

Integrated Resource Recovery Inventory

Ministry of Community and Rural Development

Title	Proponent	Project Type	Location	Stage	Funders	Private Sector	Budget	Economic Benefits	Environmental Benefits
Vancouver/Lower Mainland									
Lulu Island Wastewater Treatment Plant (WWTP)	Metro Vancouver; National Research Council	WWTP to be upgraded with anaerobic digestion (mesophilic). Biogas used for hot-water heating of buildings and to aid digestion process. Dewatered biosolids are used primarily for reclamation at former mine-sites.	Lulu Island	Announced 2008, operational by 2010	Gas Tax-2.4million, ICE Fund \$3 million	Paradigm Environmental Technologies, Micro Sludge	\$12 million	Reduces ongoing operating costs by more than \$500,000 per year, Reduced Capital Costs by eliminating purchase of \$14 million of additional anaerobic digesters and dewatering equipment.	43% of the Lulu Island WWTP's emissions. Reduced truckloads of sludge.
Annacis Island Wastewater Treatment Plant (WWTP)	Metro Vancouver	Anaerobic digestion (Thermophilic) feeding a 3.2 megawatt cogeneration system. 12,000 tonnes of Class A biosolids produced.	Annacis Island					Reduced energy costs; reduced wear and tear on boilers. 60% of electricity needs met by cogen.	80% of its energy needs from its own digester gas, producing either electricity or heat. These resources are now available to other users, reducing the environmental impact.
Southeast False Creek Neighbourhood Energy Utility (NEU)	City of Vancouver	District Energy System recovers waste-heat from sewage influent. Provides space heating and domestic hot water to 16,000 residents in SE False Creek and Olympic Village. Will be integrated with a new municipal sewage pump station, increasing efficiency. This is the first Thermal Net Metering and Raw Sewage Heat Recovery System in Canada. The rooftops of many buildings capture rainwater for use in toilet flushing and irrigation, reducing potable water use by approximately 50%.	Vancouver	Ready for 2010 Olympics	FCM Loan \$5 million, \$8.5 million grant from the Union of BC Municipalities' Innovations Fund, \$16.0 million in debenture financing,		\$29 million	Eliminates need for space heating and domestic hot water boiler production facilities in individual buildings. Operation will contribute \$500,000 per year in wages. 1st phase will inject \$29 million into consulting and construction. City of Vancouver expects 5-6% Return on Investment over 25 years.	Sewer heat will supply 70% of neighbourhood's annual thermal needs. It is incorporated into City's Climate Change Action Plan. Will likely lead to reduction of at least 70% of heating emissions in connected buildings.
Lions Gate Wastewater Treatment Plant (WWTP) Biogas Upgrade	Terasen Gas Inc.	Gas purification to recover biomethane from Metro Vancouver's Lions Gate WWTP.	Vancouver	Announced July 2008; expected completion late 2009	ICE Fund 370,000	Terasen Gas; QuestAir	\$1.12 million	The project will showcase technology used to produce biomethane from wastewater, so it can be applied to other biogas upgrade projects in municipal waste and agricultural sectors	The methane will be turned into higher-quality natural gas and injected into Terasen's natural gas pipeline system, providing enough heating energy for approximately 100 homes.
Burns Bog Landfill Gas Collection	City of Vancouver; Maxim Power Corporation	Cogeneration of landfill gas at nearby greenhouse. Project generates 5.55 MW of electricity for sale to B.C. Hydro and 100,000 GJ/year of heat for sale to the CanAgro greenhouse.	Delta	Operational since 2003	Green Municipal Fund provided a multi-million dollar loan as part of the financing scheme.	Maxim Power Corporation owns the gas and heat, while CanAgro's purchases the heat for use in its greenhouse.	Total cost of the project (approximately \$10 million) invested by Maxim Power Corp.	The City of Vancouver will receive revenues of approximately \$400,000 per year for the duration of the 20-year contract period. Delta expects to received between \$80-\$110K per year in municipal tax revenue. Low-cost heat also supports the protection of 300 greenhouse jobs.	The project results in the recovery of approximately 500,000 GJ/year of energy, the total energy requirements of 3,000 to 4,000 homes, and results in a reduction of more than 230,000 tonnes per year CO2 equivalents. This is equivalent to taking 45,000 automobiles off the road. CanGro's use of fossil fuels also reduced by 20%.
Whistler Athlete's Village District Energy Sharing System (WAVDESS)	Whistler 2020 Development Corporation	District Heating from sewage-will provide 90% of heating and up to 75% of hot water heating for Olympic Village. Cogeneration of landfill gas currently being explored. Project will be run as a municipal utility.	Whistler	Expected to be in operation by late 2009		DEC design; Kerr Wood Leidal	\$4 million capital cost, operations and financing approximately \$200,000/year.	Energy at 14\$/gigajoule (including capital cost financing, system maintenance, etc.) Actual revenue to municipality dependent on rates as set by council decision.	70% reduction compared to Business As Usual.

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Catalyst Power Anaerobic Digester	Catalyst Power	On-farm anaerobic digestion at a dairy farm to create biogas from 350 tonnes of manure per day. The bio-methane is to be upgraded to pipeline-quality using water-scrubbing technology. Water recycled into system and Co2 from process used to increase growth at on-site greenhouse and algae growing facility.	Abbotsford	Announced July 2008; expected completion July 2010.	ICE Fund \$1.5 million	Catalyst Power; PlanET Biogas Solutions; Greenlane	\$4.5 million-\$5.5 million	Revenue from gas sales and increased plant growth.	Enough biogas for 1,000 homes.
Port Mann Landfill gas capture	Norseman Engineering	Landfill gas used to fuel dryers in wallboard manufacturing plant.	Surrey	In operation since 1993		Norseman Engineering; Georgia-Pacific purchases the gas			GHG reduction equivalent to 40,000 tonnes of CO2
Jackman Landfill gas capture	Norseman Engineering; Township of Langley	Landfill gas heats commercial greenhouses and provides Co2 to encourage plant-growth.	Aldergrove	In operation since 1995		Norseman Engineering; Topgro Greenhouses Ltd.	Cost shared between Norseman and Topgro	Reduced heating bill; plants grow faster in a Co2 enriched environment.	GHG reduction equivalent to 18,000 tonnes of CO2
SunSelect Produce - Wood Waste to Energy	SunSelect Produce	Wood waste from a local sawmill is used in biomass boilers to heat 70 acres of greenhouses.	Aldergrove	Announced July 2008	ICE Fund \$2.24 million		\$6.69 million	\$4.3 million per year savings to the greenhouse industry. Commercialization of the technology will help stimulate jobs.	22,000 tonnes per year. Clean energy from a renewable fuel source and is 20% more efficient than existing wood waste plants.
Direct-Fired Boiler Biomass Gasification Demonstration Project	Nexterra, FP Innovations and Kruger Products	Direct-fired biomass gasification system to heat Kruger tissue mill. Boiler can accommodate a wide range of wood wastes.	New Westminster	Announced July 2008, slated for completion by end 2009	ICE Fund \$1.5 million, Natural Resources Canada, Ethanol BC	Nexterra; FP Innovations; Kruger Products	\$9 million	Will generate \$1.25 million of labour, 540,000 man hours of BC labour, and save \$2.8 million/year of net energy at the mill, helping to protect 200 jobs.	22,000 tonnes per year, 250,000 tonnes by 2014.
Wastewater Recovery at Vancouver Convention Center (VCC)	BC Pavilion Corporation (PavCo) - a Provincial Crown Corporation	On-site sewage treatment provides treated greywater for toilet flushing and irrigation of green roof. System requires consistent flow of sewage. As Center often empty, treatment plant imports and treats sewage from Metro Vancouver's grid.	Vancouver	Operational since April, 2009	Project funded by Infrastructure Canada's Western Economic Diversification program	Project Management by Stantec Consulting	Entire project (convention center and all related infrastructure) \$883.2 million.	Proportionate to value of reclaimed water.	Proportionate to emissions from water savings.
The Village - District Energy at Fraser Mills	Terasen Energy Services; The Beedie Group	Local industrial waste heat integrated with geoechange and natural gas. Likely that a biomass system will be integrated. Explicitly interest in other heat source-inputs over long-term.	Coquitlam, BC	Currently energy system in planning phase. Phase 1 projected to be in operation by 2011.			\$25 Million		"The district energy system will reduce the demand on the province's electricity grid, and could displace up to 8,200 tonnes of greenhouse gas emissions a year – the equivalent of removing more than 2,500 cars from the road.
Geo-Exchange District Energy Utility for Upper Gibsons	Town of Gibsons	Community Energy System using geo-exchange as primary heat source is exploring possibility of using waste-heat from nearby hockey rink.	Gibsons, BC		\$244,080 from Island Coastal Economic Trust (ICET)		Approximately \$1 million	Energy savings to customers	Expected to reduce GHG emissions from heating by 90%

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Richmond Oval Waste-Heat and Water Re-use	City of Richmond	Heat will be recovered from the ice refrigeration plant and reused for space heating and domestic hot water. The potential for use in a district heating system is being explored. The facility also uses the roof for rainwater capture, and the water is re-used for toilet flushing and irrigation.	Richmond, BC	Construction completed					
Hillcrest/Nat Bailey Stadium Park Venue - Integrated Heat Recovery Solution	City of Vancouver	Waste heat will be captured from the curling rink refrigeration plant to heat the adjacent aquatics centre. This will include the pool water and pre-heating of domestic water; the majority of the energy will be applied to space heating.	Vancouver, BC	Completed in 2009. Conversion to community center to begin after Olympics.	VANOC, and federal and provincial funding.				
Whistler Sliding Center - Integrated Heat Recovery Solution	Vancouver Olympic Committee (VANOC); post-games ownership will revert to Whistler Legacies Society	The Sliding Centre, a seasonal operation, will use about 20% of the heat captured from its refrigeration plant to heat the plant building and a guest services building. Because of the Sliding Centre's relative isolation, there is no immediate use for the rest of the recaptured heat. In the future, as Whistler implements its Sustainable Energy Strategy, this heat source could be connected to a district heating and cooling system.	Whistler, BC	Completed 2009.	VANOC, and federal and provincial funding.				Emissions from building heating avoided.
Vancouver Island & Gulf Islands									
Community Energy System at Docksider Green	Nexterra and Corix	Biomass Gasification facility will gasify locally-sourced wood waste to produce space and water heating for every building in the development.	Victoria	In operation since 2009	\$2.2 million from Natural Resources Canada, and \$350,000 from the Green Municipal Fund	Terasen Energy Services, Windmill Development Group Ltd., Vancity Capital Corporation and Corix Utilities Inc.		Plan to sell excess heat to buildings outside of the development.	Combined energy efficiency measures could result in potential reduction of 5,245 tonnes annually.
Wastewater Treatment Plant (WWTP) at Docksider Green	Windmill Developments	100% of wastewater treated on-site; re-use of over 30 million gallons of water per year; water used for irrigation, toilet flushing, and other non-potable applications; potential sewer-heat capture and use with Community Energy System described above.	Victoria	In operation since 2009				In total, approximately \$80,000 per year in water purchases will be saved through water-reuse. Residents exempt from sewage fees.	Potable water usage greatly decreased.
Hartland Landfill Gas Utilization Project	Capital Regional District	Landfill gas is collected, treated and then fires a 20-cylinder engine to generate 1.6 MW of electricity.	Saanich	In operation since 2004	CRD funded 70%, Maxim Power 30%	Maxim Power	\$2.7 million, not including the gas capture system that was already in place.	CRD receives royalties between \$250,000 and \$2 million over the 20-year project life, depending on the amount of electricity produced and its market value.	
Saanich Peninsula Thermal Energy Recovery System	Capital Regional District	District Heating from Sewage will heat nearby buildings 600 meters away. A micro-turbine at the outfall will be used to generate electricity.	Saanich	Construction beginning spring 2009	Gas Tax-2.98 million		\$3.652 million	CRD would sell energy to users	38% reduction in heating emissions

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Greater Nanaimo Pollution Control Center	Regional District of Nanaimo	Sewage treatment plant - anaerobic digestion and use of biogas to heat and operate treatment plant. Biosolids composted and used as forest fertilizer.	Nanaimo, BC	Biogas project in operations since 2004.					
Westhills Sewage Treatment Plant		LEED neighbourhood design project includes integrated utility with on-site sewage treatment, energy production, and water recovery connected to compulsory district heating system.	Langford, CRD	Housing market slowdown delays development. Future of treatment plant now uncertain.					
Gold River Energy from Waste	Covanta; Village of Gold River	Sited at a former pulp and paper mill, Gold River Power Project would likely accept 500,000 to 750,000 tonnes of waste and provide 90 Megawatts of electricity.	Region of Gold River, BC	Expected to begin operation in 2012		Covanta	\$500 million	\$500 million project providing \$1 billion in stimulus to region. Creation of 1,000 construction jobs, 130 full-time operating jobs.	
Okanagan/Southern Interior									
Okanagan College District Heating from Sewage	Okanagan College	Campus heated with new district energy system; primary heat-source is effluent from nearby Kelowna Wastewater Treatment Plant.	Kelowna	Completed in 2003; 1st wastewater heat recovery project in Canada.	Natural Resources Canada's Energy Innovators Initiative; Aquila Networks Canada	N/A	\$1.5 million	Annual savings of \$100,000 (15 year cost recovery)	8,000 tonnes/year. However, reductions not calculated separately from building retrofits, which increased heat retention. Exact reduction from sewer-heat system alone is therefore not known.
Nutrient Recovery at Kelowna Wastewater Treatment Facility	City of Kelowna	Sludge is thickened, dewatered, and blended with polymer, then trucked to the biosolids composting site where it is mixed with wood waste and composted to create Grade A soil conditioner called Ogogrow.	Kelowna						Equivalent to avoided fertilizer consumption. Heat from effluent captured by Okanagan College district heating grid, reducing campus emissions.
Penticton Wastewater Treatment Plant Upgrade	Penticton	Currently, water is reused for irrigation and biosolids are composted and used as fertilizer for landscaping and agriculture. The upgrade will allow capture of methane and use it to fire micro-turbines, generating heat and electricity. Heat will be used in the plant and in the future, excess heat can be sold to a district heating grid. Pilot scale nutrient recovery technology has been tested at the site.	Penticton	Construction beginning spring 2009	Reserves, Borrowing, DCCs, and \$10.6 million from Gas Tax	Earth Tech	\$30 million	Operational costs will be recovered through fees.	Use of methane in place of natural gas will offset 95.3 tonnes of GHG emissions. Emissions from nearby businesses will be reduced by a district heating system. 4.2 tonnes will be offset from generating electricity with biogas and micro turbines. After a 20 year upgrade, 7.5 tonnes annually will be saved by the micro turbines. More efficient effluent filtration and energy efficiency from improved bioreactor aeration will reduce 1.5 and 4.1 tonnes respectively.
Kamloops Wastewater Treatment Plant Upgrade	City of Kamloops	Upgrade of the existing wastewater treatment plant to provide tertiary treatment and nutrient management.	Kamloops	Announced February 18, 2009	\$14 million from the Federal and Provincial governments		valued at \$21.3 million	Upgrade estimated to create 1,750 direct and indirect jobs of varying length.	GHG emissions reduced through methane capture; reuse of reclaimed water offsets potable water consumption; use of composted sludge offsets demand for nutrients; nutrient removal helps protect river quality.

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Turnkey gasification system	Tolko, Nexterra	Upgrade to existing mill allows conversion of wood residue into syngas, used instead of natural gas to dry veneer and heat water for log conditioning at the Heffley Creek sawmill.	Heffley Creek, near Kamloops	In continuous operation since May 2006	Natural Resources Canada, Ethanol BC, Technology Early Action Measures (TEAM)	Nexterra		Savings of \$1.5 million per year in fuel costs.	Reduction of 12,000 tonnes of GHG emissions annually and reduction of VOCs.
Halfway Ranch Micro-Hydro Generating Plant		Converts energy of water moving through an irrigation system into hydro electric power that can be added to the grid.	Halfway Ranch, west of Kamloops	Announced July 2008	ICE Fund \$40,000		\$200,000		
Turnkey gasification System	Domtar (formerly Weyerhaeuser); Nexterra	Gasifiers convert wood biomass to combustible syngas, which is direct-fired into a lime kiln - this is a pilot study, prior to a full-scale commercial project.	Kamloops, BC	Expected completion in 2009	Natural Resources Canada; National Research Council - Industrial Research Assistance Program; \$2.7 million from Sustainable Development Technology Canada	FP Innovations, Nexterra		Savings of \$4.5 million per year in fuel costs.	Reductions of 30,000 tonnes of GHG emissions annually.
Community Energy System	City of Revelstoke	Community district heating using energy from Biomass Boiler at Sawmill. Heat used for several building in downtown core. Uses 10% of wood-waste from Downie Sawmills.	Revelstoke	Operational since 2005	FCM Green Municipal Fund grant of \$1,348,000 and loan of \$1,348,000; Equity investment of \$1,250,000 from RCFC Holding Company; Loan of \$1,000,000 from the Revelstoke Credit Union. The City of Revelstoke will purchase up to \$1,000,000 in preferred shares (interest rate 7%) using its Electrical Utility.	Downie Timber; FVB Energy	\$5.6 Million	Ten-year payback; 6.7 percent return on investment; 14.8 percent return on equity; Non-taxable source of city revenue.	45,000 GJ displacement of non-renewable fossil fuels such as propane, resulting in 3,700 to 4,000 tonnes avoided Co2 emissions; replacing local beehive burner; lower nitrogen oxide (NOX), sulphuric oxide (SOX) and particulate matter (PM). Since project began, the other 90% of the Mill's wood-waste has become increasingly valuable, and is now exported, mainly to Florida.
Wastewater Nutrient Recovery Study	City of Salmon Arm	Interest in capturing phosphate from the Wastewater Treatment Plant, most likely using a "struvite reactor". This is an emerging technology being researched through the University of British Columbia.	Salmon Arm, BC	Study completed.	Green Municipal Fund	N/A	\$58,000.00	Reduced accumulation of phosphate in water system equipment, which often leads to operational problems. Potential development of a new source of income for the city through the sale of recovered phosphate crystals, a slow release fertilizer.	Avoided emissions from fertilizer production and transport. Reduced eutrophication of the city's water source, Shuswap Lake.
Landfill gas capture at Salmon Arm landfill	Terasen Gas; Columbia Shuswap Regional District (CSRD)	Capture of landfill gas possible at a section of the landfill slated for closure in 2010. Upgrading gas to pipeline-quality for use in heating homes is under investigation. Capacity of gas enough to heat 300 homes.	Salmon Arm, BC	Goal to begin construction spring 2010		Terasen	Estimated \$2 million for facility.	Potentially \$25,000/year in revenue accruing to regional government.	26,000 GJ of natural gas per year (enough heat and hot water for approximately 300 homes). Methane emissions reduced and new fuel use avoided.

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Wastewater Recovery and Reuse	City of Vernon	Treated wastewater is used for irrigation, and digested waste is turned into compost and sold.	Vernon, BC	In operation for over 20 years.				Reduced capital costs; some revenue from fertilizer.	Reduced new fertilizer use; reduced energy use in water treatment and transport.
Micro-hydro from existing waterworks infrastructure (gravity-fed)	District of Lake Country	1.1 Mw micro-hydro project. Captures waste-energy from gravity - existing drinking water infrastructure steeply sloped and must be slowed for safe use.	District of Lake Country	In operation since June 2009	\$2.8 Million Gas Tax and ecoENERGY for Renewable Power; \$500,000 low-interest loans from Federal government, and \$30,000 from Green Municipal Fund	Canyon Power	\$3.3 million	3,900 megawatt-hours of electricity per year will be provided. \$200,000 in electricity sales to BC Hydro provided.	Electricity for 400 homes provided within existing waterworks infrastructure.
Study of Bio-energy from Agricultural and Wood-Waste in Merritt	City of Merritt; Lower Nicola Indian Band	Study to investigate viability of producing wood pellets from forest and agricultural residue, municipal waste, and mountain pine beetle infested fibre.	Merritt, BC		\$105,000 - Western Economic Diversification Canada, through the Community Economic Diversification Initiative (CEDI) a component of federal Mountain Pine Beetle Program.		\$105,000 (study)		
Northern BC									
Turnkey Gasification System	University of Northern British Columbia	Biomass Gasification facility will gasify pine beetle infested biomass, produce heat to fire a boiler at the power plant on campus and to heat university buildings.	Prince George (UNBC Campus)	Announced July 2008	ICE Fund \$3.5 million	Nexterra	\$12.86 million	Reduced fuel costs; job creation (17,000 person hours of labor); part of larger project to establish UNBC as a bioenergy "hub", which may bring direct and indirect economic benefits.	80% reduction in emissions from current heating energy practices, resulting in 3-4,000 tonnes per year of greenhouse gases avoided.
Enviro-Carbonizer	Alterna Energy	Conversion of approximately 180,000 tonnes of waste per year into "biocarbon" (charcoal). Feedstock includes forest waste, mountain pine beetle infested biomass, and eventually may incorporate municipal waste and scrap tires. Biocarbon can be used for energy, water purification, steel processing and agriculture.	Prince George	Announced July 2008	ICE Fund \$3 million	Alterna Energy	\$8.16 million		
BCR Bio-Energy Project	P.G. Interior Waste to Energy Group	Plant will use a chemical decomposition process to convert cellulosic feedstock (wood waste) into electricity, charcoal, and bio-oil. Plant will produce 8 megawatts of electricity from approximately 100,000 cubic metres of waste wood that would otherwise be burned or land filled.	BCR Industrial Site, Prince George	Contract signed with BC hydro; Expected to begin operations Spring, 2010; expected to be fully operational by Spring, 2011.		P.G. Interior Waste to Energy Ltd.	\$50 Million	Approximately 50 to 75 construction jobs & creation of 70 permanent jobs to operate the facility.	Reduce the amount of government-permitted fine particulate allowed at the site by 70 per cent.
Mackenzie Green Energy Center	Pristine Power; Harbert Power; Balanced Power Engineering	Wood waste to cogeneration (electricity and heat)	Mackenzie, BC	Expected completion date December 2009		Steam to be used at Pope and Talbot Mill.	\$225 million	260 construction jobs, 26 permanent jobs over 30 year life-cycle; cheap heat to Pope & Talbot mill; \$.5 million in property tax revenue to District of Mackenzie.	Enough electricity for 50,000 homes. Will likely result in closing of up to 6 beehive burners. Avoids burning/land filling of up to 1 million tonnes of wood waste/year.

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Canadian Examples (Outside BC)									
Lachenaie landfill gas capture		Landfill gas fuels reciprocating engines for on-site electrical generation; net output capacity of 3.7 MW, produces enough electricity for 2450 homes annually.	Lachenaie, QC	Electricity generated since 1996				Ongoing revenue to BFI from sale of electricity to Hydro Quebec.	GHG reduction equivalent to 250,000 tonnes of CO ₂ .
Disinfection at North End Water Pollution Control Centre		Heat from wastewater for heating season and rejects heat into wastewater for cooling season.	Winnipeg	Fully operational		Earth Tech	600000 for HVAC mechanical costs on a \$25 million project	Annual energy savings \$20,000.	GHG emissions completely eliminated.
Edmonton MSW-to-Energy facility	Energem Greenfield Alberta Biofuels (EGAB); City of Edmonton	Biofuels (ethanol) and green chemicals from sorted municipal solid waste at landfill. Likely to increase diversion rate from 60%-90%.	Edmonton	Expected completion date: early 2011	The City of Edmonton and the Province of Alberta, through the Alberta Energy Research Institute (AERI), are contributing a combined CDN\$20 million	GreenField Ethanol and Energem are partnered for this project.	\$70 million	36 million litres (9.5 million gallons) of ethanol produced; Payback in approximately 10 years, depending on cost of gasoline.	The ethanol will reduce Alberta's carbon dioxide (CO ₂) footprint by more than 6 million tons over the next 25 years - the equivalent of removing 12,000 cars off the road every year.
Complexe environnemental de Saint-Michel landfill gas capture	City of Montreal	23 MW landfill gas capture, gas operates boilers and stream turbines, electricity fed to Hydro-Quebec.	Montreal	In 1989 began flaring methane gas, in 1996 began generating electricity		SNC-Lavalin; Biothermica; Gazmont		Enough electricity to power 15,000 homes; Montreal receives over \$1 million per year in royalties from gas sale	Equivalent to taking 175,000 cars off the road, reduction of 1.1 million tonnes of CO ₂ .
Anaerobic Digestion	City of Toronto	An assessment of the energy potential of anaerobically digested Source Separated Organic (SSO) material. Following bench and pilot scale testing, process optimization scale up information will be used for wide application of anaerobic digester systems in the City of Toronto.	Toronto	Completion 2005-2006	City of Toronto, Environment Canada (EC), NRCan/OERD - Technology and Innovation Research and Development (T&I R&D) Initiative, and University of Waterloo				Significant reductions of Greenhouse Gas (GHG) emissions are anticipated by this research through the capture of methane and the production of renewable energy.
Keele Valley landfill methane gas capture		One of the world's largest gas-to-energy projects, supplying 33MW of almost continuous energy to the Ontario grid.	Vaughan, Ontario	In operation since 1995				Sale of energy nets over \$1.5 million per year in royalties for cities.	
Clover Bar landfill methane gas capture	City of Edmonton, EPCOR	Methane gas is collected, cleaned and supplied to the Clover Bar Generating Station, where it is burned alongside natural gas for electricity - in 2001 roughly 5000 kW electricity produced.	Edmonton	Began operation in 1992		Environmental Technologies Inc.		Provides enough electricity to supply 4,000 homes; the City of Edmonton receives royalty payments for collection of a resource that would otherwise be a liability.	Reductions equivalent to removing 44,000 cars from the road; in 2001 reduced fossil fuel emissions by roughly 22,300 tonnes; GHG emissions reductions equivalent to 182,000 tonnes.
Water Reuse	City of Edmonton	Newly constructed membrane treatment facility which uses methane gas from wastewater sludge to heat the facility. Effluent that reaches the refinery is used to produce hydrogen stream which produces low sulphur fuels. Portion of reused wastewater stocks parks and is used for irrigation and snowmaking.	Edmonton	2006	Petro-Canada	zenon Environmental			

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Energy Efficiency	City of Saint John	Installation of a energy management control system that remotely monitors energy use in individual buildings	Saint John, NB	2008	FCM's Green Municipal Fund	Province of NB, Irving Oil, Natural Resources Canada, Enbridge Gas NB		Cost savings of more than \$5 million.	Reduction of approximately 17% from 1996-2007
Niagara Waste Systems Ltd. Landfill gas capture		Filtered and dried landfill gas sold to nearby Abitibi-Consolidated Newsprint Recycling Plant in Thorold, sent via a dedicated 3km pipeline owned and maintained by Enbridge	Niagara Falls, ON	Began operation in 2002, expanded capacity in 2003 and 2007		Integrated Gas Recovery Services Inc.		Produces approximately 35% of the heat required for newsprint operations at a local fibre paper mill; reduces dependency on natural gas, thus reducing fuel costs for the newsprint company	Destruction of more than 230,000 tonnes of methane per year
Britannia landfill gas capture	Region of Peel	Produces 5.5 MW of electricity, enough to power the nearby village of Streetsville, ON; golf course operates on the final contours of the landfill, 800m of dedicated pipeline, Region of Peel owns the Britannia Sanitary Landfill site, purchases the renewable electricity on a long-term contract	Mississauga, ON			Integrated Gas Recovery Services Inc.		Region of Peel receives emissions credits from the project	GHG emissions reductions of 250,000 tonnes annually
Landfill gas to energy		Produces 275kW of electricity, powering the nearby Shaver hospital; the proponents are exploring the economic potential of heat capture from the Shaver operation	St. Catharines, ON			Glenridge Gas Utilization Inc		Potential to sell CO2 emission credits and electricity to the grid	
Trail Road landfill gas capture		5 MW facility, LFG fuels reciprocating engines providing enough electricity to supply 5000 homes; Ontario Power Authority purchases the electricity, City of Ottawa owns the landfill, Comcor Environmental Ltd. and IGRS operate the plant and wellfield, PowerTrail Inc owns the plant	Ottawa, ON	Began operation in 2007, slated to run for at least 20 years		Integrated Gas Recovery Services Inc. and Energy Ottawa Inc.		Ontario Power Authority receives all GHG emission reduction credits; City of Ottawa receives royalties from gas rights, capital contribution to the LFG collection system expansion/upgrades, and annual operation and maintenance savings relating to gas field collection system	Reduces GHG emissions by up to 180,000 tonnes per year relative to 1990 levels
Eastview Landfill Gas Energy Plant	Ecotricity Guelph Inc.	Landfill gas to energy, generates 2.5 MW annually	Guelph, ON	Began commercial operation in August 2005, expanded capacity in 2006				Contractor sells electricity to the Ontario Power Authority	
Bensford Road Landfill Site	City of Peterborough	Peterborough Utilities Inc. presently undertaking assessment of the potential	Peterborough, ON	Project announced April 2009	Ontario government will fund up to two-thirds of the project cost				
Lindsay/Ops landfill gas capture	City of Kawartha Lakes	Potential electricity generation	Kawartha Lakes, ON	Funding announced April 2009	Ontario government - \$2.07 million				
Ravensview Sewage Treatment Plant	Utilities Kingston	Sewage plant upgrade; thermophilic anaerobic digestion, waste gas capture for co-generation facility; grid-tied electricity.	Kingston, ON	Under construction; completion expected in late 2009.	\$25M (1/3) Federal - Canadian Strategic Infrastructure Fund, 1/3 province, 1/3 normal sewerage fees	Prime Contractor: Pomerleau Ontario Inc. Lead Engineer: J.L. Richards & Associates Limited	100\$ million	?	Offset GHG data unavailable/uncalculated by project. Check back after plant operational.

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Cogeneration sewage upgrade	City of Regina	Cogeneration retrofit - feasibility study completed - currently small amount of methane used for boilers, most is flared. Substantial economic and environmental savings projected from cogeneration upgrade.	Regina, SK	Expected start date 2009	Green Municipal Fund	N/A	Study: 125,000\$	Added: savings to boiler maintenance due to hydrogen sulphide in gas	3,700 tonnes
Anaerobic Digestion at Pelee Hydroponic Greenhouse	Seacliff Energy	Anaerobic digester installed at greenhouse using greenhouse waste, approx 4% manure, and off-farm food processing waste.	Leamington, ON	Construction to start 2009	\$1.6 Million loan from Federal Government	Seacliff Energy, Agrinz (Austrian company) providing tech.	\$6.5 Million	Expected revenue \$2 million/year. Tipping fee charged to food processing plants (fee will be cheaper than what they pay now). Creation of 3-4 jobs.	5,200 tonnes annually
Pinehedge & Terryland Farms	Pinehedge Farms and Terryland Farms	Anaerobic Digestion of manure. Biogas used for cogeneration. Some electricity sold into grid. Pinehedge Farms has 50 cows and a 100 kW generator, while Terryland Farms has 135 cows and a 180kW generator		Operating since August 2007	292,500 from Ontario Rural Economic Development Fund		Approximately \$900,000	12-15 cents/kWh from net metering program in Ontario	
Klaesis Power Project - Frepro Farms	500 Kw (up from original 100)	On-farm anaerobic digestion of manure and combustion of biogas for electricity. Manure collected from 300 cows; powers dairy operation and 40 homes. Entire dairy operation and 40 homes.	Foresters Falls, ON		\$50,000 innovation award from the Ontario government	Organic Resource Management Inc (ORMI) provides much of the feedstock. Tipping fee paid but reduced based on quality of feedstock.	\$180,000	Klaesi said 40 per cent is used to power the farm, cutting a monthly power bill that was once \$2,500 to only a basic \$30 fee. The remaining 60 per cent is sold to Ontario's power grid at an average of 12 cents per kilowatt hour, about \$120 a month.	
Stanton Dairy Farm	Stanton dairy farm	Anaerobic Digestion producing 1.3 mW of power. The farm was designed as a research and development facility in a joint venture with the Universities of Guelph, Waterloo and Western Ontario to do a host of research projects on bioenergy, biogas technologies, testing on organic matter and gas production.	Ilderton, ON	1.3 megawatts of power			\$4.5 million		
Growing Power Hairy Hill	Highmark Renewables, Alberta Research Council (ARC)	Wheat is grown for cattle feed. Starch is removed from the wheat for ethanol production. The wheat is fed to the cattle. The cattle excrement is anaerobically digested to create electricity. Heat by-product used to assist digestion, and remaining nutrients used for fertilizer. < 30,000 cattle	Hairy Hill, Near Town of Two Hills and Town of Vegreville, Alberta		\$ 4 million provincial funding.		< \$ 100 million project - enough power to run the next-door feedlot and turn on the lights in 700 homes in Vegreville and Two Hills.	Revenue from 75,000 tonnes of GHG credits. 15\$ in Alberta and 40\$ internationally.	75,000 tonnes
Bayview Flowers Anaerobic Digestion Project	Bayview Flowers	Anaerobic digestion of several waste streams (primarily dog kibble, but also cull potatoes, grape pomace, dairy manure and cracked corn). Biogas used for cogeneration, providing all lighting and heating needs for greenhouse and selling excess electricity to grid.	Jordan Station, Ontario	Operating since 2007	OMAFRA - provincial funding - 40% eligible costs up to \$400,000			5-10 year payback. Nearby pet food manufacturer saves \$30,000 in land-fill tipping fees.	

Integrated Resource Recovery Inventory

Ministry of Community and Rural Development

Title	Proponent	Project Type	Location	Stage	Funders	Private Sector	Budget	Economic Benefits	Environmental Benefits
Ledgecroft Farms Inc anaerobic digester	Ledgecroft	470 animal dairy farm with 500 kilowatt anaerobic digester. Electricity sold to Ontario Power Authority under Standard Offer program.	Seeley's Bay, Ont. (north of Kingston)		\$50,000 grant from National Research Council of Canada.			Organic resource Management Inc (ORMI) will deliver 5,000 cubic meters/year of organic residuals to farm. Will pay tipping fee based on performance of feedstock.	
US Examples									
District Energy System in Regent Park	Steam Plant at Western Avenue	Recovered wood waste will provide 60% of the fuel for the steam boiler, heating area buildings; natural gas comprises the remaining 40%.	Seattle, WA	Operating by July 2009	Seattle Steam Co.		\$25 million	Cost stabilization and money spent locally for fuel	Reduction of 50,000 tonnes per year; the goal is a 50% reduction
West Point Sewage Treatment Plant	King County, Washington	Digester gas used to run four internal combustion engines, which run the main pumps for incoming wastewater; the exhaust heat boils water to heat workspaces and the digesters.	Seattle, WA	Began operation in 1985					
South Point Sewage Treatment Plant	King County, Washington	The fuel cell uses digester gas to create an electrochemical reaction, creating electricity; gas turbines combust digester gas to turn fan blades and produce heat, which is used to boil water and create steam for heating purposes and generating electricity in a steam turbine.	Renton, WA	Fuel cell in demonstration from 2004 to 2006, with plans to resume operation in 2008; separate turbines in operation since 2005				Some digester gas is sold to Puget Sound Energy, and it displaces the cost of other fossil fuels	Digester gas displaces the use of other fossil fuels
Fuel cells powered by biogas	City of Oregon	Anaerobic digesters break down biosolids and produce a combustible gas used to heat buildings and operate digesters; the gas also runs fuel cells and micro-turbines, which provide crucial backup electricity for the facility.	Portland, OR	Fuel cells began operation in 1998; micro turbines began operation in 2003	\$200K from Department of Defence, \$247K from Portland General Electric Renewable Energy Rebate, \$14K from Oregon Office of Energy, \$194K from tax credit, \$645K from City of Portland		\$1.3 million	Fuel cells provide \$60K per year in savings; micro-turbines expected to save between \$70-80K per year; the City sells some biogas to a neighbouring industry	Fuel cells are an extremely clean source of electricity, and they are essentially carbon-neutral
King County Cedar Hills Regional Landfill	King County, Puget Sound Energy	Landfill gas to energy project will be the third-largest in the US, powering 24,000 homes.	Maple Valley, WA, 20 miles southeast of Seattle			Bio-Energy Washington, a subsidiary of Interco			
Biosolids to Energy	Five Los Angeles-area sanitation districts	Sludge is exposed to extreme heat and pressure, rupturing cellular structures; water is then split off from carbon dioxide gas, which will be used in place of coal at a nearby cement kiln.	Orange County, CA	In operation since mid-2008	Private equity funds	Genentech Environmental	\$78 million	Reduction in costs compared to traditional methods of drying biosolids	Reduction of fossil fuel emissions from trucks, as they will no longer ship biosolid waste out of state

Integrated Resource Recovery Inventory

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International (Outside North America)									
Biogas production from sludge	Municipality of Kristiansand	Biogas is produced at the landfill and incinerated in the district heating plant; biogas is also produced at the wastewater treatment plant and used for internal heat production and vehicle fuel.	Kristiansand, Sweden	In operation					
Biogas production from sewage treatment	United Utilities Group Plc and National Grid Plc. City of Manchester	Biomethane injected into gas grid and as fuel for sludge tankers.	Manchester, England	Completion expected in 2011			\$7.1 Million	Enough gas for 500 homes. Conversion of 24 sludge tankers is expected to save companies "hundreds of thousands" (UK currency) per year.	
Sunamachi Water Reclamation Center	Local government	Sewage sludge carbonization facility. 300 tons/day of dehydrated sludge are further dried and carbonized in a furnace, producing 8,700 tons of biomass fuel. Fuel used in power plant and mixed with coal. 9% of Tokyo's sludge is used.	Koto Ward, Tokyo, Japan	Operation started in November 2007					Total reductions of 46,200 tonnes/year. Carbonizing sludge instead of combusting offsets 37,000 tons of Co2/year. Offset coal use reduces emissions by a further 9,200 tons.
Mikasagawa Sewage Purification Center	Local government	Production of biosolids-derived fuel (BDF) in a sewage treatment plant. BDF is produced by mixing sewage sludge and oil, then heating and drying the output. BDF is also used as a fertilizer.	Hakata, Japan (island of Kyushu)	In operation since 2000					1,200 tons of BDF can reduce the use of 1,100 tons of coal, which will result in a reduction of 2,600 tons of CO2
Morigasaki Water Reclamation Center	Local government	Sewage thermophilic digestion, used for electricity generation. Also, micro-hydro generates electricity from effluent outflow.	Tokyo, Japan	AD In operation since April 2004; hydro in operation since June 2005				The biogas produces half of total power used in facility. Results in 600 million yen (US 5.7 million) in reduced electricity costs. The hydro generation produces 800,000 kWh per year, or 0.7 percent of the electricity consumed by the plant.	Biogas: 4800 tonnes of co2/year Hydro-electricity: CO2 reduction of 300 tons per year
Selby Renewable Energy Park	Whites Renewable Energy	Two new anaerobic digester to be built inside of former Citric Acid Plant. Feedstock from supermarkets, food processors, caterers, homes, etc. Will be largest power plant of its kind in the UK. Likely grid-tied CHP (cogeneration).	Selby, UK	Construction to start September '09. Expected completion of first digester at end of 2009. Expected completion second digester end 2011.		Grantham-based Whites Renewable Energy	35.5\$ million (20 million British pounds)	Enough power for 10,800 homes.	28,000 tonnes/year. 165,000 tonnes of kitchen scraps will be available as compost.