to be reused later in the hydraulic operations of the vehicle. The project's main objective was to reduce refuse truck fuel consumption by 15% as compared to the incumbent system. These savings were to be demonstrated by collecting fuel use data from different refuse trucks operating on waste collection routes.

Objectives:

Design, manufacture, and test the hybrid refuse truck system with a goal of 15% reduction in fuel consumption.

- Demonstrate that the technology is practical, viable, and reliable in normal operating conditions. Reach 90% hybrid system availability and 95% truck availability (downtime of 5% or less due to maintenance issues).
- Prepare for the commercialization of the technology by building confidence among fleet operators in the hybrid system's performance and reliability

Results:

- Effenco's Torque-Assist Hybrid System was successfully designed, manufactured, and installed on ten different refuse trucks during the demonstration period to monitor fuel savings. The average fuel savings for trucks equipped with Effenco's Torque-Assist technology was 7.7%.
- The truck availability target was easily met with a value of 98%; however, the hybrid system itself did not meet the target availability of 90%. Average system availability during the demonstration trials was 78%.
- Effenco's fleet operator partners were satisfied with the technology and continued to support the hybrid system technology throughout the demonstration project.

Project Impacts:

- The demonstration of Effenco's technology resulted in GHG emission reductions of 56 t CO₂e over the demonstration period, 2010-2012. The demonstration also resulted in small CAC emission reductions.
- Use of Effenco's technology can be expected to result in GHG emissions reductions of approximately 7 t CO₂e /yr in a diesel refuse truck and 5 t CO₂e in a compressed natural gas refuse truck.
- If Effenco's technology is rolled-out, it could be expected to result in cumulative GHG emission reductions of approximately 120 kt CO₂e in Canada and 240 kt CO₂e in the rest of the world from 2014-2026.
- A roll-out could also be expected to result in reductions of CAC emissions in Canada of approximately 90 t SOX, 280 t NOX, 60 t PM, 160 t CO, and 40 t VOCs. CAC reductions in the rest of the world would be approximately double these values.

Path to Market:

- While Effenco was pleased with the results of this demonstration project, and based on the innovation developed during the project Effenco has turned its attention to commercializing the Stop-Start technology aspect.

Market Impact:

- While Effenco will not commercialize the subject of this project, the Torque-Assist technology, this project was critical in forming the platform for Effenco's second project, the Stop-Start technology which was completed in October 2015. All further results will be reported against Effenco's second project.

MSR Innovations Inc.**Round 11-2007A****Sector:****Power Generation****Project Completion Date:****March 2013****Market Impact Report Due:****March 2015****Total Project Value:****\$1,473,397****SDTC Funding:****\$680,839****Leveraged Funding:****\$792,558****Consortium Members:**

MSR Innovations Inc.

Century Group Lands Corp.

Environmental Benefits*(primary benefit bolded)***Climate Change**

Clean Air

Project Title:

SolTrak™ Demonstration

Project Description:

Improving systems installation of building integrated photovoltaic (BIPV) is a key priority for the solar industry. MSR Innovations and its consortium members have developed and demonstrated a unique solar roofing system, SolTrak™, which dramatically improves the installation of solar PV systems. SolTrak's extensive design and manufacturing flexibility produces a sustainable product that will reduce the costs of solar power systems, enabling mainstream market entry. The production of renewable electricity by the SolTrak™ system is expected to result in a reduction of greenhouse gas (GHG) emissions in comparison with traditional power generation.

Objectives:

- Develop a modular building-integrated photovoltaic (BIPV) roof tile system consisting of polymer roofing tiles containing seamlessly integrated photovoltaic (PV) panels for electricity generation that can be mounted with an easy to install track system.
- Manufacture, install, and test a 120 W standalone SolTrak™ system providing lighting to a carport.
- Construct and operate a pilot scale assembly plant in Richmond, BC to provide data and analysis on manufacturing processes and to produce a 2.5 kW SolTrak™ system.
- Demonstrate a large scale SolTrak™ system (20 kW) in Langley, BC at the Congregate Home Centre developed by Century Group.

Results:

- The BIPV roof tile system, including active generating tiles and non-active spacer tiles, was successfully developed and tested at three different installations.
- A 120 W standalone SolTrak™ system was installed and tested, meeting technical requirements.
- A pilot scale assembly plant was constructed and operated on a carport, producing a 2.5 kW SolTrak™ system.
 - The system produced 8,500 kWh of electricity over the period from March 2009 to March 2013, with a normalized recorded peak of 2.48 kW.
- A 20 kW SolTrak™ system was installed on a Licensed Care and Seniors Congregate residence in Langley, BC.
 - The system produced 3,900 kWh of electricity over the period from January to March 2013, with a normalized recorded peak of 19.4 kW. The Levelized Cost of Energy (LCOE) for the solar tiles, including roof costs is ~\$0.21/kWh over the expected life of the roof (25 years) based on Vancouver, B.C.'s weather profile.

Project Impacts:

- The 2.5 kW and 20 kW demonstrations resulted in GHG emission reductions of 256 kg CO₂e and 41 kg CO₂e, respectively.
- The 2.5 kW installation generated sufficient electricity to assist in off-setting a significant portion of the daily electrical load of the neighbouring home (and, at times, to the surrounding homes within the neighbourhood), while the 20 kW installation provided enough electricity to cover the entire building's lighting despite being installed on only a wing (approx. 10% of the building) of the seniors structure.

Path to Market:

- MSR will initially focus on selling SolTrak™ systems to new homes being built in subdivisions by leveraging its relationships with homebuilders. The initial markets targeted will be in Ontario and California.

Market Impact:

- While MSR has endeavoured to implement the path to market noted above, the company to-date has not been able to raise sufficient funding to move these plans forward. MSR have pursued numerous opportunities, but have yet to close deals on investments and/or further projects. MSR continues to work towards raising sufficient funds and securing the necessary partnerships to successfully commercialize the SOLTRAK™ product.

EcoSynthetix Corporation

Round 13-2008A

Sector:

Forestry, Wood Products and Pulp & Paper Products

Project Completion Date

March 2013

Market Impact Report Due:

March 2015

Total Project Value:

\$5,088,882

SDTC Funding:

\$1,679,331

Leveraged Funding:

\$3,409,551

Consortium Members:

EcoSynthetix Corp.

Cascades Canada Inc.

Environmental Benefits

(primary benefit bolded)

Climate Change

Clean Air

Project Title:

EcoSphere® Biolatex™ Production and Application

Project Description:

EcoSynthetix Corp. has developed a new family of bio-based latex products, EcoSphere biolatex binders, to be used in paper and paperboard manufacturing. This plant-based substitute for traditional fossil fuel based latex achieves higher solids content and greater stiffness, reducing the energy requirements at the mill and reducing greenhouse gas emissions throughout the process. This project produced a bio-based latex product and demonstrated the commercial viability of EcoSphere biolatex binders for paperboard production. EcoSphere biolatex binders use natural polysaccharide-based feedstocks derived from corn, potatoes and rice to create a product that does not exhibit the usual flaws of traditional starch latexes, such as shrinkage. Through a unique and proprietary process, EcoSynthetix removes all of the native crystallinity and granular structure of its feedstock materials to create novel crosslinked biopolymer agglomerates in the 300 microns range which can be further reduced to the 100 nanometer particle size range in the biolatex polymer form. The resulting EcoSphere biolatex nanoparticles have comparable properties and performance as synthetic latex used as a binder in paperboard manufacturing, such as styrene butadiene latex (SB-latex), thereby making it a technically- and commercially-viable substitute.

Objectives:

- The production of a new grade of biolatex polymers suitable for paperboard applications at the new biolatex pilot plant. Biolatex pilot plant optimized processing conditions including processing of 25,000 pounds of raw materials and transforming them into new EcoSphere biolatex products.
- Testing at Cascades and a final evaluation on quality to ensure it meets commercial grade standards.

Results:

- A biolatex technology pilot plant was established in Burlington, Ontario where 25,000 pounds of raw materials were processed into novel EcoSphere biolatex paperboard grades (EcoSphere® 92227). Quality assurance was tested. Materials were used in pilot scale trials, which were conducted at Centre International de Couchage, Inc. (CIC) to test the product on pilot coater and at Cascades to test paperboard quality.
- Final evaluation on quality was completed on industrial scale and validated that EcoSphere® met commercial grade standards.

Project Impacts:

- The project resulted in GHG emission reductions (estimated 4.57 t CO₂e /t of EcoSphere). Following the completion of the project, the objectives are to roll out the use of the application over 12 years, resulting in the following anticipated reduction of GHG in the period 2012-2024: 572 kt CO₂e in Canada and 2.49 Mt CO₂e in the rest of the world.

Path to Market:

- Potential future application for EcoSphere biolatex polymers include paints and coatings, adhesives, carpets and other markets. To date, the Company has commercialized the technology with greater than 30 mills, including the largest paper producer in North America and large producers in Japan, Canada and Germany. Based on these initial early adopter customers, the Company has produced and sold in excess of 150 million lbs of EcoSphere products since the onset of commercialization.
- Additional mill trials are also in progress with some of the largest producers globally and the Company has trials underway several of the top 20 coated paper and paperboard producers globally.

Market Impact:

- In 2008, EcoSynthetix received its first commercial order for EcoSphere biolatex polymers from one of the largest South American paper producers. Sales in 2014 were USD \$18.8M with 15+ customers. These early adopter customers ordered approximately 25M lbs in 2014 and will provide both a predictable revenue stream and commercial references for significantly higher sales in the future. As of December 2015, the Company has now produced and sold in excess of 150M lbs of biolatex polymer products for the paper industry as adoption continues to take hold.

Great Northern Power Corporation..

Round 5-2004A

Sector:

Power Generation

Project Completion Date:

June 2013

Market Impact Report Due:

June 2015

Total Project Value:

\$2,680,850

SDTC Funding:

\$551,462

Leveraged Funding:

\$2,129,388

Consortium Members:

Great Northern Power Corp.

AltaGas Operating Partnership

Environmental Benefits:

(primary benefit bolded)

Climate Change

Clean Air

Project Title:

Power Generation Utilizing Great Northern Power's Organic Rankine Cycle Technology for Recovering Waste Heat from Reciprocating Engines in Alberta, Canada

Project Description:

Great Northern Power (GNP) developed the EXPANDER – a proprietary 175 kW waste heat recovery system, which uses an Organic Rankine Cycle (ORC) to generate power from waste heat. It has been conceived as a “plug-and-play” pre-engineered and packaged system to match the thermal reject heat from large reciprocating engines (1000 HP and larger). The objective of this project was to reliably recover waste heat from a variety of 1000 HP and larger engines in order to generate electricity that could offset on-site electricity generation or be sent to the grid, thereby reducing GHG and CAC emissions.

Objectives:

- Detailed engineering, fabrication, installation, commissioning and testing of the EXPANDER.
- Demonstrate that the EXPANDER is able to meet the technical objectives including a temperature adjusted power output and an on-stream operational uptime of 90%.
- Test the EXPANDER units on reciprocating engines of varying specifications and manufacturers representative of the range of 1000+HP engines.
- Evaluate the long-term performance of the EXPANDER system, confirming efficiency, up-time, maintenance requirements and costs.

Results:

- The EXPANDER system was successfully built, installed and tested on a compressor at Enerflex. The performance of the system, validated by an independent third party, demonstrated that it could produce 108 kW at design operating conditions.
- Delays in project meant that long-term performance testing of the EXPANDER system was not completed. Post the SDTC project, the goal is to complete commissioning.

Project Impacts:

- If the EXPANDER system is installed on a 1200 HP reciprocating engine in Alberta, with electricity generated used to power engine cooling fans and offset grid electricity, this would result in GHG emissions reductions of approximately 680 t CO₂e/system/year.
- CAC emission reductions per system per year would be approximately 1 t NO_x and SO_x, 0.4 t CO, with smaller reductions of TPM, VOCs, and Hg.

Path to Market:

- GNP is in the process of demonstrating their EXPANDER on one reciprocating engine.

Market Impact:

- GNP has filed four patent applications since 2007.
- One of those patent applications may provide GNP with exclusivity on waste heat recovery from natural gas compressors.
- This North American natural gas compressor market is approximately 60,000 compressors.

General Electric Canada

Round 11-2007A

Sector:

Transportation

Project Completion Date:

June 2013

Market Impact Report Due:

June 2015

Total Project Value:

\$11,721,903

SDTC Funding:

\$3,903,394

Leveraged Funding:

\$7,818,509

Consortium Members:

GE Canada

Canadian National Railway Company
Corporation

Environmental Benefits

(primary benefit bolded)

Clean Air

Climate Change

Project Title:

Clean Diesel Locomotive Program

Project Description:

GE Canada and its consortium member have developed and tested an exhaust after treatment system (ATS) for their Evolution locomotive developed in 2005. This project involved the development and implementation of 2 ATS prototypes that would improve air quality by significantly reducing criteria air contaminants (CAC) to surpass current regulations set by the U.S. Environmental Protection Agency (EPA) Tier 3 emission standards.

ATS 1 technology consisted of a urea-SCR catalyst to reduce levels of oxides of nitrogen (NO_x), a Diesel Oxidation Catalyst (DOC), and a diesel particulate Flow Through Filter (FTF), and an Ammonia Slip Catalyst (ASC) integrated into the locomotive to reduce various CACs. In particular, the integrated ATS system would significantly reduce the levels of NO_x, particulate matter (PM), hydrocarbons (HC) and carbon monoxide (CO), all of which the railway industry significantly contribute at present.

The second system, ATS 2 was developed without the Selective Catalytic Reduction (SCR) system for use on locomotives which achieve Tier 4 NO_x levels in the engine. The ATS 2 reduces particulate matter. A manual hydrocarbon (diesel fuel) injection system is also part of the ATS 2 system.

Objectives:

- Design of the ATS 1 to meet functional and design specifications. This included small scale testing of catalyst and substrate samples on a slipstream rig in Erie, PA. Data from this testing was used for ATS test prototypes.
- Field testing of the ATS 1 prototype on a GE Evolution Series Tier 2 locomotive provided by CN Rail, followed by a tear down and analysis of the unit.
- Development of ATS 2 based on the analysis and results from field tests to meet the PM reduction goals. Conduct a three month locomotive field test of the ATS 2 on the same CN Tier 2 locomotive, with stationary testing before and after the field testing to measure engine performance and emission data
- Meet environmental standards by achieving 65% reduction in NO_x compared to the current "Tier 2" limits with the ATS 1; and an 85% reduction in PM, HC and CO compared to the current "Tier 2" limits with the ATS 1 and ATS 2 systems

Results:

- Successful completion of ATS 1 design using a urea-SCR system
- Field testing of the ATS 1 demonstrated functional and design suitability when integrated with GE Evolution Series Tier 2 locomotive
- Based on the ATS 1 results and advancements in technology, ATS 2 consisted of a Diesel Oxidation Catalyst (DOC) and Flow through Filter (FTF) system design to be used as a retrofit kit for both "Tier 2" and "Tier 3" engines
- The project resulted in CAC emission reductions primarily from the application of the ATS design on a GE Evolution diesel locomotive. There was approximately an 85% reduction in PM₁₀, HC and CO compared to the same locomotive without the ATS 2 system. NO_x emissions were not reduced with the ATS 2 system

Project Impacts:

- GE Canada will provide a competitive retrofit solution for PM reductions to complement their line of locomotives thereby reaching regulated North American emission standards.
- The results of the project have validated the environmental benefits of the ATS technology integrated with a GE Evolution diesel locomotives

Path to Market:

- Due to prevailing technology development shift to the use of natural gas (NG) as locomotive fuel, the diesel locomotive ATS will be redeveloped to become an integral part of the new NG locomotive system. By switching to NG the rail industry will be able to reduce its fuel cost and lower the emissions in key categories. The NG locomotive technology is still in the developmental phase and the ATS will continue to be a necessary part of the new technology.
- NG is a clean fuel, ATS as part of the NG locomotive system will provide an attractive means for meeting regulatory emission standards, including retrofit kits for existing engines. GE is currently developing the NG locomotive technology with the ATS application. Adopting this technology by the rail industry will heavily depend on the logistics solutions for the supply of liquefied natural gas (LNG) as a fuel, the infrastructure of refueling LNG, and safe deployment of LNG fleet.

Market Impact:

- GE has two (2) prototype LNG Locomotives in field service.
- GE has sold twenty-four (24) locomotive LNG upgrades to one customer and is working on a locomotive design to support this order which is proceeding well. This order will be completed and shipped in 2017.
- GE is actively pursuing leads with Class 1 customers and the response has been positive. All future sales will be dependent on the economic value derived from operating LNG.

SunCentral Inc.

Round 13-2008A

Sector:

Energy Utilization

Project Completion Date:

June 2013

Market Impact Report Due:

June 2015

Total Project Value:

\$7,748,443

SDTC Funding:

\$2,345,208

Leveraged Funding:

\$5,403,234

Consortium Members:

SunCentral Inc.

University of British Columbia

British Columbia Institute of Technology

BC Hydro

Natural Resources Canada

3M Canada Company

Ledalite Architectural Products Inc.

Busby Perkins and Will, Architects Co.

Morrison Hershfield

York Communications Inc.

Environmental Benefits

(primary benefit bolded)

Climate Change

Clean Air

Project Title:

Solar Canopy Illumination System Demonstration Project

Project Description:

The Core Sunlight System, now called "SunCentral System," consists of external sunlight collectors (solar canopies) and internal light guides integrated with standard dimmable light fixtures. When sunlight is available, the electrical lighting is dimmed, conserving energy. During this project, the feasibility and cost-effectiveness of the system were explored through seven demonstration installations.

Objectives:

- Enable a viable industry for cost effective core daylighting within the project timeframe by demonstrating the potential for reasonable payback time on direct energy savings.
- Reduce GHG emissions and energy use in office buildings by implementing core daylighting systems, saving a minimum of 3 hours of electric light use per day, 250 days per year (about 20%).
- Develop capabilities to manufacture canopies in low volume, using processes that could readily scale to larger volumes, with an ultimate cost as low as \$1,000 per panel module.
- Refine the manufacturing and assembly processes to optimize the design for volume fabrication, and advance the integration of sunlight, control and luminaire design in order to reduce the electrical energy required to illuminate buildings by more than 36%.

Results:

- By implementing the SunCentral System and taking into account the cost savings of replacing electrical lighting with sun lighting and the HVAC savings associated with sun lighting, the payback period is 8-10 years.
- Measured savings at one SunCentral System indicated a conservative electrical lighting savings value of 24%, which leads to a corresponding reduction in GHG emissions from electrical generation. Lighting accounts for a significant amount of the electricity use in office buildings, hence the overall building emission savings will be significant.
- SunCentral believes with higher volume manufacturing and a lower cost supply chain they can achieve \$1000 per module in several years.

Project Impacts:

- At the BCIT site, the SunCentral System demonstrated an average daily savings of 36%. Subsequent installation sites deployed SunLuminaires with LEDs as the electric light source. The integration of LEDs allowed the electric light system to be fully switched off during sunny periods resulting in energy savings of more than 37%.
- Annual per module GHG emission reductions of 7 kg CO₂e for Canada and 57 kg CO₂e for the rest of the world are expected.

Path to Market:

- SunCentral will employ a highly leveraged channel partner sales model. They are offering their products to major building curtain wall manufacturers for integration with Unitized Curtain Wall Systems (the "skin" for high-rise towers). SunCentral will also partner with well-established lighting companies to market and integrate their product lines as a value added subsystem. SunCentral has secured contracts for sales channel partnerships with nine US territories and the Philippines and are in discussions for 14 more US territories and Canada.
- Market roll-out is anticipated to begin in 2014. The cumulative GHG savings, by 2030, is expected to be 4.8 kt CO₂e in Canada and 377 kt CO₂e in the rest of the world.

Market Impact:

- Since launching commercially at completion of the project, SunCentral has achieved over \$2.5M in bookings and is on track to achieve over \$2.3M in revenue in 2015 servicing established customers and developing and closing on various sales prospects.
- SunCentral currently has over \$30M in pending quotes and distribution agreements.

Woodland Biofuels Inc.

Round 17-2010A

Sector:

Forestry, Wood Products and Pulp & Paper Products

Project Completion Date:

August 2013

Market Impact Report Due:

August 2015

Total Project Value:

\$12,900,000

SDTC Funding:

\$4,275,000

Leveraged Funding:

\$8,625,000

Consortium Members:

Woodland Biofuels Inc. Bioindustrial Innovation Centre

Environmental Benefits

(primary benefit bolded)

Climate Change

Clean Water

Clean Soil

Project Title:

Biomass to Cellulosic Ethanol Demonstration Plant

Project Description:

Woodland Biofuels has developed a Catalyzed Pressure Reduction (CPR™) technology to convert waste biomass feedstocks into cellulosic ethanol. The CPR™ process involves five key steps including steam gasification of dry (5-15% (wt/wt) moisture) biomass (to produce syngas), syngas cleanup and conditioning, conversion of syngas to methanol, carbonylation of methanol (to produce methyl acetate), and hydrogenation of methyl acetate (to produce fuel grade ethanol). The greenhouse gas (GHG) emission reduction benefits of the technology, compared to fermentation based ethanol production, are realized through the use of the syngas in place of natural gas for process heating.

Objectives:

- Design, build and test a demonstration-scale plant capable of producing ethanol at a rate of 28 L/h
- Validate design parameters.
- Demonstrate the efficient, low cost conversion of biomass to cellulosic ethanol using an innovative catalytic process expected to produce 600,000 L/y of ethanol.
- Integrate process controls for efficient plant control and operation.
- Evaluate plant operating parameters and test innovations and modifications to the process.
- Validate the value proposition and market requirements of operating a biomass-to-ethanol facility using locally supplied feedstock materials.

Results:

- Woodland designed, installed and commissioned their pilot scale demonstration plant.
- Woodland has successfully converted biomass to ethanol at a rate of approximately 5 L/h and is making incremental progress as it continues to develop the technology beyond the SDTC project timeline to meet its target objective of 28 L/h.
- The gasifier, the methanol reactor, the methyl acetate reactor and the ethanol reactor were commissioned as an integrated process.
- Evaluation of plant operation and plant parameters is ongoing as Woodland was not able to complete the full commissioning test plan. As of October 2013, the plant run time was approximately 25 hours of continuous operation and 100 hours of cumulative operation.
- Woodland has researched the market requirements of operating a biomass-to-ethanol facility in southern Ontario, where it expects to build its first commercial 80 ML/y plant.

Project Impacts:

- GHG and air emission reductions (for the roll out) result from the use of syngas (generated during the gasification stage) in place of natural gas for process heating.
- GHG emissions reductions associated with the initial and subsequent plants were estimated to be 0.41 kg CO₂e/L ethanol.
- Total emissions associated with the pilot plant (operating from 2013 to 2015) were estimated to be 7,806 t CO₂e, 16.2 t NO₂, 105.4 t SO₂, 4.9 t CO, 0.44 t PM, and 0.32 t VOC.

Path to Market:

- The Woodland pilot plant will continue to refine operating processes throughout 2014 - 2015, and once continuous operation has been demonstrated, ethanol plants based on the CPR™ process will be rolled out in two phases: one initial facility, to be constructed in 2016 will produce ~80 ML ethanol/y and the first subsequent facility, to be constructed in 2018, will produce ~190 ML ethanol/y.

Market Impact:

- In 2015 Woodland continued to operate the demonstration plant for extended endurance runs and utilized different types of feedstock. The data generated via these runs will be fed into the final engineering of Woodland's first commercial ethanol project.
- To date, no product sales have been achieved as the demonstration plant does not produce saleable ethanol.
- Woodland plans to construct an 80 ML ethanol/y plant once financing can be arranged.

AUG Signals Ltd.

Round 13-2008A

Sector:

Energy Utilization

Project Completion Date

August 2013

Market Impact Report Due:

August 2015

Total Project Value:

\$5,889,341

SDTC Funding:

\$2,019,455

Leveraged Funding:

\$3,869,886

Consortium Members

AUG Signals Ltd.

EPCOR Water Services

National Water Research Institute

University of Toronto

FuseForward International Inc.

University of Calgary

Communications Research Centre

Canada

Environmental Benefits

(primary benefit bolded)

Clean Water

Climate Change

Clean Air

Project Title:

Airborne Underwater Geophysical (A.U.G) Signals' Intelligent Drinking Water Monitoring System (IDWMS)

Project Description:

AUG has developed an Intelligent Drinking Water Monitoring System (IDWMS) and has tested and demonstrated the technology at EPCOR's Edmonton Waterworks Rosedale Treatment Facility and South Service Center throughout the time period of 2009-2013. The IDWMS monitors municipal drinking water quality and provides an additional layer of protection to support water treatment systems' efforts to keep drinking water safe. The IDWMS is a multi-sensor fusion engine that combines different information domains through multiple off-the-shelf sensor array sites and innovative online spectrophotometer sensor. IDWMS units are located strategically throughout municipal water distribution system(s) providing syndromic surveillance, waterborne event detection and identification, and contaminant concentration estimation. The system also has the capacity to detect pipe leaks along the distribution system. Electricity is the only form of energy consumed by the IDWMS during unit operation. The IDWMS reduces greenhouse (GHG) emissions, water leakage, waterborne contaminants (nitrite, nitrate, copper, iron, and acrylamide), and some criteria air contaminants.

Objectives:

- Demonstrate and validate the single IDWMS unit's performance (such as detection accuracy and false alarm rate) at two testing sites at the City of Edmonton's water distribution network.
- Further enhance system's monitoring capability (more contaminants) to meet specific user requirements.
- Integrate the IDWMS into Edmonton's existing water monitoring infrastructure; and complete other necessary pre-commercialization activities to ensure successful market launch.

Results:

- The project demonstrated the use of two IDWMS units at EPCOR's Edmonton Waterworks Rosedale Treatment Facility and South Service Center and validated the technology's high detection accuracy of 96.5% with a negligible low false alarm rate throughout three (3) years of site testing.
- In cooperation with EPCOR, AUG Signals validated the use of IDWMS units integrated with EPCOR's Edmonton Waterworks System, which have the ability to monitor contaminants that were of key interest to target municipal customers (i.e., London, ON, and Tianjin, China, Keewaytinook Okimakanak (Deer Lake) and First Nation, ON). This included responses to contaminants as well as contamination source tracing and flow prediction and the interaction of sensor and non-sensor data.

Project Impacts:

- On average 20% of all municipal drinking water is lost due to pipe leaks. The amount of water to be saved will result in reduced electricity energy consumption. GHGs are produced by electricity generation using fossil fuel combustion. The project impacts per IDWMS unit installed per year is 23.9 t CO₂e along with a 70% reduction in water leakage (21.9 ML). Over the 12-year forecast, the AUG Signals' technology is expected to result in a reduction of 55 kt CO₂e and 505,114 ML reduction in water leakage.

Path to Market:

- The three main target customers for the technology are municipal utilities, public corporations, and public private partnerships (P3s, usually companies contracted to design, build, operate or manage components of a public water supply system) in North America and China. Following certification for use as a screening tool by regulatory agencies in Canada, the USA, and China, the IDWMS Technology will be marketed under the product name "Triton Intelligent Water Surveillance™". Market entry is scheduled for Q1 2014.

Market Impact:

- AUG have sold IDWMS units to First Nations communities in Ontario and also in Lanzhou, China. 60 more units are expected to be purchased over the next two years.
- TRITON has also been successfully operating at a number of facilities in Tianjin, China since 2014.
- TRITON was chosen to monitor the water at APEC 2014, providing an extra layer of protection for a number of events attended by leaders from around the world.
- AUG is working with its partner in Greece to secure the sale of 10 or more units in the next two years.

Titanium Corporation Inc.

Round 14-2008B

Sector:

Energy Exploration and Production

Project Completion Date:

October 2013

Market Impact Report Due:

October 2015

Total Project Value:

\$21,642,789

SDTC Funding:

\$6,292,635

Leveraged Funding:

\$15,350,154

Consortium Members:

Titanium Corporation Inc.

Province of Alberta & Department of Energy

Syncrude Canada Ltd.

Sojitz Corp.

Canadian Natural Resources Ltd.

Suncor Energy Inc.

Environmental Benefits

(primary benefit bolded)

Clean Water

Clean Soil

Climate Change

Project Title:

Creating Value from Waste and Reducing Emissions by the Recovery of Valuable Products from Oil Sand Tailings

Project Description:

The Canadian oil sands mining industry is heavily reliant on water. Titanium Corporation has developed a process that adapts technologies from bitumen and mineral extraction and reduces the use of fresh water, increases water recycling and recovers valuable products from oil sand tailings. The process uses cyclone separation, solvent washing, flotation, boiling point differences and flocculation to separate valuable products, prepare water for recycling and prepare residual tailings for disposal. The process is expected to reduce the amount of fresh water used by oil sands mining operations by over 10% and reduce the volume of water going to tailings ponds.

Objectives:

- Construct a Creating Value from Waste (CVW) process pilot plant to demonstrate the continuous operation of the process
- Reduce hydrocarbon levels on produced heavy minerals to less than 1% weight
- Produce a zircon concentrate with approximately 30% zircon content
- Achieve a bitumen recovery of greater than 50% and solvent recovery of greater than 80%

Results:

- The CVW Process was successfully constructed and demonstrated at CanmetENERGY in Devon, Alberta
- Hydrocarbon levels on produced heavy minerals were reduced to less than 0.5% weight
- Premium grade zircon was produced in concentrates with 65%+ zircon dioxide content
- Typical bitumen recovery values ranged from 80% to 90%. Solvent recovery exceeded expectations with 93% to 95% reporting to product

Project Impacts:

- The demonstration of Titanium Corporation's process was for testing purposes and not intended to produce saleable bitumen or minerals. When fully integrated into a commercial oil sands operation, Titanium's technology will deliver a net reduction of 5% GHG emissions and over a 70% reduction in VOC emissions.
- The CVW process is expected to result in soil benefits by reducing solids, heavy metals, and hydrocarbons sent to tailings ponds; however, these benefits have not been assessed quantitatively.
- The roll-out of the CVW process from 2014–2023 is expected to result in cumulative GHG emissions reductions of 8.9 Mt CO₂e from bitumen recovery and 1.2 Mt CO₂e from minerals recovery, for a total of 10.1 Mt CO₂e and CAC emissions reductions of approximately 28 kt NO_x and 495 kt VOCs.

Path to Market:

- Titanium Corporation's mission is to develop and build a commercial process to recover heavy minerals (primarily zircon) and bitumen solvents and water from oil sands tailings. The recovered commodities will provide a source of additional revenue and environmental benefits for the oil sands industry.
- Titanium's CVW™ process is ready for commercial implementation and the Company is working with oil sands operators to determine the appropriate business arrangements to sanction a first project.

Market Impact:

- Titanium Corporation is working with oil sands operators who are most interested in early adoption of new technologies.
- The Company is progressing through due diligence processes involving reviews with technology specialists, project engineering, economic, and site operational departments of these large organizations.
- Implementing Titanium's technology will see concentrator facilities built at oil sands sites which integrate with existing oil sands operations. Distinct minerals separation facilities would process HMC (Heavy Mineral Concentrate) into final minerals products. The facilities may be jointly owned and operated along with oil sands firms or strategic partners. The Company has advanced flexible business models whereby customers may elect to license technology and build certain of the facilities or elect to have the Company, together with partners build and operate.

Inventys Thermal Technologies Inc.

Round 16-2009B

Sector:

Energy Exploration and Production

Project Completion Date:

November 2013

Market Impact Report Due:

November 2015

Total Project Value:

\$3,914,947

SDTC Funding:

\$1,598,001

Leveraged Funding:

\$2,316,946

Consortium Members:

Inventys Thermal Technologies Inc.

Husky Oil Operations Ltd.

Environmental Benefits

(primary benefit bolded)

Climate Change

Project Title:

VeloxoTherm™ Gas Separation Demonstration Process

Project Description:

Carbon Capture and Storage (CCS) is a leading strategy to combat climate change which involves separating carbon dioxide from the gases produced by the combustion of fossil fuels (flue gases). A barrier preventing the widespread adoption of CCS is the economic separation of CO₂ from the flue gases. The VeloxoTherm™ process developed by Inventys is a post-combustion capture and separation technology which utilizes a patented process design and adsorbent architecture which greatly reduces CO₂ separation cost. The VeloxoTherm™ process targeting separating CO₂ from flue gases at a third of the cost of the leading separation technology for post combustion capture of CO₂ from industrial flue gas streams.

Objectives:

- Scale-up of the VeloxoTherm™ process from the a process demonstration (0.1 tpd) to prototype scale (1 tpd)
- Integration of multiple sorbent structures in the prototype plant to implement the separation process which fully implements all the energy saving features of the VeloxoTherm™ process cycle
- Fabrication of structured sorbent for use with the VeloxoTherm™ process
- Demonstration of the durability of the structured sorbent to rapid heating and cooling cycles, to high velocity gas flow, and to contaminants present in actual flue gases.
- Completion of a conceptual design package for a first-of-a-kind VeloxoTherm™ plant.

Results:

- The VeloxoTherm™ process was scaled up from a process demonstration unit prototype stage (0.1 tpd) to a prototype plant (1 tpd) which was operated for more than 500 hours.
- Multiple variants of structured sorbent were evaluated in the Process Demonstration Unit (PDU). Based on demonstration data and process modeling CO₂ separation can be achieved with a recovery of 90% and a CO₂ purity of 97 mol%.
- Adsorption and desorption cycles were defined for the prototype plant for use in continuous mode.
- There was no indication of any adsorbent bed performance degradation throughout the demonstration.
- The conceptual design package for the first-of-a-kind VeloxoTherm™ plant was completed.

Project Impacts:

- This project demonstrated the CO₂ separation capability of the VeloxoTherm™ process. Inventys' next step is to demonstrate the unit in the field with a major oil and gas partner.

Path to Market:

- In addition to heavy oil enhanced oil recovery (HOEOR), Inventys is targeting applications for light oil enhanced oil recovery (LOEOR) and CO₂ capture for climate change purposes (CCS)
- Inventys will demonstrate the unit in the field with Husky for an application in HOEOR.

Market Impact:

- Inventys has commissioned a project with NRG Energy to deploy the VeloxoTherm™ process at one of the company's power generation facilities located on the US Gulf Coast.
- The HOEOR field demonstration project involving the VeloxoTherm™ process is expected to be complete in 2018.
- After the field demonstration the first-of-a-kind plant for HOEOR is expected to be installed and operational by 2019.

WindSmart Inc.

Round 8-2005B

Sector:

Power Generation

Project Completion Date

March 2014*

Market Impact Report Due:

March 2016

Total Project Value:

\$2,702,614 (pending final audit)

SDTC Funding:

\$1,082,738

Leveraged Funding:

\$1,619,876

Consortium Members:

WindSmart Inc.

Tube-Mac Industries Ltd.

Environmental Benefits

(primary benefit bolded)

Climate Change

Clean Air

Project Title:

Hydrostatic Drive System for Wind Turbines

Project Description:

Wind Smart Inc. and its consortium developed a new drive system for wind turbines intended to increase power generation compared with gear-driven assemblies while reducing maintenance costs. Unlike conventional models, the motor and generator can be situated at ground level. The system replaces the gearbox presently employed on wind turbines with a hydraulic motor to drive a hydrostatic pump. This drives a synchronous generator, which in turn generates power directly into the grid. The system enables the capture of more wind energy over a wider wind speed range, using the same turbine. A key innovation is the ability to control the hydrostatic drive unit and to prevent over-speeding of the wind turbine.

Objectives:

- Design and laboratory-test systems for Low (20-100kW) Power Mariah Drive Train System (DTS) in simulated climatic conditions as low as -50°C (minimum 4 to 5 months of testing); prepare OEM-ready generic product documentation.
- Provide cost-benefit analyses for the retrofit market and new build markets.
- Quantify efficiency and energy production over a range of wind speeds (rotational speeds).
- Demonstrate Mariah DTS gust/energy absorption, maintainability, controllability, durability as more reliable than a gearbox.

Results:

- A low power Mariah DTS was built and tested in a laboratory environment including climatic testing for temperatures down to -37°C.
- Wind Smart determined there is a market to sell the Mariah DTS as part of refurbished wind turbines. Wind Smart estimates that the price of their refurbished wind turbine would be approximately half the price of a comparable new wind turbine.
- Mariah DTS prototype testing showed good correlation with simulated efficiencies. The highest efficiency was around 86%, and mid-range efficiency was around 78%. Wind Smart anticipates that a commercial system would have slightly better performance than the prototype.
- The Mariah DTS prototype successfully underwent a total of 2,000 hours of testing for gusts, turbulence, controllability and endurance.

Project Impacts:

- As the Project was conducted in a lab setting no GHG reductions were realized. Future iterations of the technology have the potential to produce efficiency improvements resulting in GHG and CAC reductions.

Path to Market:

- WindSmart has determined the Mariah DTS will demonstrate the greatest advantage in refurbished wind turbines for use in mini grids (100 kW to 2.5MW) or as stand-alone systems, particularly in remote locations where low maintenance is required.

* Project related activities were completed in March 2014 however, final project reporting was completed in 2015.

SunSelect Produce (Delta) Inc.

Round 14-2008B

Sector:

Energy Utilization

Project Completion Date:

June 2014*

Market Impact Report Due:

June 2016

Total Project Value:

\$5,609,006

SDTC Funding:

\$1,672,425

Leveraged Funding:

\$3,936,581

Consortium Members:

SunSelect Produce (Delta) Inc.

Procede Gas Treating BV

Environmental Benefits

(Primary benefit bolded)

Climate Change

Clean Air

*Project related activities were completed in June 2014 however, final project reporting was completed in 2015.

Project Title:

Wood Fired Heat and CO₂ Recovery Plant for Use in Greenhouse Applications

Project Description:

Greenhouses typically burn fossil fuels for heating and combust natural gas or use bottled gas for CO₂ enrichment to accelerate photosynthesis. The SunSelect system aimed to avoid fossil-based heating and CO₂ production by using biomass-based combustion with gas cleaning and CO₂ storage in a proprietary solvent system. When heat was required (on cool nights and during cold seasons), biomass was combusted and the exhaust was captured, cleaned and stored using a novel storage technique. The CO₂ was then used the next day to promote plant growth when the sun shines. The system eliminated natural gas combustion, increased heat recovery by 20%, reduced particulate matter, increased plant growth, reduced costs and generated GHG credits.

Objectives:

- Capture food-safe carbon dioxide from wood waste flue gases for use in the production of local produce.
- Enable greenhouse operations to convert to renewable biomass not only as a source of thermal energy but also as a replacement for natural gas in the production of carbon dioxide for use in greenhouses to enhance plant growth. Improve the energy efficiency of wood waste combustion via condensing heat recovery and catalysis in an innovative manner resulting in a 20% increase in heat recovery from wood waste combustion.
- Reduce particulate emissions from the combustion of wood waste by over 90%.
- Impact climate change by utilizing renewable wood waste as an energy source alternative to natural gas.

Results:

- Produced commercial quantities (up to 7000 t/y) of 98.5 - 100% pure CO₂ with little impurities that exceeded specifications as verified by an independent testing company.
- SunSelect and Procede have been working on modifications to the technology that would permit the operating temperature of the solvent to be below 100°C which would result in greater feasibility for existing wood waste users.
- The GC6™ Green Carbon Capture System reduces particulate emissions from the combustion of wood waste by over 90% and effectively filters volatile organic compounds, carbon monoxide, NO_x and other harmful pollutants. The GC6™ state-of-the-art computer monitoring system accurately gauges all chemical compounds in the system at all levels.
- Very low natural gas prices will delay the uptake of the technology among existing biomass users.

Project Impacts:

- Relative to a natural gas combustion system to provide heat and CO₂ fertilizer to a greenhouse, the installation of the SunSelect project technologies resulted in an average savings of 12,789 t CO_{2e} annually through the project period. In 2016, SunSelect will focus on eliminating the use of the natural gas boiler and meet the greenhouse demand for heat and CO₂ from the biomass burners, further reducing GHG emissions.

Path to Market:

- Although low natural gas prices in North America have stalled the adoption of the technology in North America, the relatively high price of natural gas in northern Europe and Australia continue to make the technology adoption by greenhouses in these regions attractive.
- There are currently three (3) medium-to-large sized greenhouse projects in quotation and design phases in Australia and northern Europe.

Echologics, a division of Mueller Canada, Ltd.**Round 17-2010A****Sector:****Energy Utilization****Project Completion Date:****July 2014*****Market Impact Report Due:****July 2016****Total Project Value:****\$3,217,390****SDTC Funding:****\$1,051,926****Leveraged Funding:****\$2,165,464****Consortium Members:**

Echologics

Pennsylvania American Water Co.

Mueller Systems, LLC

American Water

City of Ottawa

Environmental Benefits:**(primary benefit bolded)****Clean Water**

Clean Soil

Climate Change

Project Title:

Smart Automated Leak Detection System

Project Description:

Echologics developed and demonstrated an integrated, non-intrusive acoustic leak detection system called EchoShore®-DX. The system is capable of detecting leaks in virtually any type or size of commonly used potable water pipes. Wireless transmitters send acoustic sensor data to central or local sites for data processing and leak location identification. EchoShore®-DX technology can be deployed in a District Metered Area (DMA), for example a municipal drinking water distribution system. In comparison with commonly used leak detection methods, more leaks can be detected and water losses are minimized when these leaks are repaired prior to surfacing. This also results in GHG and CAC emissions reductions since less energy is required to treat and pump water through the distribution system. Release of water treatment by-products to soil, such as trihalomethanes (THM), are also reduced as a result of minimizing water leakage.

Objectives:

- To integrate a standalone smart acoustic node network for citywide deployment.
- To conduct a full-scale demonstration of the technology:
 - Deploying the system over a DMA and monitor for 4-6 months, repairing leaks detected by the system.
 - Monitoring leakage levels of the DMA to demonstrate water savings.
 - Determining the leak detection accuracy of the system as a percentage of leaks detected and percentage of false alarms.
 - Comparing results with competing technologies.

Results:

- Completed system integration and testing during two successful small scale pilot tests deployed in Liberty (PA) and Ottawa (ON).
- Completed a full-scale demonstration of the technology in Liberty (PA) over a 6-month period:
 - All known leaks (detected by the existing system) were detected by the EchoShore® system.
 - A 20 l/min leak was detected by the EchoShore® system that had not been detected by traditional approaches to leak detection.
 - No false positives were reported and the results indicate that the EchoShore® system will outperform the leak detection targets for metallic and plastic pipes¹ with 90% and 70% detection efficiency, respectively.
 - Improved signal-to-noise ratio as compared to previous versions of the EchoShore® system and competing technologies.
- The system was only partially installed in Ottawa. As such, quantitative results are not available.

Project Impacts:

- The demonstration in Liberty (PA) resulted in approximately 5 ML of water savings and 875 kg CO₂e of GHG emissions reductions. Minor (less than 1 kg) reductions of CACs and THM were also achieved.
- It is estimated that a market rollout will lead to total water savings of approximately 22,000 ML and GHG reductions of 4 kt CO₂e in Canada, and 122,000 ML and 32 kt CO₂e in the Rest of the World (ROW) between 2015 and 2024.
- Reductions in CACs are also expected to be achieved, the most significant of which will be reductions in NO_x and SO_x of about 2 t in Canada and 50 t in the ROW between 2015 and 2024.
- Releases of THM to soil are expected to be reduced by 60 kg and 3,900 kg in Canada and the ROW, respectively, between 2015 and 2024.

Path to Market:

- Echologics has launched its technology as a permanent monitoring system available through Echologics as the EchoShore® system and Mueller Systems as the Mi.Echo® system. They have received a number of significant orders since project completion. Commercial advertisements are also being run in key water industry publications with strong response.

* Project related activities were completed in July 2014 however, final project reporting was completed in 2015.

¹ The pilot tests reported herein did not include plastic pipes.

Available Energy Corporation

Round 16–2009B

Sector:

Energy Exploration and Production

Project Completion Date:

August 2014*

Market Impact Report Due:

August 2016

Total Project Value:

\$2,375,257

SDTC Funding:

\$1,020,000

Leveraged Funding:

\$1,355,257

Consortium Members:

Available Energy Corp.

Air Liquide Canada Ltd.

Canadian Nuclear Laboratories (formerly Atomic Energy of Canada Ltd.)

Isowater Corp.

Canexus Chemicals Canada Ltd.

Environmental Benefits:

(primary benefit bolded)

Clean Water

Clean Air

Climate Change

Project Title:

Hydrogen and Heavy Water Production

Project Description:

Available Energy Corporation (Available Energy) is developing a near zero emission and highly efficient method of producing heavy water (deuterium oxide) – known as the D2X Process. Deuterium oxide is used in heavy water nuclear reactors such as the CANDU reactor as well as the growing non-nuclear uses ranging from semiconductor fabrication, pharmaceuticals, fibre optics, research applications, medical procedures, health and beauty products. Available Energy's method co-produces heavy water and hydrogen from water electrolysis. For this project, a pilot plant was commissioned at an industrial partner's facility in Western Canada where various process water streams were aggregated and used as feedstock in which its deuterium concentration was increased.

Objectives:

- To develop reliable water balance models for each stage of enrichment as the deuterium content is increased from less than 150 ppm to 99.9%.
- Optimize the inter-stage concentrations so as to enhance production at the lowest capital investment cost and operating cost.
- To generate piping and instrumentation diagrams (P&IDs), stream lists, equipment lists, preliminary engineering and costing for the D2X process.
- To enable a technical Go-No Go decision on starting Phase 2 of the broader industrial-scale demonstration.

Results:

- Water balance models were developed for all stages of enrichment allowing determination of plant modifications needed for a range of inter-stage concentrations.
- Specific inter-stage concentration ranges were specified to achieve deuterium concentration and flow rates targets at each enrichment stage.
- P&IDs, stream lists, equipment lists, preliminary engineering and installed cost estimates were developed for all stages of enrichment.
- Available Energy has decided to implement the project in a step wise manner. Initial focus will be development of the final stage of enrichment to recycle downgraded deuterium oxide. This would further reduce emissions and conserve deuterium at relatively high enrichment levels. As world supply of deuterium oxide continues to diminish, full scale implementation of the D2X process will be implemented.

Project Impacts:

- Emissions were not quantified during the pilot plant demonstration. As such, no reductions are credited for the project period.
- It is estimated that the D2X process will lead to emissions reductions of 3.6 kt CO₂e/t D2O produced – which is some 95% less than current processes. Based on Available Energy's expected market rollout, the D2X process will result in GHG emissions reductions of 2,018 kt CO₂e in Canada and 2,590 kt CO₂e in the Rest of the World, for a total global GHG emissions reduction of 4,608 kt CO₂e by 2028.
- In terms of water benefits, market rollout is expected to avoid emissions of 23 t-hydrocarbons and 1 t Diethanolamine into water, and reduce process water use by 5.9 M m³ globally.
- It is also expected that within the same period, market rollout will lead to the reduction of 3.6 kt SO_x and 5.4 kt NO_x globally.

Path to Market:

- Available Energy, is a world leading supplier of deuterium oxide to the Life Science, Environmental Science and High Technology markets. As demand for recycling services increases the refinery will be implemented. Likewise, the D2X process will be implemented as existing inventories are exhausted.

*Project related activities were completed in August 2014 however, final project reporting was completed in 2015.

Westport Power Inc.

Round 17-2010A

Sector:

Transportation

Project Completion Date

September 2014*

Market Impact Report Due:

September 2016

Total Project Value:

\$11,172,245

SDTC Funding:

\$2,302,834

Leveraged Funding:

\$8,869,411

Consortium Members:

Westport Power Inc.

Electro-Motive Diesel Inc.

GazMétro

CN National Railway Company Corp.

Environmental Benefits

(primary benefit bolded)

Climate Change

Clean Air

*Project related activities were completed in September 2014 however, final project reporting was completed in 2015.

Project Title:

Natural Gas Locomotive Demonstration

Project Description:

Westport Power Inc. (Westport) and their consortium have developed and tested a High Pressure Direct Injection (HPDI) technology which allows for a fuel mixture composed of primarily natural gas to be used in high-performance diesel engines. Natural gas is stored in the form of liquefied natural gas (LNG) in tender cars and converted to natural gas prior to combustion. HPDI is ideally suited to high horsepower (HHP) applications such as locomotive engines, the application of interest for this project. HPDI entails injecting natural gas at high pressure into the engine cylinder, along with a small amount of diesel fuel which is required to initiate the combustion reaction. In operation, a HPDI engine typically runs on 95% or greater natural gas, as opposed to the typically diesel-fuelled HHP engines currently on the market.

Objectives:

- Design, procure, build, test and validate an alpha level (pre-production) HPDI on-engine fuel system for an Electro-Motive Diesel, Inc. (EMD) 710 locomotive engine.
- Conduct performance and emissions testing of the base diesel engine locomotive to be used in the demonstration project. The results of the base diesel testing will form the metrics for the HPDI engine performance targets.
- Integrate the alpha level HPDI fuel system on an EMD 710 test engine; commission, test and calibrate the HPDI-EMD 710 test engine to meet the Tier 3 emissions standards and at least the equivalent fuel consumption of the base diesel engine.
- Working with suppliers; design, build, test and evaluate LNG pump(s) suitable for a production-intent car.
- Integrate the alpha level HPDI fuel system on the locomotive, couple it to the LNG tender car; commission the system, conduct performance and emissions test, conduct preliminary operations testing and release the locomotive for demonstration service. Operate the demonstration locomotive in service to provide its performance and suitability in rail applications.

Results:

- An alpha level HPDI fuel system was designed in May 2012 and verification and testing was completed in May 2013. Design and development of components occurred at the Westport office in Vancouver, BC and at the EMD facilities in LaGrange, IL.
- Performance and emissions testing of the base diesel engine locomotive was completed and used to compare against HPDI Performance targets.
- EMD upgraded a complete test cell and added high pressure gas capability (compressor and booster), allowing them to run a full size locomotive engine using HPDI technology. An EMD 710 engine with a Westport HPDI fuel system was installed and tested in the test cell. This system successfully met all Tier 3 engine emissions targets, while reducing greenhouse gases by more than 20% and improving fuel efficiency over the cycle (exceeding Project targets).
- Westport commissioned and operated a complete cryogenic test facility to operate large cryogenic pumps while two off-the-shelf cryogenic pumps were tested. It was determined that commercially available pumps had limited applications in railway service. Ultimately, Westport designed and manufactured a cryogenic pump capable of supplying full pressure and flow for a railway application.
- The Project demonstrated the performance of a production intent fuel system on a EMD 710 engine in a test cell at an EMD facility. The demonstration was sufficient for Westport and its partners to commit to developing a production HPDI locomotive for the rail market without requiring an on-rail demonstration.

Project Impacts:

- Reduced diesel use, new market for domestic natural gas.
- The demonstration project resulted in GHG emission reductions of 0.8 kt CO₂e/locomotive and significant reduction in CAC's. The objectives are to roll out the technology, resulting in the following cumulative reductions of 157 kt CO₂e in the period 2015-2025 in Canada (projected cumulative capacity - 342 locomotives) and 323 kt CO₂e in the period 2015-2025 for the Rest of the World (projected cumulative capacity - 772 locomotives).
- The speed of transition to natural gas in the rail sector is dependent on regulatory approvals and rail road adoption rates.

Path to Market:

HPDI technology is ideally suited to HHP applications such as locomotives due to its high performance, high efficiency, low emissions and GHG reductions. Westport and its partners believe that the HPDI technology will best meet the needs of the rail industry if it is offered as both a product for retrofit of existing locomotives and for first-fit of new OEM produced locomotives.

Pure Technologies Ltd.

Round 19-2011A

Sector:

Energy Utilization

Project Completion Date:

September 2014*

Market Impact Report Due:

September 2016

Total Project Value:

\$3,121,138

SDTC Funding:

\$1,000,000

Leveraged Funding:

\$2,121,138

Consortium Members

Pure Technologies Ltd.

The City of Calgary

The Region of Peel

Environmental Benefits

(primary benefit bolded)

Clean Water

Climate Change

*Project related activities were completed in September 2014 however, final project reporting was completed in 2015.

Project Title:

Extra high resolution (XHR) magnetic flux leakage (MFL) tool for water pipelines

Project Description :

Pure Technologies Ltd. (Pure) and its consortium members developed and demonstrated a suite of extra high-resolution (XHR) magnetic flux leakage (MFL) inspection tools that enable the detection of wall corrosion and small pitting in water mains, which can be indicative of future pipeline failure. XHR-MFL tools are capable of conducting in-line and off-line inspections of metallic water pipes ranging in diameter from 36-78 inches (") and save potable water by preventing water loss associated with catastrophic failures of metallic pipes. Inspections using the tools also decrease the accidental discharge of chemical disinfectants to the environment and reduce greenhouse gas (GHG) emissions through energy saved from pumping excess water through the water mains.

Objectives:

- Develop and test a new extra high resolution MFL sensing system for in-line inspections of large (60"-78") metallic water transmission pipelines, able to detect ¼" diameter defects through 1" wall liners.
- Develop and test two smaller XHR-MFL tools to cover the full range of large diameter metallic water transmission pipes, with diameter ranges of 36"-48"; 48"-60".

Results:

- Pure developed a scalable MFL tool for large (60-78") water pipelines with a defect detection limit of ¼". Pure tested new tool sensors on a 72" mortar lined steel test pipe to validate new sensors. The tool was used to inspect 17 kms of 72" and 75" cement mortar lined steel pipelines and provided clients with onsite data analysis to identify areas of corrosion or wall loss requiring repairs.
- Pure developed and lab-tested two smaller scale MFL tools (36"-48" and 48"-60") based on the large scale MFL tool (60"-78"). Both tools were shown to operate with the same defect detection resolution as the larger 60" to 78" tool. An unexpected opportunity allowed Pure to develop and test a smaller 24" tool to inspect water disposal injection wells (vertical shafts), a new market for Pure's suite of MFL tools. Pure inspected two injection wells (2,300 and 2,700' deep) using the 24" MFL tool. Pure also developed an outer diameter inspection tool and inspected a 12" mortar lined pipeline in Southwestern Ontario.

Project Impacts:

- Market rollout is expected to result in GHG emissions reductions of 40 t CO₂e in Canada and 460 t of CO₂e in the Rest of the World (ROW) from 2015 to 2026.
- Market rollout is expected to result in water savings of 156,000 m³ in Canada and 1M m³ in the ROW from 2015 to 2026.

Path to Market:

- Pure will showcase the suite of MFL tools as part of a package with SmartBall®, Sahara® and PipeDiver® technologies to existing clients with large-diameter metallic pipes.
- Pure will focus on the power sector where regular shutdowns allow for dewatered inspection of large-diameter critical metallic lines and on emergency response inspections to provide condition assessment of a localized area after failure.

Imtex Membranes Corp.

Round 14-2008B

Sector:

Energy Utilization

Project Completion Date:

September 2014*

Market Impact Report Due:

September 2016

Total Project Value:

\$8,735,378

SDTC Funding:

\$2,753,948 (pending final audit)

Leveraged Funding:

\$5,981,430

Consortium Members:

Imtex Membranes Corp.

Shaw Canada L.P.

Monteco Ltd.

Environmental Benefits

(Primary benefit bolded)

Climate Change

Clean Air

*Project related activities were completed in September 2014 however, final project reporting was completed in 2015.

Project Title:

Membrane Technology for Olefin-Paraffin Separation

Project Description:

Olefin (ethylene/propylene) production is a \$100 billion, energy-intensive industry and the current method for separating olefins and paraffin is the most energy-consuming step in the production process. Imtex intended to develop and demonstrate a membrane technology made of composite material that is permeable to the targeted olefins while restricting paraffin and other gases. The Imtex membrane technology is designed to be 30-90% more energy efficient than the incumbent cryogenic distillation for separating olefin and paraffin in the petrochemicals industry depending on the mode of application. If successful, this technology could reduce GHG/NO_x emissions by up to 90% for the separation stage.

Objectives:

- Progressive scale-up of bench, pilot and large commercial scale olefin-paraffin membrane separation systems.
- Pilot plant testing is to be successfully demonstrated at 2 or 3 operating company sites; multiple sites are preferable due to the variety of real world operating scenarios (feedstock source & composition variation, ethylene vs. propylene, ambient conditions, etc.).
- A large commercial scale demonstration system is to be developed, field deployed and used in processing a significant fraction of the host site's capacity.
- Achieve a minimum of 99.0% purity (C₂H₄) olefin product with minimum 50% recovery at normal temperature and pressure from minimum 50 weight% olefin feed at the bench, pilot and large commercial scales for flux rates of 170-500 mL/m², 72-240 L/m² and 900-6,000 L/m² rates respectively.

Results:

- Development of membrane hydration maintenance technology that transformed the membrane technology from a semi-bath process to a truly continuous one, much preferred by the petrochemical industry. The core membrane product was scaled up to the size and design to be used as the modular building block for all commercial systems.
- The technology was tested for thousands of hours under a variety of conditions relevant to many applications in the field in Imtex's in-house test facility, which was developed to an advanced state as part of the Project. The membrane was not tested in the field.
- Process configuration and simulation applications were developed to allow system sizing and optimization for any prospective application. This also feeds information into the economic analysis for these applications. A broad base of potential adopters of the technology and channel partners was developed with wide representation from across the global olefins industry.
- All performance targets were achieved on full-size membrane units for flux rates of at least 400 mL/m² in Imtex's in-house test facility.

Project Impacts:

- Although the project did not achieve the field demonstration targets per the original scope, Imtex made significant advances in demonstrating the commercial viability of the technology and forms the basis of a follow-on project recently approved by SDTC.

Path to Market:

- Imtex will continue development of the technology as part of a SDTC follow-on project including a field demonstration confirming targets for olefin yield, energy efficiency and lower installed cost as compared to traditional olefin production.

Saltworks Technologies Inc.

Round 14-2008B

Sector:

Waste Management

Project Completion Date

September 2014*

Market Impact Report Due:

September 2016

Total Project Value:

\$8,064,022

SDTC Funding:

\$2,612,638

Leveraged Funding:

\$5,451,384

Consortium Members:

Saltworks Technologies Inc.

Powertech Laboratories Inc.

3M Canada Co.

Canadian Natural Resources Ltd.

Teck Resources Ltd.

SPX Cooling Technologies, Inc.

Environmental Benefits

(primary benefit bolded)

Clean Water

Climate Change

*Project related activities were completed in September 2014 however, final project reporting was completed in 2015.

Project Title:

Saltworks Low-Energy Desalination Demonstration

Project Description:

Saltworks developed a technology that reduces energy requirements for desalination by up to 80%, thereby improving the affordability and accessibility of clean water production from both sea water and brackish water sources. The Saltworks system, called "Thermo-Ionic", was powered by an innovative and inexpensive low temperature thermal energy conversion approach that used solar energy or process heat to reduce electricity consumption. Thermo-Ionic was subsequently split into two complementary innovations: ElectroChem, an advanced electro dialysis platform for desalination and brine concentration; and SaltMaker, a low temperature evaporator-crystallizer for treating highly aggressive wastewaters to produce solids. The project involved building and testing a transportable Thermo-Ionic pilot plant (Plant 1) for seawater desalination, a small scale ElectroChem and reverse osmosis (RO) hybrid plant (Plant 2) to treat water from steam-assisted gravity drainage (SAGD) operations, and a small scale SaltMaker for zero-liquid-discharge treatment of industrial waste waters.

Objectives:

- Build and test a 1,000 l/d mobile Thermo-Ionic pilot plant (Plant 1) for seawater treatment; a 50,000 l/d small scale ElectroChem-RO hybrid plant (Plant 2) to treat industry waters; and a 20,000 l/d SaltMaker for zero-liquid-discharge.
- Conduct Plant 2 testing on coal mine discharge water to remove selenium. Conduct Plant 2 and SaltMaker testing on basal aquifer water.

Results:

- Construction and commissioning of the 1,000 L/d Thermo-Ionic plant (Plant 1) was completed in May 2010. Construction and preliminary operation of the 50 m³/d ElectroChem-RO containerized plant (Plant 2) and 20 m³/d SaltMaker using basal aquifer water was completed in June 2012 and met all of performance metrics. Plant 1 was outfitted with Saltworks' new electrochemical softening technology and combined with reverse osmosis, allowing successful measurement of energy use, availability, output and water quality.
- Field testing with Plant 2 took place until December 2013 and selenium was successfully removed from metallurgical coal mine run-off.

Project Impacts:

- The project highlighted the potential of Saltworks' technology to treat highly impaired water, resulting in net emissions of 18.8 t CO₂e. Full scale systems provide even greater emissions savings as they exploit waste heat sources.
- Market rollout of the ElectroChem and SaltMaker technologies is estimated to reduce GHG emissions by 3.5 and 3.8 kt CO₂e /Mm³ of water treated in Canada and in the Rest of the World (ROW), respectively. It is estimated that by 2024, Saltworks' desalination systems will prevent the release of 77 kt CO₂e in Canada, and an additional 138 kt CO₂e in the ROW.
- For the selenium removal application, the demonstration project resulted in net water benefits of 188 m³ of water savings. Market rollout of the selenium application between 2014 and 2025 is expected to lead to 15M and 25M m³ of water savings in Canada and in the ROW, respectively.

Path to Market:

- Saltworks has expanded its facilities to deliver commercial units of its modular systems to global markets and has developed several innovative product lines for other applications such as wastewater treatment, enhanced oil recovery, produced water treatment, ammonia treatment and landfill leachate treatment.

Statoil Canada Ltd.

Round 14-2008B

Sector:

Energy Utilization

Project Completion Date:

September 2014*

Market Impact Report Due:

September 2016

Total Project Value:

\$38,791,337

SDTC Funding:

\$6,000,000

Leveraged Funding:

\$32,791,337

Consortium Members:

Statoil Canada Ltd.

Schlumberger Canada Ltd.

Alberta Innovates Technology Futures

Environmental Benefits

(Primary benefit bolded)

Clean Water

Climate Change

Project Title:

Solvent Steam Co-Injection (SOLVE)

Project Description:

The SOLVE project demonstrated Statoil Canada's use of steam/solvent co-injection technology (SCI); an improvement over the current, conventional method for in-situ oil sands recovery, steam-assisted gravity drainage (SAGD). The addition of solvent to the injected steam enabled enhancement of bitumen mobility and facilitated extraction with reduced steam use. The project targeted up to 25% lower energy input and water consumption compared to conventional SAGD. A 20% increase in bitumen production was also anticipated due to the ability of solvents to penetrate deeper into the bitumen bearing zone and improve sweep efficiency. Statoil constructed and operated the pilot facility, and contributed technical and financial resources to develop the technology for commercial use.

Objectives:

- Develop, demonstrate and evaluate co-injection steam and solvent technology to reduce the steam-to-oil ratio (SOR) of SAGD and thus reduce water and energy use, decrease CO₂ emissions, and improve resource recovery. The metrics identified to measure the success of this objective include:
 - Lowering SOR from 2.9 down to a range of 2.6 to 2.3 in the pilot (10-25%).
 - Increase in bitumen production rate over SAGD baseline by 10 to 20%.
 - Reduction in CO₂ emissions of 10 to 25% over SAGD baseline.

Results:

- Statoil successfully demonstrated the SCI technology at its Leismer SAGD facilities. Over the course of the three-well pilot, the project achieved a reduction in make-up water use of approximately 0.08 barrels of water per barrel of bitumen produced as a result of redirected steam requirements (approximately 27% reduction).
- During the demonstration project, SOR was reduced from 2.5 to 1.85 (approximately 25%).
- Due to process and subsurface constraints and an unexpected interruption in operation during the injection period, there was not sufficient steady-state data to demonstrate a production uplift.
- Due to the 25% decrease of the SOR, the GHG emissions were also reduced.

Project Impacts:

- The SOLVE project helps reduce water use and energy requirements by introducing solvent to the steam which lowers the viscosity of the bitumen, allowing it to flow more easily. Therefore, the water use and energy consumption per barrel of oil produced is reduced.
- Make-up water per barrel of oil produced was reduced by 0.08 during the demonstration project, for a total of 17,238 barrels of water.
- GHG emissions reductions for the demonstration were 2 kt CO₂e or 12.3 kg CO₂e/bbl oil produced.
- Market roll out would result in GHG emissions reductions of 19.5 kg CO₂e/bbl oil produced and make-up water reduction of 0.08 barrels of water per barrel of oil produced.

Path to Market:

- Statoil does not have plans to commercialize the project technology at this point as low oil prices are hindering investments into oil sands, and more collaboration within the oil sands industry is required to fully de-risk the commercial application of the technology.

*Project related activities were completed in September 2014 however, final project reporting was completed in 2015.

Eco-Ag Initiatives Inc.

Round 14-2008B

Sector:

Waste Management

Project Completion Date:

November 2014*

Market Impact Report Due:

November 2016

Total Project Value:

\$5,791,615

SDTC Funding:

\$1,948,000

Leveraged Funding:

\$3,843,615

Consortium Members:

Eco-Ag Initiatives Inc.

Alberta Agriculture and Rural
Development

Interactive Management Group

Environmental Benefits

(primary benefit bolded)

Clean Soil

Climate Change

Clean Air

Clean Water

Project Title:

Nutrient Recovery Facility Project

Project Description:

Eco-Ag Initiatives Inc. (Eco-Ag), in combination with their consortium partners, was to develop a process that integrated several basic technologies to transform wastes into nutrients for crop production or horticultural use. The project aimed to develop a process to produce safe, economically and environmentally sustainable nutrients from wastes that are currently destined for landfills. Both wet and dry materials were to be processed to create designer organic nutrients (DON) for the agriculture and horticulture industry to improve soil health, fertility and water holding capacity. DON production was also expected to reduce reliance on synthetic and mined fertilizers, resulting in GHG and CAC emissions reductions.

Objectives:

- Construct and commission the DON production process.
- Receive and process animal mortality (Specified Risk Materials (SRM)) waste, liquid organic and dry organic waste.
- Produce DON from waste inputs received.
- Produce biogas by anaerobic digestion of waste materials to provide the heat and power used by the DON production process.
- Quantify odour and volatile organic carbon (VOC) sources for each process, compare effectiveness of DON with chemical fertilizer.
- Compare the effectiveness of DON with synthetic fertilizers.

Results:

- The construction of the plant in High River, AB was completed, including integration of commercial scale alkaline hydrolysis, continuous thermo hydrolysis, anaerobic digesters, and stabilizer drums.
- DON from the integrated demonstration plant was not produced as a result of challenges in obtaining the necessary permits and approvals to run the plant. Waste inputs including processing plant waste, and food waste were tested in discrete units operations. Outputs from each of the unit operations were combined except the alkaline hydrolysis product, in order to develop and produce the DON.
- Biogas was not produced in sufficient quantities during the demonstration project due to delays in the groundwater monitoring approval process. Therefore, biogas was not used to provide process heat and power – grid electricity was used.
- VOC measurements were not completed because these measurements need to occur when plant meets 80% capacity. It is unclear when the plant will become operational and meet 80% capacity.
- Crop production trials using batch produced samples of DON from the plant showed increased yields on fall rye when compared to use of equivalent amounts of synthetic nitrogen fertilizer. Tests from the demonstration plant on DON are on-going but have not been completed.

Project Impacts:

- Eco-Ag's process is expected to result in soil benefits by enhancing soil conditions with the produced DON. Water benefits may arise if the process accepts wastes that would otherwise be discharged to waterways. These benefits have not been assessed quantitatively.

Path to Market:

- Eco-Ag expects to roll-out its DON production process, with new trains being built in Alberta from 2014 to 2017. British Columbia and Saskatchewan are also being considered as potential sites for new DON production facilities.

*Project related activities were completed in November 2014 however, final project reporting was completed in 2015.

S2G Biochemicals Inc.

Round 17-2010A

Sector:

Energy Utilization

Project Completion Date:

December 2014*

Market Impact Report Due:

December 2016

Total Project Value:

\$7,720,257

SDTC Funding:

\$2,616,952

Leveraged Funding:

\$5,103,305

Consortium Members:

S2G Biochemicals Inc.

Phoenix Pulp and Polymer

International Polyol Chemical Inc.

HTEC Hydrogen Technology
& Energy Corp.

Environmental Benefits

(primary benefit bolded)

Climate Change

Clean Water

Project Title:

Bio-Glycol Pre-Commercial Plant

Project Description:

Over \$25B worth of glycols are used each year globally in a wide array of industrial and consumer products such as antifreeze, polyester fibres, plastic drink containers, cosmetics and detergents. The project led by S2G Biochemicals Inc. (S2G) demonstrated “bio-glycol” production using low-cost renewable byproducts of the biofuel, agriculture and forest industries as feedstock instead of fossil fuels. Byproduct sugars from next-generation biofuels were of particular interest as a growing source of feedstock – these include crude glycerine from biodiesel production and C5/C6 sugars from cellulosic ethanol production. S2G’s “Sugar-to-Glycol” process is expected to improve the economics of biofuel production and the utilization of waste biomass resources, as well as reduce the lifecycle GHG emissions and water consumption associated with the production of conventional glycols. With this technology, S2G aims to help shift the industrial chemical industry from its traditional dependence on fossil fuels to a sustainable future based on renewable organic feedstocks.

Objectives:

- Design a pilot plant for pre-treatment and hydro-processing of byproduct sugars. Modify, install and commission a 40 t/y pilot facility to confirm viability of crude glycerine and C5/C6 sugars hydro-processing.
- Run pilot tests on leading byproduct sugar candidates including crude glycerine, energy crop sugars, and cellulosic sugars from different biomass sources and feedstock partners.
- Meet process performance and cost parameters required for commercial operation, for example greater than 85% conversion of feedstock to bio-glycol.

Results:

- S2G designed, constructed, and commissioned a 40 t/y capacity pilot bio-glycol production plant in Vancouver, BC.
- Pilot testing was conducted for glycerine, beet sugar, and pulp straw liquor feedstocks. A total of approximately 1.5 t of bio-glycol was produced through various campaigns during pilot testing.
- Process performance and cost parameters required for commercialization were met.

Project Impacts:

- The demonstration project resulted in a total of 4 t CO₂e GHG reductions and 8.5 m³ in water savings.
- It is estimated that market rollout will lead to GHG emissions reductions of 6.7 Mt CO₂e in Canada and 0.5 Mt CO₂e in the rest of the world, for a total global GHG emissions reductions of 7.2 Mt CO₂e between 2016 and 2024.
- The GHG reduction intensity in Canada is expected to be 4.7 t CO₂e/t bioglycol produced and 3.6 t CO₂e/t bioglycol produced in the rest of the world.
- The market rollout will also lead to savings of 6M m³ of water in Canada and 23k m³ of water in the rest of the world between 2016 and 2024.

Path to Market:

- S2G is working with strategic partners to build its first commercial scale facility. S2G’s goal is to build the first facility within three (3) years.

*Project related activities were completed in December 2014 however, final project reporting was completed in 2015.

FibraCast Ltd.

Round 17-2010A

Sector:

Energy Utilization

Project Completion Date

December 2014*

Market Impact Report Due:

December 2016

Total Project Value:

\$5,902,229

SDTC Funding:

\$1,947,736

Leveraged Funding:

\$3,954,493

Consortium Members:

FibraCast Ltd.

Alpha Plan GmbH

Anaergia Inc.

Environmental Benefits

(primary benefit bolded)

Clean Water

Climate Change

Project Title:

FibrePlate System

Project Description:

FibraCast has developed a new hybrid membrane (FibrePlate) for the municipal water and wastewater industry that leverages the benefits of both hollow fiber and flat sheet membrane topology that has twice the permeability, 100 times the strength, five (5) times the packing density and is easier to clean than hollow fiber technology. The project comprised an innovative manufacturing technology for producing FibrePlate membranes at one third the cost of current state of the art hollow fiber membranes due to easier and faster manufacturing processes.

Objectives:

- To construct a pilot manufacturing line capable of producing FibrePlate membrane sheets and module assembly processes able to produce at least 60 m² of membranes per week (2 modules).
- To validate long-term integrity of a module by completing a three (3) week accelerated test under three (3) times the aeration rates and 1,000 ppm of chlorine exposure at 40°C.
- To design and test a containerized system using FibrePlate modules that is able to treat 150 m³/d of municipal wastewater at 10,000 mg/l Total Suspended Solids (TSS) at a flux rate of 25 l/m²/h (~15 gallons/ft²/d).

Results:

- Designed and built a sheet-forming machine and dope delivery system that allows casting of consecutive FibrePlate sheets in batch mode. FibraCast also validated the casting process on the full size pilot line, tested new substrates and selected new adhesives.
- Completed accelerated testing in house at FibraCast in Hamilton using the new adhesive that allowed the module to pass the 21-day test.
- Built a containerized Membrane Bioreactor (MBR) system with a separate bioreactor tank for the Clarkson Wastewater Treatment Plant in Mississauga, ON. The system was able to treat over 150 m³/d at flux rates of 25 l/m²/h for at least nine months and capable of being fully adjusted, from remote online access, for all key process parameters. Another fully containerized MBR system was commissioned, creating a plug-and-play treatment system tested at the Victor Valley Water Reclamation Authority (VWVRA) in Victorville, CA. The VWVRA pilot unit can treat up to 227 m³/d, with an operating limit for FibrePlate membranes of 12,000 mg/l of total suspended solids (TSS).

Project Impacts:

- The Clarkson demonstration project resulted in emission reductions of 2,740 kg CO₂e /pilot project, while the VWVRA demonstration project resulted in emission reductions of 1,052 kg CO₂e /pilot project. Both demonstration projects also resulted in significant reductions in air pollutants.
- Roll out of the technology is expected to result in cumulative reductions of 109 kt CO₂e in Canada (projected cumulative annual capacity 2,273 M m³ of wastewater/water treated) and 2,248 kt CO₂e for the Rest of the World (ROW) projected cumulative annual capacity of 14,833 M m³ of wastewater/water treated.
- The market roll-out is also expected to result in significant reductions in CAC emissions and significant water savings (1,049 M m³ of water saved in the ROW roll-out).

Path to Market:

- FibraCast has successfully initiated a soft commercial launch of the FibrePlate System, with product made on the pilot line being used at demonstration sites for the establishment of an international market reference list. The containerized system that FibraCast tested for their demonstration pilots has proven successful and will provide an excellent fit for small communities due to its short commissioning time and simple process controls.

* Project related activities were completed in December 2014 however, final project reporting was completed in 2015.

Nsolv Corporation

Round 18-2010B

Sector:

Energy Exploration and Production

Project Completion Date

December 2014*

Market Impact Report Due:

December 2016

Total Project Value:

\$54,085,607

SDTC Funding:

\$10,000,000

Leveraged Funding:

\$44,085,607

Consortium Members:

Nsolv Corporation

Suncor Energy Inc.

Hatch Ltd.

Environmental Benefits

(primary benefit bolded)

Climate Change

Clean Air

Clean Water

Project Title:

BEST (Bitumen Extraction Solvent Technology) Field Pilot Plant

Project Description:

Canada has 170 billion barrels of recoverable crude oil stored in the oil sands. Of these remaining established reserves in Alberta, 80% are too deep to be mined and are currently recovered using in-situ processes such as Steam Assisted Gravity Drainage (SAGD), which is water and energy intensive. Through this project, Nsolv demonstrated 'BEST' – a low temperature, primary, in-situ production technology for bitumen reserves using a pure, condensing solvent. BEST reduces the consumption of process water to zero and emits seventy-five (75) percent less greenhouse gas (GHG) than SAGD on a per barrel basis. BEST is expected to have lower operating and capital costs than SAGD with fewer restrictions on the reservoir conditions under which it can operate. To prove the technical and economic performance of the pure solvent under actual reservoir conditions, Nsolv drilled and completed a 300 metre producer and injector well pair and constructed a supporting surface facility near Fort MacKay, Alberta.

Objectives:

- Achieve SAGD oil extraction rates or better with warm solvent instead of hot steam.
- Achieve in-situ upgrading of bitumen from ~8°API to ~13°API or better, and reduce carbon residue, nickel and vanadium content of produced oil.
- Achieve solvent hold-up in extraction chamber similar to steam (water) experienced in SAGD.
- Achieve a reduction of 80% or better in GHG emissions relative to SAGD, based on heat delivered to the reservoir.

Results:

- Nsolv produced >80,000 barrels of oil at an average of ~160 barrels per day. When normalized for well length and pay height, the extraction rate from the BEST well is approximately the same as SAGD wells producing from the same reservoir and at lower temperature.
- Nsolv produced upgraded oil with 14–16°API, and reduced carbon residue, nickel and vanadium content.
- Third party environmental quantification estimates 76% GHG emission reduction relative to SAGD for a commercial Nsolv BEST project. Although this is less than the target of 80%, Nsolv has demonstrated a step change in emissions reductions versus the incumbent technology.

Project Impacts:

- The demonstration project was successful in demonstrating the economic and environmental potential of the technology to extract bitumen under real reservoir conditions.
- The pilot facility resulted in savings of 13,375 barrels of fresh water and 11,861 barrels of saline water when compared against bitumen production from a commercial-scale SAGD facility. The GHG emission intensity of the pilot plant exceeded those of a commercial-scale SAGD facility due primarily to lack of scale.
- By 2025, the market rollout of the BEST technology is expected to result in cumulative savings of 49 million barrels of fresh water, 43 million barrels of saline water and GHG emission reductions of 3.2 megatonnes CO₂e as compared to conventional SAGD production.

Path to Market:

- Nsolv has demonstrated that it can be economic/profitable at lower oil prices when incumbent technologies for producing from oil sands cannot. BEST is competitive against SAGD due to its lower capex intensity, lower operating costs, and improved revenue per barrels resulting from in-situ upgrading.
- SDTC has recently approved a follow-on project to build the first pre-commercial demonstration plant to prove the economic viability and environmental benefits of the technology.

* Project related activities were completed in December 2014 however, final project reporting was completed in 2015.

GreenField Specialty Alcohols Inc.

Round 13–2008A

Sector:

Energy Exploration and Production

Project Completion Date:

December 2014*

Market Impact Report Due:

December 2016

Total Project Value:

\$12,963,578

SDTC Funding:

\$3,927,964

Leveraged Funding:

\$9,035,614

Consortium Members:

GreenField Specialty Alcohols Inc.

Andritz Ltd.

Andritz Group

Environmental Benefits

(Primary benefit bolded)

Climate Change

Clean Air

Clean Water

Clean Soil

Project Title:

GFE – Biochemical Lignocellulosic Ethanol Demonstration Project

Project Description:

GreenField Specialty Alcohols Inc. (GFSA) demonstrated a biochemical technology process for lignocellulosic ethanol production which addresses many of the issues producers are currently facing, including the cost of feedstock supply and pre-treatment processes, the efficiency of conversion processes, the high cost of enzymes for hydrolysis, the cost of concentration and purification and the value of co-products. This process was integrated into an existing ethanol facility on a pre-commercial, pilot scale using corn cobs – the non-food residuals from harvesting corn – and other energy crops as feedstocks. The consortium developed improved pre-treatment and enzymatic hydrolysis processes that could be applied to first generation ethanol facilities and retrofitted to second generation facilities.

Objectives:

- Undertake feedstock evaluation and determine process conditions for three ‘classes’ of feedstocks including corn cobs and stover, energy crops such as bagasse and switchgrass, and poplar.
- Confirm ethanol production from hemicellulose sugars (mechanical and chemical procedures to recover and hydrolyse hemicellulose sugars; co-fermentation process) with a target of an overall 80% production increase.
- Upgrade pilot plant (incorporate Twin-Screw Extruder (TSE) into existing pilot facility).

Results:

- All classes of feedstock were successfully evaluated at lab facilities and in the pilot facility.
- Testing of recovery and purification of hemicellulose from cobs was successfully carried out for conditioning and pre-treatment, hydrolysis and fermentation. Target metrics were achieved.
- The pilot plant was upgraded in stages with the full commissioning of the plant occurring upon Project completion. The upgraded plant has since been operated, tested and modified as required.

Project Impacts:

- GFSA lignocellulosic ethanol reduces emissions compared to conventional ethanol production through the use of waste biomass (cobs, stover, etc.) and assumptions related to emissions associated with feedstock production.
- GHG emission reductions on a unit basis were calculated to be 0.697 kg CO₂e/L ethanol produced for Canada and 0.925 kg CO₂e/L ethanol produced for the Rest of the World.
- Implementation of lignocellulosic ethanol production also results in reductions in CAC emissions: 9.23 g SO_x, 0.5 g NO_x, 0.06 g particulate matter (PM) and 0.06 g VOC/L ethanol produced.

Path to Market:

- GFSA intends to use multiple approaches to commercialize its technology which include: building, owning and operating lignocellulosic ethanol production facilities; selling licenses for the TSE technology that includes systems for cellulosic ethanol production, systems for the production of sugars used in bio-based chemical production and systems to facilitate solid-liquid separation.

* Project related activities were completed in December 2014 however, final project reporting was completed in 2015.

MEG Energy Corporation

Round 14-2008B

Sector:

Energy Exploration and Production

Project Completion Date

December 2014*

Market Impact Report Due:

December 2016

Total Project Value:

\$18,142,245

SDTC Funding:

\$4,270,000

Leveraged Funding:

\$13,872,245

Consortium Members:

MEG Energy Corp.

Western Research Institute

Alberta Innovates - Energy and
Environment Solutions

Environmental Benefits

(primary benefit bolded)

Climate Change

*Project related activities were completed in December 2014 however, final project reporting was completed in 2015.

Project Title:

MEG Field Upgrading Process (known as the HI-Q® process)

Project Description:

Bitumen extracted from the oil sands requires upgrading to remove asphaltenes and other residuals before it can be fed to a conventional refinery for final processing into end products. This upgrading is an energy and capital intensive process. Additionally, the transportation of bitumen via pipeline to a central upgrader or refinery also requires the use of diluent to reduce viscosity and facilitate bitumen flow. This diluent is the largest component of bitumen production and transportation costs. MEG Energy (MEG) designed, built and demonstrated HI-Q®, a field upgrading technology which can negate the need for diluent in transportation while reducing the energy intensity of the upgrading by more than 20%. The HI-Q® technology results in lower greenhouse gas emissions, higher netbacks from the reduced bitumen price differential, elimination of diluent and enhanced access to downstream markets.

Objectives:

- The project includes the completion of the design, construction and operation of the MEG HI-Q® process pilot plant, consisting of combined thermal cracking and solvent deasphalting. The five (5) barrels per day (bpd) pilot plant will be built in Alberta, shipped, installed and operated at the Western Research Institute in Laramie, WY.
- The purpose of this program is to prove technical feasibility of the MEG HI-Q® process, leading to sufficient process definition to scale the process up to field pilot demonstration scale (300-1,500 bpd). It is also required in order to produce sufficient volumes of asphaltene products, at different operating conditions, for subsequent clean energy technology testing.

Results:

- The five (5) bpd pilot plant in Laramie, WY processed over 1,300 barrels of bitumen and achieved >700 hours of operations over 50 test runs proving the concept technically. It also demonstrated the ability to produce a high yield, pipeline ready (19-20 API Gravity) product that is less energy intensive than the incumbent technology and capable of capturing >50% of the light/heavy oil differential.
- The pilot tests demonstrated sufficient positive technical and economic incentive for MEG to proceed with a 1,500 bpd field demonstration pilot (also co-funded by SDTC) located in Bruderheim, AB. Over 10 t of asphaltene by-products were produced during the project for testing. MEG evaluated a variety of uses for the asphaltene by-products and the asphalt product pathway appeared to be the most promising with the highest potential value generated and the lowest potential environmental footprint. Third-party analysis of asphaltene solids from the HI-Q® process demonstrated they met the requirement for solid fuels market distribution and as a back-up disposal in non-hazardous landfill is a viable option.

Project Impacts:

- Based on the results from this project, the next scale up (1,500 bpd) is expected to result in GHG emission reductions of 3.4 kt CO₂e/y for 1,500 bpd of production.
- The HI-Q® technology market roll-out, calculated based on the results of this project, also expects to generate significant GHG emission reductions, in the range of 138 kt CO₂e/y/plant with 60,000 bpd capacity.
- The objectives are to roll out the use of the technology, resulting in the cumulative reductions of 629 kt CO₂e from 2017-2025 in Canada (projected cumulative processing capacity of 64,500 bpd).
- The roll-out is also expected to result in a reduction in CAC emissions.

Path to Market:

- Upon construction completion of the Bruderheim demonstration pilot (slated for 2018), MEG intends to deploy the technology with a first commercial plant in 2023. For HI-Q® to reach a critical mass in the market and realize the full value uplift, MEG estimates production should be in the 250,000 – 300,000 bpd range. MEG's own initial facility will produce 60,000 - 100,000 bpd of product, so an additional 150,000 – 200,000 bpd of licensed production is attractive. This translates to 10-13% of Canadian SAGD production by 2022 to achieve critical penetration. While the broad market context is compelling, key to the success will be to attract and capture or partner with individual licensors.
- As part of the commercialization process, MEG obtained a trademark for the HI-Q® product and process. Going forward, MEG is also looking at developing a certification mark for the HI-Q® product to further control the quality of all HI-Q® barrels produced, similar to a CSA, UL, or ISO certification mark.

Terragon Environmental Technologies Inc.

Round 15-2009A

Sector:

Waste Management

Project Completion Date

December 2014*

Market Impact Report Due:

December 2016

Total Project Value:

\$8,006,425

SDTC Funding:

\$3,174,000

Leveraged Funding:

\$4,832,425

Consortium Members:

Transport Desgagnes

Canadian Coast Guard

Alion Science and Technology

(Canada) Corporation

Les Investissements de

l'Estrie Inc. (Le Vertendre)

Environmental Benefits

(primary benefit bolded)

Clean Water

Climate Change

Clean Air

Project Title:

Wastewater Electrochemical Treatment Technology (WETT) and System for Total Environmental Protection

Project Description:

Terragon's WETT system operates on electricity, does not use chemicals or biological treatment and does not require specially-trained personnel. The system is compact, robust and capable of intermittent operation. It can be adjusted to handle almost any type of wastewater and can provide tertiary treatment. WETT effectively treats organic and inorganic contaminants (suspended or dissolved), persistent organic pollutants such as pharmaceutical residues, and pathogens. Terragon demonstrated the WETT technology on a merchant marine vessel, a government vessel, and in a remote resort. Terragon also integrated the MAGS (Micro Auto Gasification System) which was demonstrated in an earlier SDTC project with the WETT system to create a System for Total Environmental Protection (STEP). The combined process enhances the MAGS process by treating any liquid residual while providing a method of disposal for sludge from the WETT process.

Objectives:

- Proof-of-Concept prototype modifications/investigations to finalize WETT development.
- Design, construction, commissioning and onsite operation of two WETT application-specific prototypes, one for sewage and one for bilge water.
- Design, construction, commissioning and demonstration of four WETT demonstration prototypes, and demonstration of STEP approach for land-based and marine situations
- Paper Study to assess the implications of the STEP integrated waste management approach on ship design and operations.

Results:

- The various aspects of the WETT System were developed to address treatment of domestic and marine wastewater (sewage, greywater, blackwater), and treatment of marine bilge water under simulated marine motion. Results compared positively with applicable standards for these different wastewaters.
- Four WETT prototypes were successfully demonstrated; one for greywater at a resort, two for bilge water on ships, and one for sewage on a ship.
- Two STEP demonstrations were carried out. One was demonstrated at the Terragon facility; a second one was successfully demonstrated on board a Canadian Coast Guard ship and then retrofitted for a land-based demonstration in Cambridge Bay, Nunavut.
- A Paper Study to assess the implications of the STEP approach for ship design and operations was completed considering three types of ships: a Transport Ship, an Offshore Supply Vessel, and a Frigate. By utilizing STEP as compared to conventional equipment/approaches, it was possible to treat almost all waste onboard for each platform, and at the same time reduce operating costs by significant margins.

Project Impacts:

- The WETT-O for Oily water produced water to meet the IMO discharge standard. The WETT system for grey water met TSS, Fecal coliform and pH standards. The STEP System successfully treated solid waste, blackwater, greywater and sludge at demonstration installations.
- The roll-out of the technology is forecast to result in cumulative reductions of 550 t CO₂e from 2015-2020 in Canada (11 STEP installations) and 8,713 t CO₂e over the same time period for the Rest of the World (152 installations).
- The roll-out is also expected to result in a reduction in CAC emissions, a reduction in harmful bacteria and improved water quality.

Path to Market:

- Terragon has finalized development of the commercial WETT models. WETT-O is for marine application and WETT-G is for grey water applications in single family dwellings as well as small hotels or camps. The scale up of the technology for use in isolated communities is currently being studied. A final design iteration for the WETT-S for black water is in progress and is expected to be demonstrated in a shipboard trial.
- Terragon is finalizing a study of the STEP concept for 150 person groups. Over the next year Terragon will propose this concept for various applications, particularly marine, once the development efforts are completed.

*Project related activities were completed in December 2014 however, final project reporting was completed in 2015.

InvoDane Engineering Ltd.

Round 16-2009B

Sector:

Energy Exploration and Production

Project Completion Date

December 2014*

Market Impact Report Due:

December 2016

Total Project Value:

\$10,034,750

SDTC Funding:

\$2,467,125

Leveraged Funding:

\$7,567,625

Consortium Members:

InvoDane Engineering Ltd.

Northeast Gas Association

Enbridge Gas Distribution Inc.

Environmental Benefits

(primary benefit bolded)

Climate Change

* Project related activities were completed in December 2014 however, project reporting was completed in 2015.

Project Title:

Unpiggable Pipeline Inspection

Project Description:

Current inspection methods for unnavigable natural gas pipelines require the pipeline to be shut down and the gas vented to the atmosphere. InvoDane demonstrated a technology designed to detect anomalies or weaknesses while the pipeline is in service, allowing the pipeline operator to determine the pipe condition and schedule repairs minimizing interruption of the gas service and venting. The technology, called Transmission Inspection of Gas mains via Robotic Explorer (TIGRE), consists of robotic linked sections that are self-propelled, reversible and use magnetic flux leakage (MFL) sensors to detect anomalies. TIGRE can be launched at any accessible location while the pipeline is under pressure and the robot can change shape to negotiate pipeline features. The technology aims to reduce the number of gas pipeline failures and the associated cost, environmental impact and risk to human safety.

Objectives:

- Resolve remaining technology barriers in the pre-commercial prototype which will be scaled up to a market ready system by simplifying and improving the reliability of the robot.
- Develop auxiliary technology enabling deployment of the robot into live gas pipelines with diameters in the 20"-26" range including a launch and retrieval system.
- Develop data analysis software and anomaly sizing methodology to detect metal loss including the depth, width and length of the defect to strict tolerances.
- Extend the inspection range to 1 - 5 miles and extend the wireless communication to 0.5 - 1 mile.
- Demonstrate the technology in both abandoned and live, high pressure (750 psi) gas pipelines.
- Detect and measure cracks, mechanical damage and ovality in welds and base materials of the pipe

Results:

- The prototypes were iteratively tested and optimized to increase the reliability of the robot; this is a key criterion for pipeline operators when considering deployment of new technologies.
- Developed dedicated auxiliary equipment including launch chambers, valve protection sleeves, control interface and other components to launch and retrieve the robot in live, unpiggable pipelines in the specified diameter range.
- Robot sensors and data analysis software demonstrated ability to provide pipeline operators with accurate measurements of defects, allowing operators to make repairs and reduce the number of pipeline failures.
- The longest inspection achieved to date is 0.8 mile. The longest demonstrated wireless range to date is 0.4 miles from the antenna. The wireless range currently matches the effective range of the robot.
- The technology has been demonstrated in both abandoned and live, high pressure (740 psi) gas pipelines.
- InvoDane deployed the robot with crack sensors twice in underground pipe networks; commercializing is expected in 2016. InvoDane successfully commercialized a sensor to measure dents and ovality

Project Impacts:

- The project resulted in GHG emission reductions of 7.4 kt CO₂e by eliminating the need to vent natural gas from live pipelines for inspection and/or by identifying gas leakages for repair.
- The market roll-out of the technology is expected to result in the cumulative reductions of 34 kt CO₂e in the period 2013-2022 in Canada and 250 kt of CO₂e in the period 2013-2022 for the Rest of the World (ROW).

Path to Market:

- The project technology is being commercialized through a newly created subsidiary, Pipetel, which is now serving existing and new clients by offering a service that currently has no direct competition, only less quantitative substitutes.
- One of the better path to market options for Pipetel is through its access to a group of 20 utilities in North America who have indirectly funded the Project through the Northeast Gas Association (NGA) and whose top integrity managers met quarterly to discuss the progress of this technology.
- Since 2013, a total of six TIGRE systems have been introduced (or are currently being commissioned) for commercial service. It is a management choice to cap the number of robots at nine and ten in the North American and ROW market respectively.

Himark bioGas Inc.

Round 12-2007B

Sector:

Agriculture

Project Completion Date

February 2015

Market Impact Report Due:

Not Applicable

Total Project Value:

\$11,833,908

(pending final audit)

SDTC Funding:

\$3,331,976

Leveraged Funding:

\$8,501,932

Consortium Members:

Himark bioGas Inc.

Growing Power LP (GPHH)

Providence Grain Group Inc.

Environmental Benefits

(primary benefit bolded)

Clean Water

Climate Change

Clean Soil

Project Title:

Growing Power Integrated BioRefinery

Project Description:

Himark bioGas Inc.'s technology was used by Growing Power Hairy Hill LP (GPHH LP) to build an integrated grain-based ethanol plant near Vegreville, Alberta. The project consisted of a 36,000 head cattle feedlot, a 440 t/d anaerobic digestion facility, and a 40 ML/y fuel ethanol plant. Grain entering the process was used once to produce ethanol. The resulting distillers' grain was then used to offset a large portion of the ration fed to cattle. The manure generated was used as feedstock for the anaerobic digester, which produces energy to power ethanol production. Waste heat from the ethanol production process was to be used to maintain the anaerobic process temperature. These integrated systems were to reduce water consumption compared to conventional ethanol plants.

Objectives:

- Produce the sugars that will become ethanol; offset a large portion of the ration fed to cattle at the feedlot in the form of wet distillers' grain (16 t/h); utilize the manure as a feedstock for the anaerobic digester.
- Use the biogas from the Integrated Manure Utilization System (IMUS™, Himark's technology) anaerobic digester to produce sufficient power (net 2.4 MWe) to run the ethanol plant (with seasonal excess being sold to the grid) and also provide 80% of the heat energy required to run the boilers (20% supplemented by natural gas). In addition, use waste heat from the ethanol production process to maintain the anaerobic process, reducing the need for ethanol plant cooling water consumption. Through the use of such water-efficient heat management practices, consume 50% of the water of a conventional distillation plant through the Integrated BioRefinery ethanol plant. This should translate into a savings of roughly 150k L/d of water for the 40 ML/y ethanol plant.

Results:

- The ethanol plant started production in December 2012, however, as a result of design, construction and operational challenges the plant never ran continuously at full production. Distillers grain from the ethanol plant was used in the feedlot when the ethanol plant was operating, though it did not meet expected specifications. Manure from the feedlot was used as a feedstock for the IMUS anaerobic digestion facility. Electrical power was produced and sold to the grid but never used to power the ethanol plant.
- All components of the full system were built (co-gen plant, boiler house, ethanol plant and IMUS systems) but the components never operated as a fully integrated system, as a result of challenges in getting the ethanol plant to be fully operational.

Project Impacts:

- The Himark technology provides an innovative process for integrating a feedlot, anaerobic digester and ethanol plant in a sustainable manner with the potential to reduce water and energy consumption for the production of ethanol.
- As the integration of the various processes was not completed, the project did not generate quantifiable water use or GHG emission reductions.

Path to Market:

- Despite the Himark system being built the integrated system was never fully tested. Himark's commercialization efforts are currently suspended indefinitely.

General Fusion Inc.

Round 13-2008A

Sector:

Power Generation

Project Completion Date:

May 2015

Market Impact Report Due:

May 2017

Total Project Value:

\$38,971,362 (pending final audit)

SDTC Funding:

\$12,748,560

Leveraged Funding:

\$26,222,802

Consortium Members:

General Fusion Inc.

Los Alamos National Laboratory

Environmental Benefits:

(primary benefit bolded)

Climate Change

Clean Air

Project Title:

Acoustically Driven Magnetized Fusion Reactor

Project Description:

General Fusion is working to unlock the enormous potential for emissions-free power generation inherent in nuclear fusion. They have developed an innovative concept: magnetized target fusion, where the high temperatures and intense pressures known from theory to be required for fusion is produced by focusing an acoustic wave on a magnetically confined hydrogen plasma ring. Their approach is expected to lead to a viable power plant much sooner than their competitors in the international field of fusion power and do so at a scale and cost compatible with widespread deployment. The project focused on developing the key steps in the process: the formation and compression of the plasma ring and the precise production of the acoustic wave.

Objectives:

- Demonstrate the ability to create and control magnetically confined plasma rings suitable for fusion power production.
- Develop and validate the performance of an acoustic compression system.
- Demonstrate fusion relevant heating of a compressed magnetically confined plasma ring.
- Prepare a preliminary cost analysis for commercial power plants based on this technology and show that power production is cost competitive in current markets.

Results:

- General Fusion constructed and commissioned a number of power plant-scale plasma injectors. Despite significant progress in hardware design and simulation capabilities, adequate stability at the highest degree of compression in the injectors was not achieved. Development will continue after the SDTC-funded project.
- A 14 piston array was built and tested. Speed and timing targets relevant to full power plant operation were met.
- A reduced scale plasma injector was built to explore the upper ranges of pressure and temperature in parallel to the power-plant scale injector work and acoustic compression development.
- Target plasma metrics were achieved individually, but not simultaneously.
- A detailed review of power plant costs validated projections of electricity production costs that are competitive with current fossil fuel power plants.

Project Impacts:

- The rollout of General Fusion's power plants is expected to result in emissions reductions, mostly due to the avoidance of emissions from higher-emitting electricity generation.
- Today's grid mix is used as the baseline, resulting in an emission reduction intensity of 0.15 and 0.50 t CO₂e/ MWh in Canada and the Rest of World (ROW).
- It is estimated that market rollout will lead to GHG emissions reductions of 2 Mt CO₂e in Canada and 81 Mt CO₂e in the ROW, for a total global GHG emissions reductions of 83 Mt CO₂e between 2016 and 2030. Market rollout will also lead to reductions of 368 t NO_x, 653 t SO_x, 3 t VOC, 34 t PM, and 68 t CO in Canada and 4,394 t NO_x, 7,794 t SO_x, 30 t VOC, 403 t PM, and 809 t CO in ROW.
- Given that the first plant is forecasted to commission in 2024, when grid emission factors will be lower, it is expected that actual emissions savings will be less than what is forecasted using today's grid emission factors as the baseline, by an estimated 5–20%.

Path to Market:

- General Fusion's technology remains in its development stage.
- The first power plant is expected to start construction in Canada in 2021 and commission in 2024.
- SDTC has recently approved a follow-on project.

Soane Energy (Canada) Inc.

Round 14-2008B

Sector:

Waste Management

Project Completion Date:

August 2015

Market Impact Report Due:

August 2017

Total Project Value:

\$9,507,807

(pending final audit)

SDTC Funding:

\$2,658,878

Leveraged Funding:

\$6,848,929

Consortium Members:

Soane Energy (Canada) Inc.

Teck Resources Ltd.

Soane Energy LLC

Environmental Benefits

(Primary benefit bolded)

Clean Water

Climate Change

Project Title:

An Innovative Approach to Oil Sands Tailings Treatment

Project Description:

According to the Alberta Energy Regulator (AER), tailings ponds arising from oil sands surface mining operations cover an area of over 130 million square metres with some 720 million cubic metres of fine tailings (FT) collected. Directive 74 was issued in 2009 to address the tailings problem and required oil sands operators to reduce the amount of FT going into liquid tailings by 50% by 2013 and to turn captured FT into stackable deposits ready for reclamation. Soane Energy developed the Anchor-Tether-Activator (ATA) a novel process based on using polymers to attach the fine clay particles to heavier sand particles in tailings to facilitate separation and settling. The resultant aggregate is a solid material with high stability that meets the Directive requirements. Soane's technology was intended to directly treat tailings from an extraction plant and therefore potentially eliminate the need for tailings ponds and enable immediate water recycling and heat recovery.

Objectives:

- Develop and test a continuous process that is representative of the needs of an oil sands mining operator.
- Establish parameters including chemical dosing, input material requirements, mixing requirements and process parameters necessary to operate a continuous process.
- Build a demonstration scale system capable of testing the process and produce a commercially relevant deposit (25m x 10m x 5m) with geotechnical properties consistent with piloting tests. Monitor the geotechnical performance of the deposit for a minimum of one year to demonstrate the capability of the technology to meet Directive 74 criteria.

Results:

- Soane installed a pipe loop at the Saskatchewan Research Council (SRC) Pipe Flow Technology Centre and performed tests on a representative tailing stream.
- Soane established important process requirements through testing at SRC. Testing of the continuous process produced materials showing significant improvements in hydraulic conductivity and reduced consolidation time over incumbent technologies.
- Development of the demonstration scale system did not take place however, geo technical modelling based on the SRC results indicate that Soane's ATA process would be able to meet Directive 74 requirements whereas incumbent technologies could not.

Project Impacts:

- Due to current regulatory and economic conditions, no plans are currently in place for the market roll-out of the project technology and therefore, market roll-out environmental benefits are not reported.

Path to Market:

- Directive 74 was suspended in 2015 as industry was largely unable to meet the targets. Soane currently does not have any plans to commercialize the technology because regulatory uncertainty and the low oil price environment severely hinders the ability of oil sands companies to commit to any large scale technology development and adoption.
- Quantified environmental benefits vary significantly depending on the incumbent technology used as the baseline and the type of tailings (live or legacy).

Développement Effenco Inc.

Round 20 – 2011B

Sector:

Transportation

Project Completion Date:

October 2015

Market Impact Report Due:

October 2017

Total Project Value:

\$6,242,312 (Pending final audit)

SDTC Funding:

\$2,080,188

Leveraged Funding:

\$4,162,124

Consortium Members:

Waste Management, Inc.

Gaudreau environnement Inc.

BFI Canada Inc.

City of Edmonton

Panda Waste Management Solutions

Waste Industries LLC

Grundon Waste Management Limited

Biffa Municipal Limited

Refuse Vehicle Solution Ltd.

Department of Sanitation of New York City

Environmental Benefits

(Primary benefit bolded)

Climate Change

Clean Air

Project Title:

Large Scale Demonstration of a Stop-Start Hybrid System for Heavy Duty Utility Trucks

Project Description:

Garbage trucks, which already spend 40-50 percent of their time idling between stops, require considerable energy to power the hydraulic systems that collect and compact waste. Effenco is developing Hydraulic Equipment Assisting Devices (HEAD) that capture and use the energy from braking in large Class Eight trucks (i.e., the largest, heaviest trucks on the road, including garbage trucks). The initial HEAD development funded by SDTC (2007-A-1257) used the energy from braking to assist with the operation of the hydraulic pumps currently operated by the truck's engine. The current technology, called "Stop-Start", actually shuts off the engine when stopped, then uses the stored braking energy to power hydraulic equipment and assist with restarting the truck's engine. The improvement is expected to reduce energy losses related to idling, resulting in estimated fuel savings of as much as 25 percent. Each device is estimated to reduce a garbage truck's annual CO₂e emissions by 19 to 28 t.

Objectives:

- To manufacture and install Stop-Start hybrid systems on 24 vehicles.
- To achieve 15-25% fuel savings.
- To achieve 90% availability for systems and 95% for trucks.
- To achieve production cost targets for varying production volumes.

Results:

- Effenco manufactured and installed Stop-Start hybrid systems (multiple variations) on 27 vehicles.
- Fuel savings ranged from 14 to 33%, depending mainly on truck routes.
- System availability was 90% and truck availability exceeded 95%.
- Production costs targets were met or exceeded.

Project Impacts:

- The demonstration of Effenco's Stop-Start system resulted in a GHG emission reduction of 31 t CO₂e.
- The GHG emission reduction intensity associated with the refuse truck was 0.7 kg CO₂e/L diesel. The GHG emission reduction intensity associated with the terminal tractor was 1.15 kg CO₂e/L diesel.
- The demonstration also resulted in reductions in CAC emissions.
- The roll-out of Effenco's Stop-Start system is expected to result in annual GHG emission reductions per refuse truck of 23 t CO₂e and per terminal tractor of 19 t CO₂e.
- Roll-out will result in GHG emission reductions of 59 kt CO₂e in Canada in 2026 and 526 kt CO₂e in the Rest of the World. The roll-out is also expected to result in reductions in CAC emissions.

Path to Market:

- Développement Effenco is on track to sign an agreement with New York City to retrofit existing refuse trucks and install their technology on new trucks.
- They also signed an exclusive agreement with Dennis Eagle for the distribution of the technology in Europe.
- Développement Effenco is also planning demonstrations of terminal tractors equipped with the technology.

Western Hydrogen Limited

Round 12-2007-B

Sector:

Energy Exploration and Production

Project Completion Date:

June 2014*

Market Impact Report Due:

June 2016

Total Project Value:

\$12,357,745

SDTC Funding:

\$4,162,653

Leveraged Funding:

\$8,195,092

Consortium Members:

Western Hydrogen Ltd.

Aux Sable Canada Ltd.

Environmental Benefits:

(primary benefit bolded)

Climate Change

Clean Air

Project Title:

Molten Salt Catalyzed Gasification Plant

Project Description:

Western Hydrogen Limited (WHL) is a Canadian company, based in Calgary, Alberta dedicated to the development and commercialization of a new hydrogen manufacturing technology that can use multiple low cost feedstock including glycerol, crop waste and petroleum coke/residuals called Molten Salt Catalyzed Gasification (MSG). This process was projected to have economic and environmental advantages over current hydrogen manufacturing technologies including lower hydrogen supply costs, maximum feedstock flexibility, lower greenhouse gas (GHG) emissions, high pressure hydrogen production, and “sequestration ready” carbon dioxide.

Objectives:

- To demonstrate the continuous operation of the MSG process at 5 t/day of hydrogen production.
- To demonstrate the economic and environmental benefits associated with producing high pressure hydrogen from waste feedstocks like petroleum coke/residuals.

Results:

- The pilot plant operated for a total of 327 hours, during which 53 kg of Hydrogen gas was produced; however, multiple unforeseen issues were encountered and the pilot plant did not operate as expected.
- The process required significantly more heat than expected coupled with the drop in natural gas feedstock cost made the technology not operationally or economically viable at this time.
- Plans to increase pilot plant production capacity (as intended in the original contribution agreement) were not pursued. The pilot plant is, however, being used to support a subsequent WHL SDTC project.

Project Impacts:

- Pilot plant operation resulted in approximately 460 t CO₂e of GHG emissions.
- Due to the technology not being operationally or economically viable at this time, there are no market rollout forecasts attributable to this project.

Path to Market:

- Western Hydrogen is exploring ways to enhance the performance of its technology in order to achieve a path to market which includes niche markets for renewable hydrogen.

* Project related activities were completed in June 2014 however, final project reporting was completed in 2015.

Section 5: SD Tech Fund™ – Funding Summary for Projects Approved since Inception

Active Projects

*Project is contracted **Project is Funded through the SD Natural Gas Fund™ under which 50% of SDTC funding is contributed by CGA

Lead Organization	Approved SDTC Funding	% of Eligible Project Costs	Eligible Recipient Funding Contribution	% of Eligible Project Costs	Other Government & Academia Funding	% of Eligible Project Costs	Total Eligible Project Costs	Environmental Benefits (Primary Benefits Bolded)				Priority Tech Area (see codes below)
Round 27-2015A												
ARDA Power Inc.	\$400,000	38.1%	\$648,542	61.9%	\$0	0.0%	\$1,048,542	CC	CA			2
ASE Smart Energy Inc*	\$300,000	42.3%	\$289,148	40.7%	\$120,540	17.0%	\$709,688	CC				3
Cellufuel Inc.	\$2,152,693	33.0%	\$4,370,619	67.0%	\$0	0.0%	\$6,523,312	CC				4
Comet Biorefining Inc.	\$10,890,000	31.4%	\$18,822,338	54.2%	\$5,000,000	14.4%	\$34,712,338	CC		CW		4
Nanoleaf	\$2,879,925	32.8%	\$5,504,846	62.7%	\$393,000	4.5%	\$8,777,771	CC	CA			3
FORGE Hydrocarbons Corporation	\$4,201,814	33.0%	\$8,530,956	67.0%	\$0	0.0%	\$12,732,770	CC				4
General Fusion Inc.	\$12,748,560	32.7%	\$21,692,802	55.7%	\$4,530,000	11.6%	\$38,971,362	CC	CA			2
Imtex Membranes Corp.	\$3,336,960	33.0%	\$6,775,435	67.0%	\$0	0.0%	\$10,112,395	CC	CA			3
Loop Energy Inc.	\$7,500,000	33.1%	\$8,790,650	38.8%	\$6,389,476	28.2%	\$22,680,126	CC	CA			4
May-Ruben Thermal Solutions	\$832,000	33.0%	\$1,295,802	51.4%	\$395,000	15.7%	\$2,522,802	CC	CA			3
Nano One Materials	\$2,081,297	32.9%	\$3,992,045	63.1%	\$250,000	4.0%	\$6,323,342	CC	CA			4
Netlift Transport Social Inc.	\$448,000	47.6%	\$410,480	43.6%	\$83,125	8.8%	\$941,605	CC	CA			4
NextGrid Inc.***	\$300,000	39.8%	\$453,306	60.2%	\$0	0.0%	\$753,306	CC				2
Nsolv Corporation	\$13,000,000	15.4%	\$46,311,075	54.9%	\$25,000,000	29.7%	\$84,311,075	CC	CA	CW		1
QD Solar Inc.	\$2,550,000	31.6%	\$5,515,050	68.4%	\$0	0.0%	\$8,065,050	CC	CA			2
Quantiam Technologies Inc.	\$4,250,000	26.2%	\$11,980,148	73.8%	\$0	0.0%	\$16,230,148	CC	CA			3
Ronin8 Technologies Ltd.*	\$300,000	20.2%	\$1,184,313	79.8%	\$0	0.0%	\$1,484,313	CC				3
Sherbrooke OEM Ltd.	\$1,275,000	31.7%	\$2,750,000	68.3%	\$0	0.0%	\$4,025,000	CC			CS	3
Smart Pipe Company Canada Inc.	\$2,363,709	33.0%	\$4,799,047	67.0%	\$0	0.0%	\$7,162,756	CC				1
Syscor Controls & Automation Inc.	\$1,626,138	33.3%	\$1,600,275	32.8%	\$1,652,000	33.9%	\$4,878,413				CS	1
Teck Resources Limited	\$2,673,652	33.0%	\$5,428,325	67.0%	\$0	0.0%	\$8,101,977	CC	CA	CW	CS	3
Terrestrial Energy Inc.	\$5,739,167	33.3%	\$11,484,056	66.7%	\$0	0.0%	\$17,223,223	CC	CA			2
Round 26-2014B												
Alliance Magnesium Inc.*	\$3,000,000	31.6%	\$4,568,085	48.2%	\$1,912,500	20.2%	\$9,480,585	CC			CS	3
Avalon Rare Metals Inc.	\$1,313,630	33.0%	\$995,175	25.0%	\$1,671,892	42.0%	\$3,980,697	CC	CA		CS	3
CO2 Solutions Inc. **	\$2,442,000	33.0%	\$2,400,000	32.4%	\$2,558,000	34.6%	\$7,400,000	CC				4
DMF Medical Incorporated*	\$686,575	42.0%	\$804,000	49.2%	\$145,000	8.9%	\$1,635,575	CC	CA			7

Environmental Benefits

CC = climate change, **CA** = clean air,
CW = clean water, **CS** = clean soil

Priority Tech Area:

1 = Unconventional Oil & Gas 2 = Distributed Power Generation 3 = Energy Efficiency for Industry and Communities
4 = Next Generation Technology 5 = Hydrogen 6 = Clean Fossil Fuel
7 = Other * = Uncategorized - not required under previous funding agreements

Lead Organization	Approved SDTC Funding	% of Eligible Project Costs	Eligible Recipient Funding Contribution	% of Eligible Project Costs	Other Government & Academia Funding	% of Eligible Project Costs	Total Eligible Project Costs	Environmental Benefits (Primary Benefits Bolded)				Priority Tech Area (see codes below)	
Hydrogenics Corp. **	\$2,500,000	32.8%	\$5,125,890	67.2%	\$0	0.0%	\$7,625,890	CC					7
Liquid Light (Canada) Inc	\$8,585,597	29.8%	\$20,231,016	70.2%	\$0	0.0%	\$28,816,613	CC					4
Pyrowave Inc*	\$1,048,474	33.5%	\$2,081,853	66.5%	\$0	0.0%	\$3,130,327	CC			CS		3
Quest Rare Minerals Ltd.	\$4,934,504	33.0%	\$8,018,537	53.6%	\$2,000,000	13.4%	\$14,953,041	CC	CA		CS		3
Sigma Energy Storage Inc.	\$2,436,068	33.0%	\$2,048,955	27.8%	\$2,897,000	39.2%	\$7,382,023	CC	CA				2
Thetis Environmental Inc*	\$1,100,000	37.0%	\$1,376,043	46.2%	\$500,000	16.8%	\$2,976,043	CC	CA	CW			3
Round 25-2014A													
CHAR Technologies Inc.* **	\$750,000	31.2%	\$1,173,402	48.8%	\$480,000	20.0%	\$2,403,402	CC	CA				1
CrossChasm Technologies Inc.*	\$430,000	35.6%	\$778,556	64.4%	\$0	0.0%	\$1,208,556	CC	CA				4
David Bromley Engineering Ltd	\$3,225,000	33.2%	\$6,500,000	66.8%	\$0	0.0%	\$9,725,000	CC	CA				1
Field Upgrading Limited*	\$5,150,000	23.0%	\$8,652,089	38.6%	\$8,585,700	38.3%	\$22,387,789	CC	CA				6
Fractal Systems Inc.*	\$3,700,000	32.3%	\$7,771,324	67.7%	\$0	0.0%	\$11,471,324	CC					6
Kelvin Storage Canada Inc.	\$2,830,936	32.1%	\$5,997,637	67.9%	\$0	0.0%	\$8,828,573	CC	CA				2
OTI Lumionics Inc.	\$5,668,675	33.3%	\$5,668,675	33.3%	\$5,668,675	33.3%	\$17,006,025	CC	CA				3
Sigma Devtech Inc.	\$3,100,000	29.6%	\$5,967,875	56.9%	\$1,422,255	13.6%	\$10,490,130	CC			CS		4
SWITCH Materials*	\$2,500,000	24.2%	\$7,813,892	75.8%	\$0	0.0%	\$10,313,892	CC	CA				4
West Fraser Mills Ltd.*	\$6,100,000	32.8%	\$9,481,707	51.0%	\$3,000,000	16.1%	\$18,581,707	CC	CA				4
Round 24-2013B													
BBCP Conductor Inc.	\$3,660,000	32.1%	\$7,750,000	67.9%	\$0	0.0%	\$11,410,000	CC	CA				3
CelluForce inc*	\$4,004,254	30.9%	\$8,809,449	68.1%	\$129,398	1.0%	\$12,943,101	CC		CW			1
GaN Systems Inc*	\$2,187,971	33.0%	\$3,442,251	51.9%	\$1,000,000	15.1%	\$6,630,222	CC	CA				4
Grafoid Inc.*	\$8,120,646	32.4%	\$15,777,905	62.9%	\$1,170,725	4.7%	\$25,069,276	CC	CA				3
Ionada Incorporated*	\$1,394,495	28.6%	\$3,047,267	62.4%	\$440,000	9.0%	\$4,881,762	CC	CA				4
Miovision Technologies Incorporated*	\$1,400,000	19.0%	\$5,955,499	81.0%	\$0	0.0%	\$7,355,499	CC	CA				7
OpenHydro Technology Canada Ltd.*	\$6,352,500	18.9%	\$27,233,449	81.1%	\$0	0.0%	\$33,585,949	CC	CA				2
Polar Sapphire Ltd.*	\$2,650,000	33.8%	\$5,187,919	66.2%	\$0	0.0%	\$7,837,919	CC	CA				3
Questor Technology Inc.*	\$1,977,878	35.5%	\$3,598,825	64.5%	\$0	0.0%	\$5,576,703	CC	CA				2
Ranovus Inc.*	\$4,250,000	29.3%	\$9,185,317	63.3%	\$1,068,000	7.4%	\$14,503,317	CC	CA				3
Terramera Inc.*	\$1,984,581	33.5%	\$3,945,805	66.5%	\$0	0.0%	\$5,930,386	CC	CA	CW	CS		7

Environmental Benefits

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Round 23-2013A												
BRIC Engineered Systems Inc.*	\$710,000	32.2%	\$1,497,430	67.8%	\$0	0.0%	\$2,207,430			CW	CS	4
Carbon Engineering Ltd.*	\$3,000,000	32.8%	\$4,523,118	49.4%	\$1,626,723	17.8%	\$9,149,841	CC				4
Electro Kinetic Solutions Inc.	\$2,116,140	33.3%	\$2,232,279	35.2%	\$2,000,000	31.5%	\$6,348,419	CC	CA	CW	CS	1
Green Power Labs Inc.*	\$1,604,531	29.6%	\$1,398,932	25.8%	\$2,415,420	44.6%	\$5,418,883	CC	CA			3
GreenMantra Technologies*	\$2,007,450	31.6%	\$4,353,435	68.4%	\$0	0.0%	\$6,360,885	CC	CA		CS	7
Inventys Thermal Technologies Inc.	\$3,100,000	32.7%	\$6,392,458	67.3%	\$0	0.0%	\$9,492,458	CC				4
Morgan Solar Inc.*	\$2,067,778	31.7%	\$2,600,494	39.9%	\$1,850,000	28.4%	\$6,518,272	CC	CA			2
Nemaska Lithium Inc.	\$12,870,000	32.1%	\$17,225,000	43.0%	\$10,000,000	24.9%	\$40,095,000	CC	CA		CS	3
Orbite Technologies Inc.	\$4,500,000	32.0%	\$8,562,000	61.0%	\$981,310	7.0%	\$14,043,310	CC		CW	CS	3
Pure Technologies Ltd.*	\$1,000,000	33.2%	\$1,400,000	46.4%	\$615,000	20.4%	\$3,015,000	CC				1
Saltworks Technologies Inc.*	\$2,500,000	33.3%	\$5,000,000	66.7%	\$0	0.0%	\$7,500,000	CC	CA	CW		1
Sysgaz Inc.*	\$2,205,539	27.1%	\$2,488,090	30.5%	\$3,455,000	42.4%	\$8,148,629	CC	CA			4
Verolube Inc	\$3,994,060	32.9%	\$8,149,440	67.1%	\$0	0.0%	\$12,143,500	CC	CA			7
ZincNyx Energy Solutions*	\$2,900,000	29.1%	\$6,870,000	68.9%	\$200,000	2.0%	\$9,970,000	CC	CA			2
Round 22-2012B												
Hifi Engineering Inc.*	\$2,000,000	33.7%	\$3,926,220	66.3%	\$0	0.0%	\$5,926,220			CW	CS	*
Luxmux Technology Corporation*	\$980,350	32.5%	\$1,049,367	34.8%	\$985,542	32.7%	\$3,015,259	CC	CA	CW		*
Macrotek Inc.*	\$1,953,700	33.3%	\$3,912,580	66.7%	\$0	0.0%	\$5,866,280	CC	CA	CW	CS	*
Polymer Research Technologies	\$1,116,826	33.3%	\$2,233,652	66.7%	\$0	0.0%	\$3,350,478	CC			CS	*
Soilless Technology Inc.	\$2,500,000	33.0%	\$2,125,668	28.1%	\$2,950,000	38.9%	\$7,575,668	CC	CA	CW	CS	*
Solantro Semiconductor Corp.*	\$3,800,000	33.0%	\$7,716,019	67.0%	\$0	0.0%	\$11,516,019	CC	CA			*
Steeper Energy Canada Limited	\$3,000,000	28.7%	\$2,953,000	28.3%	\$4,500,000	43.0%	\$10,453,000	CC		CW		*
Ubiquity Solar Inc.*	\$3,122,445	31.2%	\$3,921,356	39.2%	\$2,965,000	29.6%	\$10,008,801	CC	CA			*
Unit Electrical Engineering Ltd*	\$300,000	32.9%	\$611,235	67.1%	\$0	0.0%	\$911,235	CC				*
Vive Crop Protection, Inc.*	\$3,723,504	33.7%	\$7,326,695	66.3%	\$0	0.0%	\$11,050,199			CW	CS	*
Round 21-2012A												
Airex Energy Inc.*	\$2,700,000	32.4%	\$3,008,030	36.1%	\$2,631,092	31.6%	\$8,339,122	CC	CA			*
Borealis Geopower Inc.*	\$2,379,962	29.1%	\$5,807,383	70.9%	\$0	0.0%	\$8,187,345	CC	CA			*
Diacarbon Energy Inc.*	\$2,100,000	19.3%	\$8,805,476	80.7%	\$0	0.0%	\$10,905,476	CC	CA			*
Dundee Sustainable Technologies*	\$8,000,000	18.4%	\$35,513,594	81.6%	\$0	0.0%	\$43,513,594			CW	CS	*
Nortek Air Solutions Canada*	\$2,671,129	30.2%	\$6,044,655	68.3%	\$138,000	1.6%	\$8,853,784	CC	CA	CW	CS	*

Environmental Benefits

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NuWave Research Inc.*	\$3,430,000	39.7%	\$4,117,690	47.7%	\$1,081,440	12.5%	\$8,629,130	CC	CA		CS	*
Polystyvert Inc.*	\$1,980,000	38.0%	\$3,236,992	62.0%	\$0	0.0%	\$5,216,992	CC			CS	*
R.I.I. North America Inc.*	\$6,453,754	26.0%	\$16,583,327	66.7%	\$1,817,793	7.3%	\$24,854,873	CC	CA	CW		*
Yava Technologies Inc.*	\$399,123	32.6%	\$824,479	67.4%	\$0	0.0%	\$1,223,602	CC	CA	CW	CS	*
Round 20-2011B												
Agri-Neo Inc.*	\$2,500,000	28.5%	\$4,887,595	55.8%	\$1,375,000	15.7%	\$8,762,595			CW	CS	*
Atlantis Operations (Canada) Ltd.*	\$5,000,000	32.7%	\$10,296,788	67.3%	\$0	0.0%	\$15,296,788	CC	CA			*
Développement Effenco Inc.*	\$2,080,188	33.3%	\$2,937,688	47.1%	\$1,224,436	19.6%	\$6,242,312	CC	CA			*
GHGsat Inc.*	\$2,317,648	32.7%	\$2,656,296	37.5%	\$2,118,081	29.9%	\$7,092,025	CC	CA			*
MEG Energy Corp.*	\$13,000,000	6.0%	\$184,488,811	84.8%	\$20,000,000	9.2%	\$217,488,811	CC	CA			*
Minesense Technologies Ltd.*	\$4,435,794	30.9%	\$8,875,108	61.8%	\$1,059,525	7.4%	\$14,370,427	CC	CA	CW	CS	*
New Flyer Industries ULC Canada*	\$3,400,000	34.1%	\$4,537,418	45.5%	\$2,042,986	20.5%	\$9,980,404	CC	CA			*
Whale Shark Environmental Technologies Ltd.*	\$829,266	42.3%	\$939,158	47.9%	\$191,165	9.8%	\$1,959,589	CC	CA	CW		*
Round 19-2011A												
Accelerated Systems Inc.*	\$1,400,000	35.0%	\$2,600,624	65.0%	\$0	0.0%	\$4,000,624	CC	CA			*
CVTCORP Transmission*	\$1,027,887	30.9%	\$1,777,683	53.4%	\$521,403	15.7%	\$3,326,973	CC	CA			*
Hydrostor Inc.*	\$2,171,011	37.0%	\$1,901,057	32.4%	\$1,795,529	30.6%	\$5,867,597	CC	CA			*
Round 18-2010B												
BioAmber Sarnia Inc.*	\$14,513,650	33.2%	\$23,783,754	54.4%	\$5,400,000	12.4%	\$43,697,404	CC				*
CarbonCure Technologies Inc.*	\$1,492,000	34.7%	\$2,114,042	49.2%	\$690,140	16.1%	\$4,296,182	CC	CA	CW		*
CoolEdge Lighting Ltd.*	\$4,469,000	35.1%	\$3,902,635	30.7%	\$4,343,496	34.2%	\$12,715,131	CC	CA	CW	CS	*
Logistik Unicorp*	\$1,012,828	36.2%	\$1,124,396	40.2%	\$660,419	23.6%	\$2,797,643	CC	CA		CS	*
Namgis First Nation*	\$5,650,000	35.5%	\$8,953,065	56.3%	\$1,297,575	8.2%	\$15,900,640			CW		*
Northex Environnement Inc.*	\$1,552,354	32.0%	\$2,464,251	50.8%	\$832,125	17.2%	\$4,848,730			CW	CS	*
Nova Green Inc.*	\$1,098,905	33.9%	\$970,000	29.9%	\$1,177,356	36.3%	\$3,246,261	CC			CS	*
Paradigm Shift Technologies Inc.*	\$1,955,250	35.9%	\$3,494,106	64.1%	\$0	0.0%	\$5,449,356	CC	CA			*
PAVAC Industries Inc.*	\$3,549,865	33.7%	\$6,976,755	66.3%	\$0	0.0%	\$10,526,620	CC	CA			*
Shipstone Corp.*	\$2,813,498	46.8%	\$3,204,544	53.2%	\$0	0.0%	\$6,018,042	CC	CA			*
TM4 Inc.*	\$3,135,371	20.4%	\$4,469,334	29.1%	\$7,772,936	50.5%	\$15,377,641	CC	CA			*

Environmental Benefits

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Priority Tech Area:

1 = Unconventional Oil & Gas
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Round 17-2010A												
Corvus Energy Ltd.*	\$582,467	33.0%	\$1,182,585	67.0%	\$0	0.0%	\$1,765,052	CC	CA			*
CRB Innovations Inc.*	\$5,362,500	26.1%	\$10,208,476	49.6%	\$5,000,000	24.3%	\$20,570,976	CC	CA			*
eCAMION Inc.*	\$5,435,750	33.3%	\$10,873,138	66.7%	\$0	0.0%	\$16,308,888	CC	CA			*
Temporal Power Ltd.*	\$4,123,572	34.3%	\$7,898,506	65.7%	\$0	0.0%	\$12,022,078	CC	CA			*
Tyne Engineering Inc.*	\$1,534,097	31.1%	\$2,190,344	44.4%	\$1,210,508	24.5%	\$4,934,949		CA	CW	CS	*
Round 16-2009B												
Electrovaya Inc.*	\$8,224,171	31.2%	\$14,147,976	53.8%	\$3,948,026	15.0%	\$26,320,173	CC	CA			*
EnerMotion Inc.*	\$1,210,704	40.0%	\$1,259,652	41.6%	\$560,000	18.5%	\$3,030,356	CC	CA			*
Etalim Inc.*	\$2,936,530	39.0%	\$2,264,838	30.1%	\$2,330,031	30.9%	\$7,531,399	CC	CA	CW	CS	*
MARA Renewables Corporation*	\$9,614,045	35.0%	\$17,854,655	65.0%	\$0	0.0%	\$27,468,700	CC	CA	CW	CS	*
Quadrogen Power Systems Inc.*	\$2,910,145	39.1%	\$3,477,831	46.7%	\$1,053,245	14.2%	\$7,441,221	CC	CA			*
SBI BioEnergy Inc.*	\$2,175,495	18.6%	\$3,192,205	27.4%	\$6,300,364	54.0%	\$11,668,063	CC	CA	CW	CS	*
Tenova Goodfellow Inc.*	\$1,822,513	29.5%	\$4,346,389	70.5%	\$0	0.0%	\$6,168,902	CC				*
Round 15-2009A												
Exro Technologies Inc.*	\$881,235	22.0%	\$3,119,807	78.0%	\$0	0.0%	\$4,001,042	CC	CA			*
PV Labs Inc.*	\$965,253	32.7%	\$1,987,791	67.3%	\$0	0.0%	\$2,953,044	CC		CW	CS	*
Round 12-2007B												
Marine Exhaust Solutions Inc.*	\$1,320,804	37.4%	\$2,206,991	62.6%	\$0	0.0%	\$3,527,795	CC	CA			*
Total	\$407,022,786	26.5%	\$939,994,041	61.1%	\$191,578,952	12.5%	\$1,538,595,77					

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Completed Projects												
Note: Amounts are based on actual disbursements at project completion												
Round 20-2011B												
semiosBIO Technologies Inc.	\$4,980,000	31.1%	\$10,923,807	68.1%	\$130,000	0.8%	\$16,033,807			CW	CS	*
Round 19-2011A												
Pure Technologies Ltd.	\$1,000,000	32.0%	\$1,831,138	58.7%	\$290,000	9.3%	\$3,121,138	CC		CW		*
Vision Ecoproducts Ltd.	\$3,252,342	30.8%	\$7,303,675	69.2%	\$0	0.0%	\$10,556,017	CC	CA		CS	*
Round 18-2010B												
Nsolv Corp.	\$10,000,000	18.5%	\$28,141,727	52.0%	\$15,943,880	29.5%	\$54,085,607	CC	CA	CW		*
Solantro Semiconductor Corp.	\$2,049,234	28.8%	\$4,932,430	69.4%	\$125,000	1.8%	\$7,106,664	CC	CA			*
Round 17-2010A												
Ballard Power Systems Inc.	\$7,304,367	34.4%	\$13,934,617	65.6%	\$0	0.0%	\$21,238,984	CC	CA			*
Echologics Engineering Inc.	\$1,051,926	32.7%	\$1,794,785	55.8%	\$370,679	11.5%	\$3,217,390	CC		CW	CS	*
FibraCast	\$1,947,736	33.0%	\$2,662,860	45.1%	\$1,291,633	21.9%	\$5,902,229	CC		CW		*
S2G Biochemicals Inc.	\$2,616,952	33.9%	\$3,851,969	49.9%	\$1,251,336	16.2%	\$7,720,257	CC		CW		*
SWITCH Materials Inc.	\$2,363,621	29.4%	\$4,089,113	50.8%	\$1,594,045	19.8%	\$8,046,780	CC	CA			*
Westport Power Inc.	\$2,302,834	20.6%	\$8,869,411	79.4%	\$0	0.0%	\$11,172,245	CC	CA			*
Woodland Biofuels Inc.	\$4,275,000	33.1%	\$4,625,000	35.9%	\$4,000,000	31.0%	\$12,900,000	CC		CW	CS	*
Round 16-2009B												
Available Energy Corp.	\$1,020,000	42.9%	\$1,132,662	47.7%	\$222,595	9.4%	\$2,375,257	CC	CA	CW		*
InvenTYS Thermal Technologies Inc.	\$1,598,001	40.8%	\$1,957,239	50.0%	\$359,707	9.2%	\$3,914,947	CC				*
InvoDane Engineering Ltd.	\$2,467,125	24.6%	\$7,567,625	75.4%	\$0	0.0%	\$10,034,750	CC				*
Johnson Matthey Battery Materials Ltd.	\$4,700,508	27.8%	\$12,210,547	72.2%	\$0	0.0%	\$16,911,055	CC	CA			*
Lakeshore EMPC Two L.P.	\$1,037,669	41.6%	\$1,456,728	58.4%	\$0	0.0%	\$2,494,397	CC		CW	CS	*
MPT Mustard Products & Technologies Inc.	\$2,217,949	31.0%	\$4,853,152	67.7%	\$94,957	1.3%	\$7,166,058		CA	CW	CS	*
Round 15-2009A												
Agrisoma Biosciences Inc. **	\$3,275,000	30.2%	\$6,822,753	62.9%	\$750,587	6.9%	\$10,848,340	CC	CA	CW	CS	*
Automotive Fuel Cell Cooperation	\$11,506,305	22.2%	\$40,253,953	77.8%	\$0	0.0%	\$51,760,258	CC	CA			*
Ballard Power Systems Inc.	\$6,905,887	21.3%	\$25,546,585	78.7%	\$0	0.0%	\$32,452,471	CC	CA			*
Entropex Ltd.	\$6,330,000	25.3%	\$14,521,709	58.0%	\$4,172,680	16.7%	\$25,024,389	CC	CA	CW	CS	*
Morgan Solar Inc.	\$2,351,580	21.1%	\$8,191,860	73.4%	\$620,181	5.6%	\$11,163,621	CC	CA			*
NutraCanada	\$1,900,000	20.1%	\$5,512,146	58.3%	\$2,050,000	21.7%	\$9,462,146	CC		CW	CS	*

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Pulse Energy Inc.	\$2,556,801	28.9%	\$4,327,413	48.9%	\$1,962,868	22.2%	\$8,847,082	CC	CA			*
RER Hydro Ltd.	\$2,760,000	14.0%	\$14,322,725	72.4%	\$2,700,000	13.6%	\$19,782,725	CC	CA			*
Terragon Environmental Technologies Inc.	\$3,174,000	39.6%	\$2,239,827	28.0%	\$2,592,598	32.4%	\$8,006,425			CW	CS	*
Round 14-2008B												
Alcoa Ltd.	\$170,958	28.5%	\$428,887	71.5%	\$0	0.0%	\$599,845	CC	CA	CW	CS	*
Canadian Pallet Council	\$1,058,755	43.6%	\$1,369,582	56.4%	\$0	0.0%	\$2,428,338	CC	CA			*
Duopar Technologies Inc.	\$2,829,000	44.6%	\$2,789,675	43.9%	\$729,999	11.5%	\$6,348,674		CA	CW	CS	*
Eco-Ag Initiatives Inc.	\$1,948,000	33.6%	\$3,455,615	59.7%	\$388,000	6.7%	\$5,791,615	CC	CA	CW	CS	*
Imtex Membranes Corp.	\$2,753,948	31.5%	\$5,909,930	67.7%	\$71,500	0.8%	\$8,735,378	CC	CA			*
Lignol Innovations Ltd.	\$6,370,076	34.2%	\$7,021,385	37.7%	\$5,246,146	28.1%	\$18,637,607	CC	CA		CS	*
MEG Energy Corp.	\$4,270,000	23.5%	\$12,472,245	68.7%	\$1,400,000	7.7%	\$18,142,245	CC				*
Produits Enuchem Inc.	\$595,000	39.7%	\$904,904	60.3%	\$0	0.0%	\$1,499,904			CW	CS	*
Saltworks Technologies Inc.	\$2,612,638	32.4%	\$3,595,900	44.6%	\$1,855,484	23.0%	\$8,064,022	CC		CW		*
Soane Energy (Canada) Inc	\$2,658,878	28.0%	\$6,848,929	72.0%	\$0	0.0%	\$9,507,807	CC		CW		*
Statoil Hydro Canada Ltd.	\$6,000,000	15.5%	\$32,791,337	84.5%	\$0	0.0%	\$38,791,337	CC		CW		*
SunSelect Produce (Delta) Inc.	\$1,672,425	29.8%	\$3,409,622	60.8%	\$526,959	9.4%	\$5,609,006	CC	CA			*
Sunwell Technologies Inc.	\$2,779,849	39.0%	\$4,340,464	61.0%	\$0	0.0%	\$7,120,313	CC	CA			*
Titanium Corp. Inc.	\$6,292,635	29.1%	\$13,554,184	62.6%	\$1,795,970	8.3%	\$21,642,789	CC		CW	CS	*
Xogen Technologies Inc.	\$1,974,104	43.6%	\$2,453,769	54.2%	\$100,001	2.2%	\$4,527,874			CW	CS	*
Round 13-2008A												
A.U.G. Signals Ltd.	\$2,019,455	34.3%	\$3,869,886	65.7%	\$0	0.0%	\$5,889,341	CC	CA	CW		*
dPoint Technologies Inc.	\$1,378,254	39.3%	\$2,130,441	60.7%	\$0	0.0%	\$3,508,695	CC	CA			*
EcoSynthetix Corp.	\$1,679,331	33.0%	\$1,612,596	31.7%	\$1,796,955	35.3%	\$5,088,882	CC	CA			*
General Fusion Inc.	\$13,897,455	23.9%	\$44,180,136	76.0%	\$60,000	0.1%	\$58,137,591	CC	CA			*
GreenField Specialty Alcohols Inc.	\$3,927,964	30.3%	\$5,034,928	38.8%	\$4,000,686	30.9%	\$12,963,578	CC	CA	CW	CS	*
Innovente inc.	\$2,730,526	46.2%	\$1,503,130	25.4%	\$1,675,100	28.3%	\$5,908,755	CC		CW	CS	*
Integran Technologies Inc.	\$1,481,328	33.2%	\$2,236,794	50.1%	\$746,400	16.7%	\$4,464,522	CC	CA	CW		*
Nexterra Systems Corp.	\$5,518,777	27.2%	\$11,014,887	54.4%	\$3,730,000	18.4%	\$20,263,664	CC	CA			*
Paragon Soil and Environmental Consulting Inc.	\$230,879	43.8%	\$296,242	56.2%	\$0	0.0%	\$527,122	CC	CA	CW	CS	*
SunCentral Inc.	\$2,345,208	30.3%	\$3,043,711	39.3%	\$2,359,523	30.5%	\$7,748,443	CC	CA			*
Vive Crop Protection Inc.	\$3,954,706	35.8%	\$2,911,011	26.4%	\$4,172,886	37.8%	\$11,038,603	CC	CA	CW	CS	*

Environmental Benefits

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								CC	CA	CW	CS	
Round 12-2007B												
Atlantec BioEnergy Corp.	\$1,833,482	26.3%	\$4,769,998	68.3%	\$376,629	5.4%	\$6,980,109	CC	CA	CW	CS	*
GaN Systems Inc.	\$1,500,000	25.8%	\$4,304,880	74.2%	\$0	0.0%	\$5,804,880	CC	CA			*
Himark bioGas Inc.	\$3,331,976	28.2%	\$8,501,932	71.8%	\$0	0.0%	\$11,833,908	CC		CW	CS	*
Integrant Technologies Inc.	\$5,616,635	32.7%	\$11,411,024	66.4%	\$170,000	1.0%	\$17,197,659	CC	CA			*
Pathogen Detection Systems Inc.	\$2,671,627	31.1%	\$3,388,328	39.4%	\$2,539,045	29.5%	\$8,599,000			CW		*
Petroleum Technology Research Centre Inc.	\$5,000,000	18.2%	\$13,473,745	49.0%	\$9,000,000	32.8%	\$27,473,745	CC				*
Pure Technologies Ltd.	\$795,000	31.7%	\$1,133,335	45.2%	\$580,000	23.1%	\$2,508,335	CC	CA	CW		*
Verdant Power Canada ULC	\$487,324	40.6%	\$472,178	39.3%	\$240,844	20.1%	\$1,200,346	CC	CA			*
Western Hydrogen Ltd.	\$4,162,653	33.7%	\$8,195,092	66.3%	\$0	0.0%	\$12,357,745	CC	CA			*
Round 11-2007A												
bstNRG.com Inc.	\$1,651,169	45.0%	\$2,018,095	55.0%	\$0	0.0%	\$3,669,264	CC	CA		CS	*
Corporation HET - Horizon Environnement	\$1,509,807	23.4%	\$4,431,590	68.8%	\$500,000	7.8%	\$6,441,396	CC		CW	CS	*
Développement Effenco Inc.	\$1,074,955	28.3%	\$2,093,388	55.1%	\$633,456	16.7%	\$3,801,799	CC	CA			*
Fuseforward International Inc.	\$400,000	26.2%	\$679,343	44.6%	\$444,578	29.2%	\$1,523,921		CA	CW	CS	*
General Electric Canada	\$3,903,394	33.3%	\$7,818,509	66.7%	\$0	0.0%	\$11,721,903	CC	CA			*
MSR Innovations Inc.	\$680,839	46.2%	\$456,929	31.0%	\$335,629	22.8%	\$1,473,397	CC	CA			*
St-Jean Photochemicals	\$1,506,082	30.7%	\$1,256,989	25.6%	\$2,139,386	43.6%	\$4,902,456	CC	CA		CS	*
TM4 Inc.	\$3,818,787	30.9%	\$7,272,737	58.8%	\$1,286,000	10.4%	\$12,377,524	CC	CA			*
Round 10-2006B												
Advanced Lithium Power Inc	\$1,400,000	25.3%	\$3,734,876	67.5%	\$400,000	7.2%	\$5,534,876	CC	CA			*
Calisolar Inc.	\$4,074,505	26.0%	\$10,022,872	64.0%	\$1,559,432	10.0%	\$15,656,809	CC	CA			*
CVTCORP Transmission Inc.	\$2,131,950	27.9%	\$3,892,915	50.9%	\$1,625,000	21.2%	\$7,649,865	CC	CA			*
Fifth Light Technology Ltd.	\$3,911,300	30.5%	\$7,225,340	56.3%	\$1,700,000	13.2%	\$12,836,640	CC	CA			*
Middle Bay Sustainable Aquaculture Institute	\$3,591,444	32.0%	\$7,638,883	68.0%	\$0	0.0%	\$11,230,327			CW	CS	*
SiREM ULC	\$318,304	32.8%	\$652,135	67.2%	\$0	0.0%	\$970,439	CC		CW	CS	*
Terragon Environmental Technologies Inc.	\$1,592,500	38.9%	\$1,787,094	43.6%	\$718,190	17.5%	\$4,097,783	CC	CA	CW	CS	*
TM4 Inc. Wind	\$622,542	18.6%	\$1,824,460	54.5%	\$900,000	26.9%	\$3,347,002	CC	CA			*
Turbo Trac Systems ULC Inc.	\$188,934	4.5%	\$4,012,688	95.5%	\$0	0.0%	\$4,201,622	CC	CA			*
Round 9-2006A												
Dynamic Systems Incorporated	\$738,531	36.4%	\$1,289,550	63.6%	\$0	0.0%	\$2,028,081	CC	CA			*
Enekem Technologies Inc.	\$2,660,476	15.5%	\$14,486,785	84.5%	\$0	0.0%	\$17,147,261	CC	CA			*

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General Electric Canada	\$2,485,395	33.3%	\$783,047	10.5%	\$4,187,741	56.2%	\$7,456,183	CC	CA	CW	CS	*
Milligan Biofuels Inc	\$7,004,493	24.9%	\$21,117,230	75.0%	\$19,892	0.1%	\$28,141,614	CC	CA			*
Round 8-2005B												
ARISE Technologies Corporation	\$6,439,037	32.8%	\$13,192,174	67.2%	\$0	0.0%	\$19,631,211	CC	CA			*
BESTECH (Boudreau-Espley-Pitre Corporation)	\$1,448,000	32.2%	\$3,046,502	67.8%	\$0	0.0%	\$4,494,502	CC	CA			*
Chinook Mobile Heating and De-icing Inc.	\$3,063,766	41.5%	\$3,078,016	41.7%	\$1,236,500	16.8%	\$7,378,282	CC		CW	CS	*
EcoVu Analytics Inc.	\$1,035,555	32.7%	\$1,957,513	61.8%	\$172,647	5.5%	\$3,165,715			CW		*
Hydrogenics Corporation	\$2,248,493	28.4%	\$5,668,736	71.6%	\$0	0.0%	\$7,917,229	CC	CA			*
Maritime Innovation (IMAR)	\$979,800	38.5%	\$1,128,392	44.4%	\$435,565	17.1%	\$2,543,757			CW		*
New Energy Corporation Inc.	\$2,000,000	31.4%	\$1,633,467	25.6%	\$2,741,058	43.0%	\$6,374,525	CC	CA			*
Nutriloc Ingredients Corporation	\$847,319	35.2%	\$822,782	34.2%	\$734,393	30.5%	\$2,404,493	CC	CA		CS	*
Ostara Nutrient Recovery Technologies Inc.	\$375,760	21.1%	\$682,959	38.4%	\$718,910	40.4%	\$1,777,628	CC	CA	CW	CS	*
Power Measurement Ltd.	\$2,960,871	32.5%	\$5,893,795	64.7%	\$250,000	2.7%	\$9,104,666	CC	CA	CW		*
Pure Technologies Ltd.	\$2,200,000	32.2%	\$3,858,424	56.4%	\$782,138	11.4%	\$6,840,562		CA	CW	CS	*
Tantalus Systems Corp.	\$2,981,310	29.5%	\$7,121,213	70.5%	\$0	0.0%	\$10,102,523	CC	CA			*
Unicell Ltd.	\$756,155	21.3%	\$1,960,040	55.2%	\$833,828	23.5%	\$3,550,024	CC	CA			*
Wind Smart Inc.	\$1,082,738	40.1%	\$980,258	36.3%	\$639,618	23.7%	\$2,702,614	CC	CA			*
Round 7-2005A												
EcoSmart Foundation Inc.	\$1,499,143	48.8%	\$1,453,483	47.3%	\$119,389	3.9%	\$3,072,015	CC	CA			*
Nsolv Corporation	\$4,155,843	26.3%	\$11,650,516	73.7%	\$0	0.0%	\$15,806,359	CC	CA			*
Petroleum Technology Research Centre (JIVE)	\$3,168,990	33.0%	\$5,854,010	61.0%	\$580,000	6.0%	\$9,603,000	CC	CA			*
Plasco Trail Road Inc.	\$9,494,466	13.3%	\$53,077,190	74.6%	\$8,572,538	12.0%	\$71,144,194	CC	CA	CW		*
Power Diagnostic Technologies Ltd.	\$1,191,107	34.1%	\$2,296,365	65.8%	\$1,910	0.1%	\$3,489,382	CC	CA			*
Vaperma Inc.	\$5,049,958	33.3%	\$8,169,915	53.9%	\$1,930,000	12.7%	\$15,149,873	CC	CA			*
Round 6-2004B												
Angstrom Power Incorporated	\$169,752	13.4%	\$978,519	77.5%	\$115,000	9.1%	\$1,263,271	CC	CA			*
Clean Current Power Systems Incorporated	\$1,582,000	33.0%	\$3,213,500	67.0%	\$0	0.0%	\$4,795,500	CC	CA			*
Electrovaya Corp	\$1,859,530	33.0%	\$3,775,410	67.0%	\$0	0.0%	\$5,634,940	CC	CA			*
Leapfrog Lighting Inc.	\$3,724,663	31.0%	\$3,805,821	31.7%	\$4,486,251	37.3%	\$12,016,734	CC	CA			*
Prairie Pulp and Paper Inc.	\$1,237,290	35.1%	\$1,989,235	56.5%	\$295,000	8.4%	\$3,521,525	CC	CA		CS	*
Pratt & Whitney Canada Corporation	\$5,368,257	32.0%	\$10,831,080	64.6%	\$576,463	3.4%	\$16,775,800	CC	CA			*
Science Applications International Corporation	\$1,009,588	20.8%	\$246,143	5.1%	\$3,590,824	74.1%	\$4,846,555	CC	CA			*

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Sunarc of Canada Inc.	\$545,357	30.0%	\$730,538	40.2%	\$543,327	29.9%	\$1,819,222	CC	CA		*
University of British Columbia	\$2,408,702	33.0%	\$3,776,993	51.7%	\$1,113,403	15.3%	\$7,299,098	CC	CA		*
Round 5-2004A											
Atlantic Hydrogen Inc.	\$2,096,948	30.4%	\$3,220,266	46.7%	\$1,576,334	22.9%	\$6,893,548	CC	CA		*
Atlantic Packaging Products Ltd.	\$2,268,430	28.5%	\$5,690,974	71.5%	\$0	0.0%	\$7,959,404	CC	CA		CS
Great Northern Power Corp.	\$551,462	7.6%	\$6,589,080	90.7%	\$125,000	1.7%	\$7,265,541	CC	CA		*
M.A. Turbo/Engine Ltd.	\$152,844	46.0%	\$179,760	54.0%	\$0	0.0%	\$332,604		CA		*
Tenova Goodfellow Inc.	\$3,322,440	30.0%	\$6,337,962	57.2%	\$1,417,145	12.8%	\$11,077,548	CC	CA		*
Round 4-2003B											
BIOX Corporation	\$5,000,000	11.3%	\$35,423,977	79.7%	\$4,000,000	9.0%	\$44,423,977	CC	CA		*
Fifth Light Technology Ltd.	\$3,036,000	33.0%	\$3,914,000	42.5%	\$2,250,000	24.5%	\$9,200,000	CC			*
Lignol Innovations Ltd.	\$6,240,816	30.7%	\$9,369,986	46.1%	\$4,715,120	23.2%	\$20,325,922	CC	CA		*
Nanox Inc.	\$1,774,548	40.0%	\$1,249,748	28.2%	\$1,413,500	31.9%	\$4,437,796		CA		*
Sacré-Davey Engineering Inc.	\$5,727,711	32.4%	\$6,208,370	35.1%	\$5,745,629	32.5%	\$17,681,710	CC	CA		*
Synodon Inc	\$1,056,790	23.1%	\$2,748,328	60.1%	\$767,752	16.8%	\$4,572,871	CC			*
Whitefox Technologies Canada Ltd.	\$2,608,545	37.4%	\$4,374,554	62.6%	\$0	0.0%	\$6,983,099	CC	CA		*
Round 3-2003A											
Blue-Zone Technologies Ltd.	\$2,700,000	32.4%	\$3,851,540	46.2%	\$1,783,981	21.4%	\$8,335,521	CC			*
Hydrogenics Corporation	\$1,350,419	44.0%	\$1,327,716	43.3%	\$391,000	12.7%	\$3,069,135		CA		*
Paradigm Environmental Technologies Inc.	\$250,000	20.7%	\$653,804	54.1%	\$305,000	25.2%	\$1,208,804	CC	CA	CW	*
PlugPower Canada Inc.	\$2,000,000	22.2%	\$6,026,000	66.8%	\$1,000,000	11.1%	\$9,026,000		CA		*
Quantiam Technologies Inc.	\$1,450,000	14.7%	\$5,487,819	55.7%	\$2,907,000	29.5%	\$9,844,819	CC	CA		*
Saskatchewan Power Corporation (SaskPower)	\$2,414,610	21.7%	\$8,714,998	78.2%	\$20,000	0.2%	\$11,149,608		CA		*
Round 2-2002B											
Enerkem Technologies Inc.	\$720,573	32.0%	\$1,316,047	58.4%	\$216,798	9.6%	\$2,253,418	CC	CA		CS
Ensyn Technologies, Inc.	\$2,000,000	22.5%	\$3,295,871	37.0%	\$3,600,000	40.5%	\$8,895,871	CC	CA		*
Highmark Renewables Inc.	\$1,000,000	14.2%	\$3,801,570	53.9%	\$2,254,675	32.0%	\$7,056,245	CC	CA	CW	CS
Mikro-Tek Inc.	\$500,400	14.4%	\$2,982,950	85.6%	\$0	0.0%	\$3,483,350	CC			CS
Radient Technologies Inc.	\$810,000	44.7%	\$751,912	41.5%	\$250,000	13.8%	\$1,811,912	CC	CA		*
University of New Brunswick	\$257,826	35.5%	\$325,228	44.8%	\$142,457	19.6%	\$725,511	CC	CA		*
West Lorne Bio-Oil Co-Generation Limited	\$5,000,000	40.9%	\$7,015,947	57.4%	\$200,000	1.6%	\$12,215,947	CC	CA		*
ZENON Environmental Inc.	\$1,760,000	33.0%	\$3,574,000	67.0%	\$0	0.0%	\$5,334,000	CC	CA	CW	*

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Round 1-2002A												
Bio-Terre Systems Inc.	\$864,375	37.5%	\$800,974	34.7%	\$639,651	27.8%	\$2,305,000	CC	CA	CW	CS	*
Carmanah Technologies Inc.	\$466,167	22.9%	\$1,568,895	77.1%	\$0	0.0%	\$2,035,062	CC	CA			*
CO2 Solutions inc.	\$1,000,000	17.0%	\$1,614,557	27.5%	\$3,267,001	55.5%	\$5,881,558	CC				*
Westport Innovations Inc.	\$1,000,000	32.1%	\$1,565,376	50.2%	\$550,000	17.7%	\$3,115,376		CA			*
Total	\$381,023,444	26.5%	\$886,058,811	61.6%	\$170,540,982	11.9%	\$1,437,623,23					

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Early Termination Projects												
Note: Amounts are based on actual disbursement prior to termination												
Round 21-2012A												
RB Energy Inc.	\$333,444	28.9%	\$818,727	71.1%	\$0	0.0%	\$1,152,171	CC	CA	CW		*
Western Hydrogen Ltd.	\$1,480,000	32.9%	\$3,012,123	67.1%	\$0	0.0%	\$4,492,123	CC	CA	CW		*
Round 20-2011B												
Power Measurement Ltd.	\$0	0.0%	\$0	0.0%	\$0	0.0%	\$0	CC	CA			*
Solar Ship Inc.	\$2,180,000	35.3%	\$2,637,893	42.7%	\$1,366,313	22.1%	\$6,184,205	CC	CA			*
Round 19-2011A												
EcoSynthetix Corp.	\$2,100,000	32.9%	\$2,031,875	31.8%	\$2,250,000	35.3%	\$6,381,875	CC	CA	CW		*
RER Hydro Ltd.	\$3,779,966	51.5%	\$565,450	7.7%	\$3,000,000	40.8%	\$7,345,417	CC				*
Round 17-2010A												
Mining Technologies International Inc.	\$51,937	24.9%	\$156,637	75.1%	\$0	0.0%	\$208,573	CC	CA			*
NIMTech Inc.	\$326,778	96.1%	\$13,428	3.9%	\$0	0.0%	\$340,205	CC		CW		*
Round 16-2009B												
3XR Inc.	\$516,976	28.9%	\$646,068	36.1%	\$624,524	34.9%	\$1,787,568	CC		CW		*
6574262 Canada Inc. (ICUS)	\$102,400	33.7%	\$201,554	66.3%	\$0	0.0%	\$303,954	CC		CW	CS	*
Gestion TechnoCap Inc., SpaceWatts Division	\$840,000	31.2%	\$1,136,140	42.2%	\$718,168	26.7%	\$2,694,308	CC	CA			*
Spartan Bioscience Inc.	\$923,992	14.5%	\$5,030,810	79.2%	\$400,000	6.3%	\$6,354,802			CW	CS	*

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											CC	CA	CW	CS	
Round 15-2009A															
HTEC Hydrogen Technology & Energy Corp.	\$400,000	33.3%		\$585,053	48.8%		\$214,947	17.9%		\$1,200,000	CC	CA			*
Round 14-2008B															
ThermalFrost Inc.	\$639,659	62.0%		\$391,618	38.0%		\$0	0.0%		\$1,031,277	CC	CA			*
Round 13-2008A															
Alterna Energy Inc.	\$564,443	43.7%		\$725,813	56.3%		\$0	0.0%		\$1,290,256	CC	CA	CW		*
Performance Plants Inc.	\$651,400	33.5%		\$1,293,077	66.5%		\$0	0.0%		\$1,944,476	CC		CW	CS	*
Round 12-2007B															
Aboriginal Cogeneration Corp.	\$1,369,354	26.5%		\$3,795,178	73.5%		\$0	0.0%		\$5,164,532	CC	CA	CW	CS	*
Alstom Hydro Canada Inc.	\$1,396,351	29.3%		\$3,370,582	70.7%		\$0	0.0%		\$4,766,932	CC	CA			*
BioDiesel Reactor Technologies Inc.	\$498,000	10.0%		\$1,739,263	35.1%		\$2,720,769	54.9%		\$4,958,032	CC	CA	CW	CS	*
Lancaster Wind Systems Inc.	\$566,194	34.6%		\$1,071,006	65.4%		\$0	0.0%		\$1,637,200	CC	CA			*
SiXtron Advanced Materials	\$1,331,823	20.6%		\$5,132,979	79.4%		\$0	0.0%		\$6,464,802	CC	CA			*
Round 11-2007A															
Biothermica Technologies Inc.	\$78,726	35.1%		\$81,018	36.1%		\$64,458	28.7%		\$224,202	CC				*
EnviroTower Inc.	\$291,356	31.4%		\$637,500	68.6%		\$0	0.0%		\$928,856	CC		CW		*
Ferrinov Inc.	\$1,083,366	19.9%		\$3,809,358	70.1%		\$542,251	10.0%		\$5,434,975	CC	CA		CS	*
Round 10-2006B															
Biogénie S.R.D.C. Inc.	\$230,137	30.7%		\$518,367	69.3%		\$0	0.0%		\$748,504	CC	CA		CS	*
Early Warning Inc.	\$2,068,041	33.7%		\$2,984,119	48.6%		\$1,085,296	17.7%		\$6,137,455		CA	CW	CS	*
HTC Purenergy Inc.	\$535,414	35.4%		\$976,304	64.6%		\$0	0.0%		\$1,511,718	CC	CA			*
Nova Scotia Power Inc.	\$4,650,000	39.7%		\$7,054,996	60.3%		\$0	0.0%		\$11,704,996	CC	CA	CW		*
NxtGen Emission Controls Inc.	\$2,265,194	24.2%		\$7,078,533	75.8%		\$0	0.0%		\$9,343,727	CC	CA			*
Round 9-2006A															
Biothermica Technologies Inc.	\$200,487	33.4%		\$400,000	66.6%		\$0	0.0%		\$600,487	CC	CA		CS	*
Magenn Power Inc.	\$691,119	12.7%		\$4,205,462	77.4%		\$539,000	9.9%		\$5,435,581	CC	CA			*
MinMiner Oilsands Inc.	\$3,435,372	27.2%		\$8,500,573	67.3%		\$700,000	5.5%		\$12,635,945	CC	CA	CW	CS	*
Zenon Membrane Solutions	\$619,860	35.8%	\$1,111,128		64.2%	\$0		0.0%	\$1,730,988	CC		CW		*	
Round 8-2005B															
Bio Vision Technology Inc.	\$749,848	28.7%		\$1,183,727	45.4%		\$675,000	25.9%		\$2,608,575	CC	CA			*
Cerestech Inc.	\$751,627	32.3%		\$1,575,391	67.7%		\$0	0.0%		\$2,327,017	CC		CW		*
Mechtronix Systems Inc.	\$1,423,427	27.9%		\$1,450,817	28.4%		\$2,233,320	43.7%		\$5,107,563	CC		CW	CS	*

Environmental Benefits

CC = climate change,
CW = clean water

CA = clean air,
CS = clean soil

Priority Tech Area:

1 = Unconventional Oil & Gas
4 = Next Generation Technology
7 = Other

2 = Distributed Power Generation
5 = Hydrogen

3 = Energy Efficiency for Industry and Communities
6 = Clean Fossil Fuel

* = Uncategorized - not required under previous funding agreements

Lead Organization	Approved SDTC Funding	% of Eligible Project Costs	Eligible Recipient Funding Contribution	% of Eligible Project Costs	Other Government & Academia Funding	% of Eligible Project Costs	Total Eligible Project Costs	Environmental Benefits (Primary Benefits Bolded)				Priority Tech Area (see codes below)
Round 7-2005A												
AirScience Technologies Inc.	\$375,895	28.2%	\$956,224	71.8%	\$0	0.0%	\$1,332,119	CC	CA			*
Dépôt Rive-Nord Inc.	\$0	50.0%	\$0	50.0%	\$0	0.0%	\$0	CC	CA			*
Envirogain Inc.	\$957,623	43.3%	\$1,252,582	56.7%	\$0	0.0%	\$2,210,205	CC	CA	CW	CS	*
Maratek Environmental Inc.	\$915,205	28.1%	\$1,240,905	38.1%	\$1,100,000	33.8%	\$3,256,110	CC	CA	CW		*
Netistix Technologies Corp.	\$471,199	40.3%	\$698,007	59.7%	\$0	0.0%	\$1,169,206	CC	CA			*
Nexterra Energy Corp.	\$1,159,518	33.0%	\$1,052,280	29.9%	\$1,301,893	37.1%	\$3,513,692	CC	CA			*
Round 5-2004A												
Alternative Green Energy Systems Inc.	\$517,041	29.3%	\$1,244,887	70.7%	\$0	0.0%	\$1,761,928	CC	CA		CS	*
Xantrex Technology Inc.	\$1,213,614	33.0%	\$2,464,004	67.0%	\$0	0.0%	\$3,677,618	CC	CA			*
Round 4-2003B												
DeCloet Greenhouse Manufacturing Ltd.	\$176,434	31.7%	\$325,387	58.4%	\$55,000	9.9%	\$556,821	CC				*
NxtPhase T&D Corp.	\$887,598	24.6%	\$2,727,097	75.4%	\$0	0.0%	\$3,614,695	CC				*
Round 3-2003A												
RailPower Technologies Corp.	\$584,079	35.7%	\$800,521	49.0%	\$250,000	15.3%	\$1,634,600		CA			*
Round 2-2002B												
IBC Technologies Inc.	\$168,785	28.0%	\$416,903	69.2%	\$16,420	2.7%	\$602,108	CC	CA			*
Round 1-2002A												
Mabarex Inc.	\$225,000	40.9%	\$300,000	54.5%	\$25,000	4.5%	\$550,000	CC	CA			*
NOVA Chemicals Corporation	\$320,000	33.5%	\$636,575	66.5%	\$0	0.0%	\$956,575	CC	CA			*
Suncor Energy Inc.	\$889,132	25.0%	\$1,826,418	51.4%	\$840,119	23.6%	\$3,555,669	CC				*
Total	\$47,987,814	29.9%	\$91,864,357	57.2%	\$20,722,478	12.9%	\$160,574,643					

Environmental Benefits

CC = climate change,
CW = clean water

CA = clean air,
CS = clean soil

Priority Tech Area:

1 = Unconventional Oil & Gas
4 = Next Generation Technology
7 = Other

2 = Distributed Power Generation
5 = Hydrogen

3 = Energy Efficiency for Industry and Communities
6 = Clean Fossil Fuel

* = Uncategorized - not required under previous funding agreements

Section 6: SD Tech Fund™ – Classification of Projects by Technology Area and Environmental Benefits since Inception

Project Classification

SDTC Approved Funding in Hydrogen Economy, Clean Fossil Fuels, Clean Water and Clean Soil Projects (as of December 31, 2015)

Round	Lead Organization	Total Eligible Project Costs	SDTC Announced Funding
Hydrogen Economy Projects			
Round 27 - 2015A	Loop Energy Inc.*	\$22,680,126	\$7,500,000
Round 26 - 2014B	Hydrogenics Corp.*	\$7,625,890	\$2,500,000
Round 21 - 2012A	Western Hydrogen Ltd.	\$4,492,123	\$1,480,000
Round 17 - 2010A	Ballard Power Systems Inc.	\$21,238,984	\$7,304,367
Round 16 - 2009B	Available Energy Corp.	\$2,375,257	\$1,020,000
	Quadrogen Power Systems, Inc.	\$7,441,221	\$2,910,145
Round 15 - 2009A	Automotive Fuel Cell Cooperation Corp.	\$51,760,258	\$11,506,305
	Ballard Power Systems	\$32,452,471	\$6,905,887
	HTEC Hydrogen Technology & Energy Corp.	\$1,200,000	\$400,000
Round 12 - 2007B	Western Hydrogen Ltd.	\$12,357,745	\$4,162,653
Round 10 - 2006B	HTC Hydrogen Technologies Corp.	\$1,511,718	\$535,414
Round 8 - 2005B	Hydrogenics Corp.	\$7,917,229	\$2,248,493
Round 7 - 2005A	AirScience Technologies Inc.	\$1,332,119	\$375,895
Round 6 - 2004B	Angstrom Power Inc.	\$1,263,271	\$169,752
Round 5 - 2004A	Atlantic Hydrogen Inc.	\$6,893,548	\$2,096,948
Round 4 - 2003B	Sacre-Davey Innovations Inc.	\$17,681,710	\$5,727,711
Round 3 - 2003A	Hydrogenics Corp.	\$3,069,135	\$1,350,419
	Plug Power Canada Inc.	\$9,026,000	\$2,000,000
18 Projects		\$212,318,805	\$60,193,989

Section 6: SD Tech Fund™ – Classification of Projects by Technology Area and Environmental Benefits since Inception

Round	Lead Organization	Total Eligible Project Costs	SDTC Announced Funding
Clean Fossil Fuel Projects			
Round 27 - 2015A	Nsolv Corporation*	\$ 84,311,075	\$13,000,000
Round 26 - 2014B	Hydrogenics Corp.*	\$7,625,890	\$2,500,000
Round 25 - 2014A	Fractal Systems Inc.	\$11,471,324	\$3,700,000
	Field Upgrading Limited	\$22,387,789	\$5,150,000
Round 23 - 2013A	Saltworks Technologies Inc.	\$7,500,000	\$2,500,000
	Electro Kinetic Solutions Inc.*	\$6,348,419	\$2,116,140
	Carbon Engineering Ltd.	\$9,149,841	\$3,000,000
	Inventys Thermal Technologies Inc.*	\$9,492,458	\$3,100,000
Round 22 - 2012B	Luxmux Technology Corporation	\$3,015,259	\$980,350
	Hifi Engineering Inc.	\$5,926,220	\$2,000,000
Round 21 - 2012A	Western Hydrogen Ltd.	\$4,492,123	\$1,480,000
	R.I.I. North America Inc.	\$24,854,873	\$6,453,754
Round 20 - 2011B	MEG Energy Corp	\$217,488,811	\$13,000,000
Round 18 - 2010B	N-Solv Corp.	\$54,085,607	\$10,000,000
Round 16 - 2009B	InvenTyS Thermal Technologies Inc.	\$3,914,947	\$1,598,001
	InvoDane Engineering Ltd.	\$10,034,750	\$2,467,125
Round 14 - 2008B	MEG Energy Corp.	\$18,142,245	\$4,270,000
	Soane Energy (Canada) Inc.	\$9,507,807	\$2,658,878
	Statoil Hydro Canada Ltd.	\$38,791,337	\$6,000,000
	Titanium Corp. Inc.	\$21,642,789	\$6,292,635
Round 13 - 2008A	Paragon Soil and Environmental Consulting Inc.	\$527,122	\$230,879
Round 12 - 2007B	Petroleum Technology Research Centre	\$27,473,745	\$5,000,000
	Western Hydrogen Ltd.	\$12,357,745	\$4,162,653
Round 10 - 2006B	Turbo Trac Systems ULC Inc.	\$4,201,622	\$188,934
Round 9 - 2006A	MinMiner Oilsands Inc.	\$12,635,945	\$3,435,372
Round 7 - 2005A	N-Solv Corp.	\$15,806,359	\$4,155,843
	Petroleum Technology Research Centre	\$9,603,000	\$3,168,990
	Power Diagnostic Technologies Ltd.	\$3,489,382	\$1,191,107
Round 4 - 2003B	Synodon Inc.	\$4,572,871	\$1,056,790
Round 1 - 2002A	Suncor Energy Inc.	\$3,555,669	\$889,132
	CO2 Solution Inc.	\$5,881,558	\$1,000,000
31 Projects		\$670,288,582	\$116,746,583

Section 6: SD Tech Fund™ – Classification of Projects by Technology Area and Environmental Benefits since Inception

Round	Lead Organization	Total Eligible Project Costs	SDTC Announced Funding
Clean Water / Clean Soil Projects			
Round 27 - 2015A	Nsolv Corporation*	\$84,311,075	\$13,000,000
Round 27 - 2015A	Syscor Controls & Automation Inc.*	\$4,878,413	\$1,626,138
Round 27 - 2015A	Sherbrooke OEM Ltd.*	\$4,025,000	\$1,275,000
Round 24 - 2013B	CelluForce inc	\$12,943,101	\$4,004,254
	Terramera Inc.	\$5,930,386	\$1,984,581
Round 23 - 2013A	Orbite Aluminae Inc.*	\$14,043,310	\$4,500,000
	BRIC Engineered Systems Inc.	\$2,207,430	\$710,000
	Saltworks Technologies Inc.	\$7,500,000	\$2,500,000
	Electro Kinetic Solutions Inc.*	\$6,348,419	\$2,116,140
	GreenMantra Technologies*	\$6,360,885	\$2,007,450
Round 22 - 2012B	Hifi Engineering Inc.	\$5,926,220	\$2,000,000
	Vive Crop Protection, Inc.	\$11,050,199	\$3,723,504
	Soilless Technology Inc.*	\$7,575,668	\$2,500,000
	Polymer Research Technologies*	\$3,350,478	\$1,116,826
Round 21 - 2012A	Dundee Sustainable Technologies	\$43,513,594	\$8,000,000
	Polystyvert Inc.	\$5,216,992	\$1,980,000
	Yava Technologies Inc.	\$1,223,602	\$399,123
Round 20 - 2011B	semiosBIO Technologies Inc.	\$16,033,807	\$4,980,000
	Whale Shark Environmental Technologies Ltd.	\$1,959,589	\$829,266
	Minesense Technologies Ltd.	\$14,370,427	\$4,435,794
	Agri-Neo Inc.	\$8,762,595	\$2,500,000
Round 19 - 2011A	Pure Technologies Ltd.	\$3,121,138	\$1,000,000
Round 18 - 2010B	Namgis First Nation	\$15,900,640	\$5,650,000
	Northex Environnement Inc.	\$4,848,730	\$1,552,354
Round 17 - 2010A	Echologics Engineering Inc.	\$3,217,390	\$1,051,926
	FibraCast	\$5,902,229	\$1,947,736
	Tyne Engineering Inc.	\$4,934,949	\$1,534,097
Round 16 - 2009B	3XR Inc.	\$1,787,568	\$516,976
	6574262 Canada Inc. (ICUS)	\$303,954	\$102,400
	Available Energy Corp.	\$2,375,257	\$1,020,000
	Lakeshore EMPC Two L.P.	\$2,494,397	\$1,037,669
	MPT Mustard Products & Technologies Inc.	\$7,166,058	\$2,217,949
	Spartan Bioscience	\$6,354,802	\$923,992
Round 15 – 2009A	Agrisoma Biosciences Inc.	\$10,848,340	\$3,275,000
	Entropex a partnership of Unitec Inc. and 629728 Ontario Ltd	\$25,024,389	\$6,330,000
	PV Labs Inc.	\$2,953,044	\$965,253
	NutraCanada	\$9,462,146	\$1,900,000
	SBI BioEnergy Inc.	\$11,668,063	\$2,175,495
	Terragon Environmental Technologies Inc.	\$8,006,425	\$3,174,000

Section 6: SD Tech Fund™ – Classification of Projects by Technology Area and Environmental Benefits since Inception

Round	Lead Organization	Total Eligible Project Costs	SDTC Announced Funding
Round 14 – 2008B	Produits Enuchem Inc.	\$1,499,904	\$595,000
	Duropar Technologies Inc.	\$6,348,674	\$2,829,000
	Eco-Ag Initiatives	\$5,791,615	\$1,948,000
	Statoil Hydro Canada Ltd.	\$38,791,337	\$6,000,000
	Saltworks Technologies Inc.	\$8,064,022	\$2,612,638
	Soane Energy (Canada) Inc.	\$9,507,807	\$2,658,878
	Titanium Corp. Inc.	\$21,642,789	\$6,292,635
	Xogen Technologies Inc.	\$4,527,874	\$1,974,104
	Round 13 – 2008A	A.U.G. Signals Ltd.	\$5,889,341
Innoventé Inc.		\$5,908,755	\$2,730,526
Paragon Soil and Environmental Consulting Inc.		\$527,122	\$230,879
Performance Plants Inc.		\$1,944,476	\$651,400
Vive Crop Protection Inc.		\$11,038,603	\$3,954,706
Round 12 – 2007B	Aboriginal Cogeneration Corp.	\$5,164,532	\$1,369,354
	Atlantec BioEnergy Corp.	\$6,980,109	\$1,833,482
	BioDiesel Reactor Technologies Inc.	\$4,958,032	\$498,000
	Himark bioGas Inc.	\$11,833,908	\$3,331,976
	Pathogen Detection Systems Inc.	\$8,599,000	\$2,671,627
	Pure Technologies Ltd.	\$2,508,335	\$795,000
Round 11 – 2007A	Fuseforward International Inc.	\$1,523,921	\$400,000
	Corp. HET - Horizon Environnement Technologies	\$6,441,396	\$1,509,807
	Envirotower Inc.	\$928,856	\$291,356
	Ferrinov Inc.	\$5,434,975	\$1,083,366
Round 10 - 2006B	Biogénie S.R.D.C. Inc.	\$748,504	\$230,137
	Early Warning Inc.	\$6,137,455	\$2,068,041
	Middle Bay Sustainable Aquaculture Institute	\$11,230,327	\$3,591,444
	SiREM Canada	\$970,439	\$318,304
	Terragon Environmental Technologies Inc.	\$4,097,783	\$1,592,500
Round 9 - 2006A	MinMiner Oilsands Inc.	\$12,635,945	\$3,435,372
	Zenon Membrane Solutions	\$1,730,988	\$619,860
Round 8 - 2005B	Chinook Mobile Heating & Deicing Corp.	\$7,378,282	\$3,063,766
	EcoVu Analytics	\$3,165,715	\$1,035,555
	Maritime Innovation (IMAR)	\$2,543,757	\$979,800
	Ostara Nutrient Recovery Technologies Inc.	\$1,777,628	\$375,760
	Pure Technologies Ltd.	\$6,840,562	\$2,200,000
74 Projects		\$629,013,477	\$170,354,651

*Amounts are based on approved project value – contracting to be finalized.

Classification Allocation % to Climate Change and Clean Air

Of the SD Tech Fund™'s total value, 80 percent is to be allocated to projects that have an environmental benefit that relates primarily to climate change and clean air. The remaining 20 percent is to be allocated to clean soil and clean water projects.

To date, SDTC has approved \$666M in funding to projects that address climate change and clean air where:

- 90% has been allocated to projects that address primarily climate change; and 10% has been allocated to projects that address primarily clean air.

Since 2006, SDTC has allocated \$170M to projects that primarily address water and soil environmental benefits.

While projects are classified in a primary benefit category, multiple benefits are encouraged. The attribution to a specific primary environmental impact needs to be interpreted in conjunction with the following. Of the total portfolio of three hundred and sixteen (316) funded projects:

- 91% of SDTC-funded projects have climate change benefits;
- 74% have clean air benefits;
- 41% have soil or water benefits and,
- 87% of all SDTC projects have more than one environmental benefit.

SDTC Portfolio Environmental Benefits

The unique contribution of clean technologies is derived from the coupling of environmental benefits with productivity and economic growth. SDTC portfolio projects achieve positive economic and environmental impacts relating to clean air, clean water, reduced waste, soil protection, and climate change mitigation. In fact, nearly 90% of SDTC projects have multiple environmental benefits. As the portfolio matures, SDTC is developing better ways to quantify and report these benefits in order to clearly and accurately capture the full environmental value derived from SDTC investments in clean technologies.

SDTC is required to report on environmental benefits relating to clean air, clean water, soil, and climate change. Due to the advancement and growth in climate change mitigation initiatives, sophisticated methods for greenhouse gas (GHG) emissions quantification and reporting have been established. SDTC applies these internationally accepted methods to estimate climate change mitigation benefits of its investments based on forecasted and actual market roll-out. This approach has been very successful, however, similar estimating methodologies based on a common unit (e.g. CO₂e) are not currently available or in common use for clean air, clean water, or soil projects – either domestically or internationally. Consequently, SDTC has developed approaches for quantifying and reporting the benefits of clean air, clean water, and soil projects that accurately capture the value of SDTC investments in these areas.

Environmental benefits are realized when clean technologies are commercialized and deployed. For this reason, environmental benefits are associated with product sales and revenue figures. The expected annual revenues for SDTC-funded technologies in market at the end of 2015 are \$1.4 billion. The forecast for 2022, for the same pool of projects grows to \$4.6 billion annually. These values include only those projects that are reported to be in-market or projected to be in the market by the start of fiscal year 2016/2017.

Revenue reports and forecasts are based on market rollout reports provided by the funded organization (preferably), or by publicly-available market data for companies that disclose their financial and sales figures publicly.

The preferred vehicle for these reports are ad hoc questionnaires submitted to SDTC after project completion. Those sales and revenue reports for past years are taken at face value. Future sales and revenues and projects not reported directly to SDTC are subject to a discount factor ranging from 10% to 65% to account for this uncertainty.

Climate change

The estimated GHG reductions from a total of 73 SDTC projects in the market and reporting GHG benefits, at the end of 2015 are 6,345 kilotonne of CO₂ equivalents emission reductions (CO₂e). As market presence grows, the forecasted emission reductions for 2022 range between 70 and 100 ktonnes of CO₂e. This forecast is calculated based on the expected emission reductions per unit multiplied by the number of units forecasted to be deployed in the year. These numbers are also discounted on two major uncertainties: market rollout and technology performance. Market rollout discount is based on the estimated probability of the sales forecasted by the funded technology becoming real, and ranges from 5 to 100% likelihood depending on the perceived market risk by SDTC. Technology performance discounting is based on SDTC's assessment of the likelihood of a technology achieving its claimed environmental performance. That discount is assessed to each specific technology application and ranges from no discount for proven market-ready units to 35% discount for technologies that are in advanced prototype phase and require more development for market entry by the time a project is concluded. Normally, SDTC doesn't fund technologies at earlier technological stages.

Clean Air

Assessing the clean air benefits of projects is usually more complex than evaluating GHG reductions, as proponents quantify and report on potential benefits from total Criteria Air Contaminants (CAC) emissions reductions in tonnes(CAC)/year.

With regard to clean air impacts, a total of 45 projects have been identified as providers of clear air benefits in 2015. The actual environmental and human health impacts of CACs depend on population density and air shed concentrations in areas where they are emitted, and so merely reporting the emission reductions in amounts of pollutant does not fully reflect the actual benefits from these projects.

Using the input and validation from external environmental experts, SDTC has established a conservative methodology to quantify the benefits from clean air projects in terms of abated health impacts on human populations. This is based on Environment Canada's airshed concentration measurements and modeling and Health Canada's model (AQBAT), which allows a determination of the risk of health incidents in populations based on airshed concentration exposure. A similar approach is used by the US EPA to quantify the benefits of certain clean air policies. Using industry sub-sector specific parameters, the change in smog exposure risk that would result from CAC emissions reductions achieved through the

Section 6: SD Tech Fund™ – Classification of Projects by Technology Area and Environmental Benefits since Inception

deployment of SDTC clean air technologies can be estimated and translated to a change in likely health related cost impacts. Based on this approach, SDTC has modeled the impact of the 45 projects with clean air benefits, which report a reduction of health-related costs of \$14.5 million in 2015, and a forecasted reduction of \$82 million in 2022. This forecast is discounted for market rollout and technology performance uncertainties as described in the GHG section above.

Soil / Water

Impact quantification in terms of soil and water benefits depends on a wide range of factors which make the estimation of environmental benefits more complex than evaluating GHG or CAC emissions reductions. SDTC requests that proponents identify total water conservation, contaminant removal, waste reduction, and land conservation as part of their application. SDTC compiles and tracks these as potential water and soil benefits.

The actual environmental and human health benefits and value to society of water and soil related projects depend on considerations such as; the type of contaminant, environmental fate of pollutants, paths of exposure, location, existing use of land or watershed. Contaminated or degraded freshwater and soil resources represent a cost burden to the Canadian economy. Conversely, the availability and access to clean water and healthy, viable soil provide valuable ecological services to the Canadian economy that generally go undervalued. Simply presenting the net water conservation or contaminant removal from water or soil does not provide a clear and quantifiable representation of the actual benefits.

Working with external experts in this area, SDTC has developed methodologies to quantify and report the benefits from SDTC's investments in water technologies over the past few years. This exercise identified an approach for estimating the avoided costs from the displaced environmental impacts.

In 2015, 15 projects reported water benefits. These were quantified to have a positive impact valued at \$30.25 million. By the year 2022, the portfolio of SDTC projects with water impacts is estimated to achieve a benefit value of approximately \$48 million.

SDTC has recently implemented methodologies for estimating the benefits of clean soil projects that are completed or in progress. The clean soil benefits are based on the avoided costs associated with several parameters including; landfill tipping fees, soil treatment and remediation for contaminated soils, and the environmental effects of diverse pollutants present in soils. Loss of agricultural productivity is considered, but population health effects of pesticide application are currently excluded from the methodology pending approval of a reliable quantification metric. Valuing soil quality is difficult so a conservative estimate of parameters is used. With respect to soil, in 2015 SDTC had funded 20 projects with claimed soil benefits. These had benefits quantified at \$60 million. In the year 2022, the portfolio of SDTC projects with soil benefits is estimated to have benefits valued at \$104 million. The discounting methodology for the forecast uncertainty is similar to the air pollutant methodology above.

Landfill avoidance is reported in terms of total tonnes of material and monetized value based on avoided landfill tipping fee costs (using a \$40/tonne tipping fee). Soil treatment avoidance includes diverse technologies and projects with wide-ranging applications. Benefits are reported as cost savings using the appropriate metric for each project, including; tailing pond size reduction for oil sands projects, rehabilitation of brownfield sites, treatment of halogenated soils, and other chemical treatments. Soil pollutant emissions reductions are also monetized based on parameters for managing key pollutants including: lead, cadmium, chromium, mercury, selenium, arsenic, copper, zinc, and dioxins.

SDTC Methodology for Reporting on GHG/CAC Emission Reductions

Methodology at the Statement of Interest (SOI) Level

Reporting at the SOI level is based on applicant self-reported and unverified GHG emission reductions estimates. Some of the proponents supply calculations of GHG emission reductions and these estimates are used in tabulations. The SOI form requires applicants to indicate GHG emission reductions estimates in kilotonnes CO₂ and CO₂ equivalents over a 10 year period.

These GHG emission reductions estimates, when reported by SDTC, are always classified as undiscounted and considered optimistic.

Methodology at the Full Proposal Level

At the Full Proposal level, applicants are required to submit a table indicating their individual per-unit technology impact (as a baseline), along with their anticipated market roll-out over a period of 10 years. To account for the variety of technologies, market factors, and quality of proposals, a discounting factor is applied by SDTC to figures reported by applicants. These numbers are stated as discounted GHG emission reductions estimates. To avoid violating confidentiality agreements, proponent data is only shared with the external community in aggregate form.

The GHG emission reductions factors and calculation methodologies used are those determined by the Government of Canada so that SDTC is consistent with federal department reporting. SDTC provides applicants with assistance in producing estimates of GHG emission reductions estimates. It may refer applicants to GHG measurement and reporting experts in ENGO's or Sustainability Consultants, to undertake the calculations on their behalf. Note that applicant reported GHG emission reductions values are evaluated by technical experts during Gate Two of the Funding Allocation Process.

Methodology for Discounting GHG Emission Reductions Estimates

Completed projects have well developed and demonstrated technology performance parameters. Therefore, there is no discount applied to the per-unit environmental benefits of these technologies.

The most accurate data sources include Post Project Completion Questionnaires (PPCQ's) completed by project proponents to retroactively report successful sales. These are not discounted and are used as reported.

There are, however, some uncertainties from the market rollout figures. Projects do not report each and every sale and market deployment to SDTC as PPCQ's are only provided every two years on a voluntary basis. In the absence of these reports, SDTC will seek to find up-to-date information through media, marketing reports, financial statements, or other information sources where trustworthy sales figures can be tied to a specific SDTC project. For example, a company's annual financial statements may include product lines that are directly the result of the SDTC projects and so are considered "confirmed" sales. However, they also cite other sales that may be related to the SDTC funded project, but outside the direct scope of the funded project. Due to the uncertainty these are excluded in keeping with the principle of conservativeness.

In the absence of up-to-date, retroactive sales data, SDTC refers to project forecasts. The simplest sources are documents submitted to SDTC, such as company CA or market reports for final milestones. Forward-looking sales projections, including those for the current year, are discounted due to their uncertainty. Where a project has confirmed previous sales, the discount ranges from 25% to 75%, depending on the level of uncertainty perceived by SDTC. Non-completed projects with medium levels of uncertainty (standard) are discounted by 83% on their sales, while projects with high and very high risk are discounted from 90% to 99%.

In summary there are two different discount factors applied, one based on technology performance risk and the second based on market deployment. The technology performance risk for completed projects is zero, and therefore this parameter is undiscounted. With regard to the market rollout, projects that report successful market deployment in past years are not discounted. Unconfirmed sales (current or future years) are applied a discount between 25% and 99% based on SDTC's perception of likelihood.

Methodology for Discounting Future GHG Emission Reductions Estimates

These figures include adjustments for the uncertainty of projections by applying a discounting factor to individual projects. GHG emission reductions projections are inherently forward-looking statements. They involve risks and uncertainties that could cause actual results to differ materially from those contemplated. SDTC believes it has a reasonable basis for making such forward-looking statements by:

- Requiring every applicant to estimate future GHG emission reductions using a prescribed methodology based on accepted ISO and IPCC practices;
- Reviewing the reasonableness of projected GHG emissions reductions reported by applicants and, as new information is reported, adjusting projections and excluding projects on hold; and,
- Applying a discount rate. This discount rate is based on two major sources of uncertainty: technological performance and market deployment.

Technology Performance

SDTC funds unproven, high-risk technologies. Therefore, we apply an uncertainty factor to the expected performance of the technology. At the beginning of a project, we expect it to undergo numerous iterations and refinements; SDTC denominates this a non-validated technology, and therefore an untested, "desktop" presentation of a technology will have its expected performance adjusted down by 35%.

As the project progresses, the performance discrepancy between the current version of the technology and the final product is expected to diminish. Normally, this stage also includes an adjustment to the original expected performance. Once a project presents significant technological progress on the field SDTC will change its status to validated, it is assessed by a third-party environmental consultant and its discount factor is reduced to 20%.

Finally, as project is completed, SDTC receives a final assessment of the technology as it is expected to be deployed on the field. The performance of each unit is analyzed by an additional environmental consultant (two different experts), after all the iterations are finished. This technology is now considered to be confirmed, and is undiscounted.

Market Roll-out

The second discount parameter refers to market rollout. This is similar to the methodology for completed projects presented above. SDTC funds projects with substantial risks and barriers to market entry. We consider 4 levels of market uncertainty:

- Certain:** this applies to confirmed sales (i.e. for completed projects). 0% discount – note that SDTC does not generally audit invoices, receipts, or other documentation that confirm sales. We trust that our proponents will report actual sales truthfully.
- High likelihood:** this applies to projects that SDTC deems to be very likely to deploy in the numbers forecasted. The discount ranges from 10% for completed projects with high reliability (e.g. standing orders reported) to 75% for non-completed projects that are perceived to be low risk. We apply the higher likelihood to short-term forecasts of projects that are already in the market (e.g. an increase in Westport’s deployment in 2014 and 2015).
- Medium likelihood:** this applies to most of the forward-looking sales estimates. Our basic discount parameters are 50% for completed projects and 87% (only 13% likelihood of sales) for projects in progress, based on work done by SDTC and Robinson Research for portfolio performance in 2005–2010. This reflects the high-risk nature of SDTC projects.
- Low likelihood:** some projects have even higher risks of failure. For these, we apply a discount factor of 75% for completed projects, up to 90%–99% for projects deemed to be high-risk. This is reserved for unusually problematic problems, or those which presented a very ambitious market rollout that SDTC considers very unlikely to be met or difficult to verify. Ecosmart is a good example: the structure of the consortium has made it very difficult to trace the actual deployment of this ambitious technology in a manner that would allow SDTC to quantify the extent to which it is being used.

Summary

These two discount parameters are used to evaluate the annual benefits forecasted by each project. SDTC has historically used a 93.5% discount rate (low likelihood of sales, non-validated technology equivalent to $0.1 \times 0.65 = 6.5\%$ likelihood of benefits materializing) on a project’s initial benefits estimate. However, current understanding tends to suggest that the market entry risk is actually higher (i.e. less than 1 in 10 of the sale units forecasted by proponent at the initial presentation of a project take place as scheduled), while technology risk is lower since the SDTC team has a strong grasp on technological capabilities.

Methodology for Calculating and Discounting CAC Emission Reductions

SDTC-funded projects report clean air impacts in tonnes of criteria air contaminant (CAC) emissions reduced per year. This calculation includes the criteria air contaminants; particulate matter (PM), Nitrogen Oxides (NO_x), Sulfur Oxides (SO_x), and volatile organic compounds (VOCs).

The actual environmental and human health impacts of CACs depend on population density and air shed concentrations in areas where they are emitted. For example, the impact of smog precursors emitted in a high-population-density urban area is more significant than if they were emitted in a low-population-density area. Therefore, presenting the net CAC emissions reductions in “tonnes of X” alone does not give the full picture of the actual benefits from SDTC clean air projects. To show the benefits of these projects at the national level, SDTC has followed industry best practices to calculate avoided health-related impact costs.

Using input and validation from external experts, SDTC has established a defensible and conservative methodology for presenting the benefits from clean air projects in a way that takes into account regional and industrial variations in impacts. This methodology is based on Environment Canada’s regional air shed concentration measurements and modeling and Health Canada’s Air Quality Benefit Assessment Tool (AQBAT), which allows a determination of the risk of health incidents in populations based on air shed concentration exposure.

The procedure is similar to the GHG benefit discount, but is adjusted by an extra parameter: the monetization of environmental damages caused by air pollutants. The methodology for this estimate is based on the Damage Function Approach (DFA) to monetize the impacts from individual pollutants. This approach follows a logical progression from emissions, through dispersion in the atmosphere and exposure, quantification of health impacts, and their valuation. This approach has been used consistently in Canada and globally to estimate damages associated with air pollution. For instance, Environment Canada used this method to quantify the benefits of the Regulatory Framework for Air Emissions.

These parameters have been devised by environmental experts, based on technology sector, exposure rates, and damage estimates. The most significant parameters are those related to morbidity and mortality, as these costs tend to constitute the majority of the unit-intensity effects calculated.

Similar to GHGs, these results have been discounted by a maximum 93.5% to account for market entry and uptake risk, subject to the same adjustments – when a project’s technical capabilities are well understood its tech risk uncertainty is reduced, and the market rollout discount factors are adjusted or removed upon successful market entry.

Evaluation, Contracting, and Reporting

Projects approved for funding go through a rigorous contracting process which obligates the proponent to achieve set milestones before subsequent payment is issued. These milestones are indicators of progress towards creating GHG/CAC emissions impact—covering the performance of the technology, scaling of associated demonstration facilities, and ultimate rolling sales forecast based on actual units sold by region and year. Using internationally accepted standard methodologies (CAN/ISO 14064-1) for GHG emission reductions measurement, SDTC uses in-region baselines to determine the incremental improvement or acceleration of emissions reduction of a given approach. However, SDTC takes this baseline one step further by providing a rolling forecast based on sales projections. This bottom-up and sales-based approach enables SDTC to report GHG emission reductions impacts with a high degree of confidence. The source of error, therefore, is the confidence level placed in the benchmark itself. This benchmark data is typically provided in the form of tables from the industry in conjunction with Environment Canada and NRCan.

Section 7: NextGen BioFuels Fund™ – Introduction

Purpose

The purpose of the NextGen Biofuels Fund™ is to:

- Facilitate the establishment of First-of-Kind Large Demonstration-scale facilities for the production of next-generation renewable fuels and co-products;
- Improve the sustainable development impacts arising from the production and use of renewable fuels in Canada; and,
- Encourage retention and growth of technology expertise and innovation capacity for the production of next-generation renewable fuels in Canada.

The NextGen Biofuels Fund™ incorporates a requirement that all contractual agreements between SDTC and Eligible Recipients include repayment terms based on free cash flow over a period of 10 years after project completion.

Eligible Projects

To be eligible, a project must:

- Be a first-of-kind facility that primarily produces a next-generation renewable fuel at large demonstration-scale;
- Be located in Canada; and
- Use feedstocks that are or could be representative of Canadian biomass.

Funding Criteria

The Foundation will exercise its discretion in the allocation of funding to Eligible Recipients, in accordance with the following criteria:

- The Eligible Recipient's access to the necessary technical, financial and management capacity to successfully undertake the Eligible Project;
- The level of necessary funding required from the Foundation to ensure that the Eligible Project proceeds;
- The potential of the production pathway to deliver sustainable development benefits (social, economic and environmental) by:
 - sustainably expanding renewable fuel production in Canada;
 - improving the environmental benefits arising from the production and use of renewable fuels including the life-cycle fossil energy balance and life-cycle emissions of greenhouse gases;
 - reducing the overall financial costs of Renewable Fuels; and,
 - generating economic benefits for a wide range of communities.

More detail on the funding process can be found in the Funds section of the SDTC website at: www.sdtc.ca

Section 8: NextGen BioFuels Fund™ – Portfolio since Inception

A continued trend of slow deployment of next generation biofuel technologies at commercial scale was observed globally in 2015. Low cost crude oil, natural gas, and the exploitation of shale oil reserves in the United States also adversely impacted the commercial demonstration of biofuel technology platforms. The overall next generation biofuels industry deployment has been slower than expected which has impacted fund disbursement. Challenges with respect to technology and availability of investment capital persist with a deployment trend of initial commercial biofuel plants at small scale. While a longer-term outlook for competitiveness of the next generation biofuels industry is likely, some short term opportunities for advanced biofuels and co-products exist in Canada. The importance of biochemical and bioenergy technology development along the path to realizing a competitive advanced bio-fuels industry is also noted.

The Next Generation Biofuels Fund (NGBF) is in its wind-down phase. As a result, the NGBF is now focused on construction-ready projects that have successfully progressed through pre-construction planning in accordance with the NGBF Project Assurance Program (PAP), and is no longer accepting applications. Based on the remaining program time, new applicants would not be able to complete required phases of project development, construction, plant commissioning and start-up for commercial operation before the scheduled March 2017 fund sunset date. While two Applications for Funding (AFFs), the Mascoma Drayton Valley Biorefinery (Drayton Valley, AB) and the Vanerco Project by Enerkem and Greenfield Ethanol (Varenes, QC) were progressing under the NGBF PAP, as of December 31, 2015 two projects, the Enerkem Alberta Biofuels Project and the AE Côte-Nord RTP™ Project were approved for final funding commitments by the SDTC Board of Directors.

Details regarding the two AFF's and the two approved projects are noted below.

Vanerco

Environmental Benefits:

Total Project Value: \$127,200,000	Enerkem Inc. ("Enerkem"), in partnership with Greenfield Ethanol Inc. ("GFE"), intends to implement the Vanerco Project ("Vanerco"). The \$127.2 M cellulosic ethanol facility will be located in Varenes, QC, on a brown field site where GFE currently operates a corn ethanol plant. The facility will convert 100,000 metric tonnes per year (mtpy) of urban waste into 38 M litres of cellulosic ethanol. The Enerkem thermo-chemical process which is currently being demonstrated in Westbury, QC with support from SDTC's SD Tech Fund™ includes feedstock preparation, gasification of biomass, syngas conditioning and catalytic synthesis of ethanol.	Partners: Enerkem Inc
Potential SDTC Contribution*: \$39,800,000		
SDTC Contribution To Date: \$734,000		

Mascoma Drayton Valley Biorefinery

Environmental Benefits:

Total Project Costs*: \$385,100,000	Mascoma Canada Inc. ("Mascoma"), intends to implement the Mascoma Drayton Valley Biorefinery ("MDVB"). The \$385.1 M cellulosic ethanol facility will be located in Drayton Valley AL, on a brown field site in the Bio Mile biotechnology industrial cluster. MDVB proposes to convert woody biomass into 83 M litres of cellulosic ethanol and co-products annually. The MDVB process includes fibre preparation, feedstock pretreatment, Consolidated Bioprocessing (CBP), distillation and drying, Isopropanol (IPA) production, xylose purification, and power generation via the production of fuel-grade lignin. Pre-commercial demonstrations are run in Rome, NY.	Partners: Mascoma Corp. Catchlight Energy Xylitol Canada
Potential SDTC Contribution*: \$138,000,000		
SDTC Contribution To Date: \$643,000		

Enerkem Alberta Biofuels Project

Environmental Benefits:

Total Project Costs*: Enerkem Inc. intends to build, own, and operate a commercial next generation cellulosic ethanol plant capable of converting 100,000 Bone Dry Metric Tons (BDMT) of sorted Municipal Solid Waste (MSW) into 38 million litres of cellulosic ethanol. The Project will utilize thermochemical gasification process technology developed by Enerkem and is sited adjacent to the City of Edmonton Integrated Waste Management Centre (EWMC). In addition to producing ethanol the facility will have the capability to provide bio-methanol as a co-product.

\$174.5M

Approved Final SDTC Contribution:

\$63.6M

SDTC Contribution

To Date:

\$734,000

Partners:
Enerkem Inc.

AE Côte-Nord RTP™ Project

Environmental Benefits:

Total Project Costs*: The AE Côte-Nord RTP™ Project will employ Ensyn Technologies' fast pyrolysis process to convert wood and woody materials into a liquid fuel product. Renewable Fuel Oil ("RFO"), produced by the Project will be substituted for fossil derived fuel oil in industrial and institutional applications. The project will be located on the existing Arbec Port Cartier Sawmill site and will be capable of processing 36,400 BDMT of feedstock into 21 M liters of RFO annually.

\$71.7M

Approved Final SDTC Contribution:

\$27M

Approved SDTC Contribution

To Date:

\$449,000

Partners:
Ensyn Bioenergy
Canada Inc.
Arbec Forest Products Inc.

For NGBF Funding process, see the Funds section of the SDTC website at: www.sdtc.ca.