



Clean Energy Innovation in Canada



Government
of Canada

Gouvernement
du Canada

Canada

Agenda

1. Clean Energy Innovation in Canada: Overview

Frank Des Rosiers, Assistant Deputy Minister, Innovation and Energy Technology, Natural Resources Canada

2. Federal Organizations involved in Clean Energy Technology

A. Natural Resources Canada

Frank Des Rosiers

B. Innovation, Science and Economic Development Canada

Andrew Noseworthy, Federal Co-Chair, Working Group on Clean Technology, Innovation and Jobs and Senior Advisor to the President (Energy and Strategic Initiatives), Atlantic Canada Opportunities Agency

C. Natural Sciences and Engineering Research Council of Canada

Bettina Hamelin, Vice-President, Research Partnerships

D. National Research Council

Andrew Reynolds, General Manager, Energy, Mining and Environment

E. Sustainable Development Technology Canada

Chris Boivin, Vice-President, Investments

3. Moderated Q&A Session

1

Clean Energy Innovation in Canada: Overview



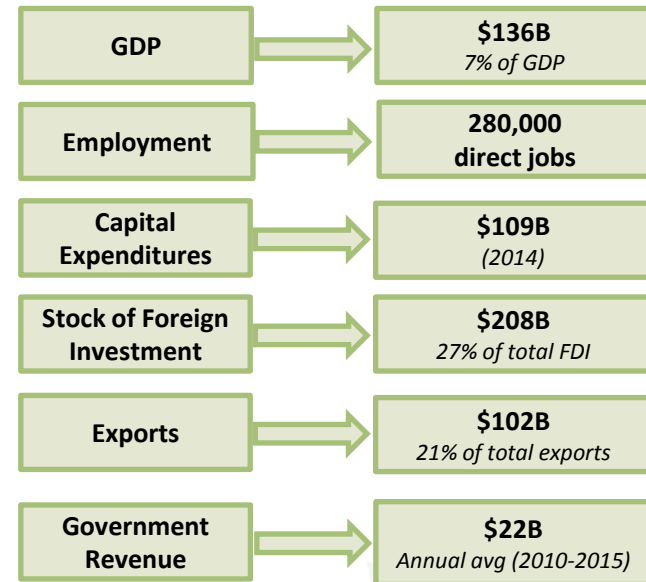
Frank Des Rosiers

Assistant Deputy Minister
Innovation and Energy Technology
Natural Resources Canada

The transition to a clean, low-carbon economy is underway.

- The energy sector is an important contributor to Canada's economy.
- With growing global energy demand – 32% from 2013 to 2040 – there is a need to make natural resource development cleaner, and energy use more efficient.
- Lowering carbon emissions has become a global priority – the energy sector contributes over 80% of Canada's GHG emissions.
- Investments in clean technology and adoption are needed to accelerate environmental performance and GHG reductions.

Canada's Energy Sector



Canada has a diverse and abundant energy portfolio...

80% of electricity generation is non-emitting

Renewable Energy

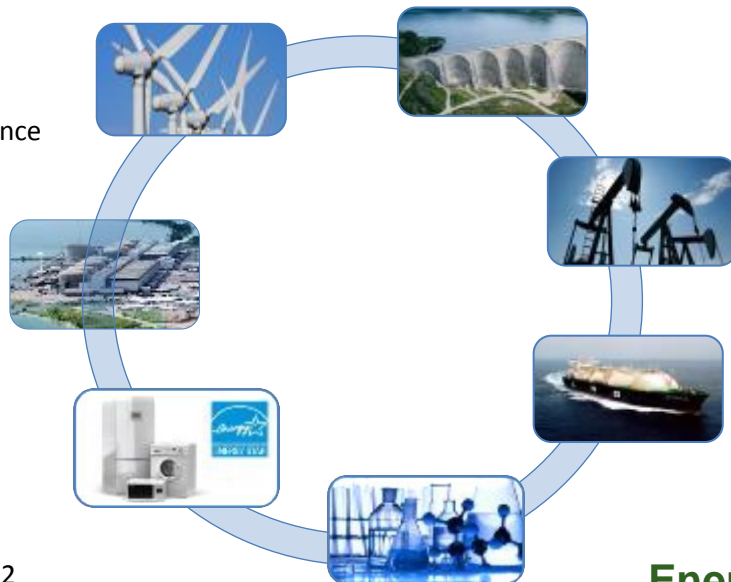
- 65% of electricity portfolio
- 7th in wind power capacity
- 555% growth in solar capacity since 2010

Nuclear

- 2nd largest uranium producer
- Own nuclear reactor technology (CANDU)

Energy Efficiency

- \$37B in energy costs saved in 2012
- GHG reductions equivalent to emissions of more than 27M cars



Hydro

- 2nd largest hydroelectricity producer

Crude Oil

- 5th largest producer
- 3rd largest proved reserves

Natural Gas

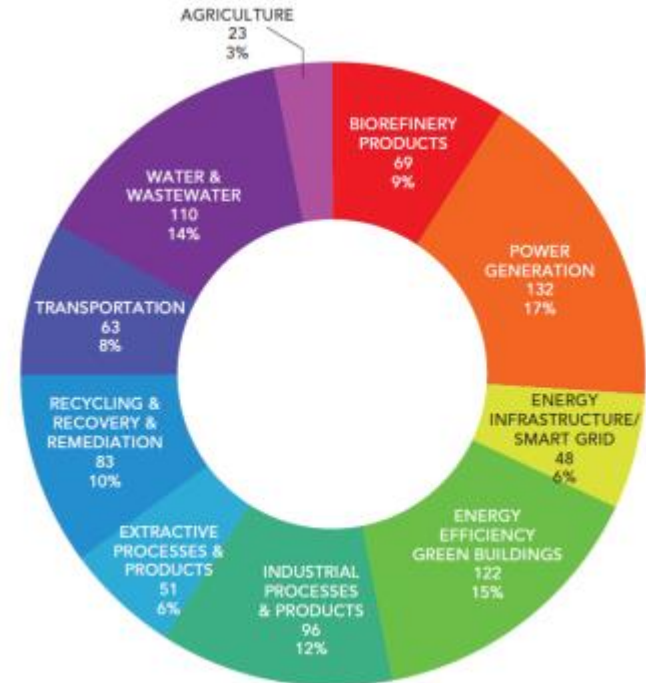
- 4th largest producer
- \$10.6B net exports

Energy Technology Innovation

- Significant investment in energy RD&D
- >55,000 employed in clean tech sector employs and is growing 4X faster than rest of economy

...with a growing and vibrant clean technology sector.

- Clean technology offers tremendous growth potential for Canada
 - Global clean technology industry market expected to grow to \$2.5T by 2022.
 - Shaping the transformation of Canada's natural resources
- A diverse sector, comprised largely of small and medium sized enterprises
 - Strong representation across the energy, mining, forestry, agriculture, and fisheries sectors.
 - Highly-educated workforce - over 55,000 people - and world-class labs and research facilities.
 - Adopters incorporate clean technologies into their operation across sectors creating important environmental gains.



Source: 2016 Canadian Clean Technology Report

Canada has a strong federal mandate for clean growth...

- Canada's vision for a clean, innovative economy balances both economic growth and environmental protection goals.
- **These goals are not incompatible — they go hand in hand.**
Supporting a clean growth economy will help Canada create jobs and take advantage of new opportunities both at home and abroad.
- Canada can dramatically reduce or eliminate carbon emissions via new clean technology solutions.



Prime Minister Justin Trudeau at COP 21

"Canada can and will do more to address the global challenge of climate change... ..because it's the right thing to do, for our environment and our economy, and as part of the global community."
PM Trudeau, COP21, Dec. 2015

...delivered through key commitments and early funding actions...

- **Over \$1B** to support clean technology in the natural resource sectors.
- **\$2B** to establish a *Low Carbon Economy Fund* to support the Pan-Canadian Framework on Clean Growth and Climate Change working with Provinces and Territories.
- **\$20B** in green infrastructure and public transit across the country
- **\$200M** to accelerate clean energy technology research, development and demonstration (RD&D).
 - Technology areas include electric vehicle charging technologies , renewables, smart grid and storage systems, and technologies to reduce GHG emissions from the oil and gas sector.
- **\$20M** to create Canada Excellence Research Chairs in fields related to clean and sustainable technology.
- Expanding tax support for clean energy to include electric vehicle charging and electrical energy storage.



...supported by an enabling environment...

- Canada is recognized by the World Economic Forum as one of the most innovative and competitive economies in the world.
- Well-developed infrastructure with a strong intellectual property regime
- Attractive tax treatments with the second lowest corporate tax rate in the G7 with strong tax incentives for R&D
- Strong talent pool
 - Canada generates about 4.1% of global knowledge, despite accounting for just 0.5% of the world's population
 - R&D spending in higher education as a share of GDP is higher in Canada than any other G7 country (OECD, Main Science and Technology Indicators 2014).
 - Canada is the 2nd most talent-competitive country in the G20 (Institute for Management Development) and a top destination for researchers.

Market uptake and early adoption supported by:

- ✓ Carbon pricing – The federal government has set a minimum carbon price for all Canadian jurisdictions starting at \$10 a tonne in 2018, and rising to \$50 a tonne by 2022.
- ✓ Green infrastructure
- ✓ Greening Government Operations
- ✓ Green Procurement

...and advanced through international collaboration.

Canada's strategic objectives under Mission Innovation:

- Double federal government investment in clean energy R&D over five years from \$387M to \$775M by 2019-20.
- Encourage private sector investment in early-stage clean energy innovation companies in Canada.
- Increase domestic and international collaboration to advance Mission Innovation goals.



Canada is playing an active role in the implementation of Mission Innovation by supporting the three sub-groups, including co-leading the Analysis and Joint Research sub-group.

2a

Natural Resources Canada (NRCan)



Frank Des Rosiers

Assistant Deputy Minister
Innovation and Energy Technology

Natural Resources Canada is well positioned to support Canada's clean energy sector.

- Energy department for Canada and lead for Mission Innovation.
- Over 40 years of experience in managing clean energy RD&D programs in Canada.
- Strong and extensive networks with industry, academia, provinces and territories and international partners.
- Responsible for CanmetENERGY - Canada's national energy laboratories with leading edge test facilities and more than 400 scientific experts.



Canmet and AECL laboratories conduct world-class energy R&D...

Canmet and AECL scientists are internationally-recognized experts in key energy R&D domains:

- Clean electricity
- Renewables and bioenergy
- Fossil fuels
- Energy efficiency and improved industrial processes
- Nuclear



Areas of Focus:

- Oil sands and heavy oil processes (incl. tailings, water management, bioprocessing, partial upgrading, future fuels)
- Tight oil & gas
- Oil spill recovery and response
- Flaring, venting and emissions

Devon

Areas of Focus (energy related):

- Lightweighting
- Materials technologies

Hamilton (CanmetMATERIALS)

Areas of Focus (energy related):

- Nuclear energy
- Hydrogen and energy storage

Chalk River Laboratories

Areas of Focus:

- Buildings energy efficiency
- Industrial processes
- Energy solutions for Northern and remote communities
- Integration of renewable and distributed energy resources

Vareennes

Areas of Focus:

- Buildings and communities energy efficiency
- Industrial processes
- Clean fossil energy
- Bioenergy
- Renewables

Ottawa

...working closely with partners across the innovation spectrum both at home and abroad...



Since 2006, \$1.6B in NRCan program funding has catalyzed an additional \$5.3B from Canadian partners (3.1:1 leverage ratio).

...on innovative energy technologies.



Oxy-Pressurized Fluidized Bed Combustion

This new pilot test facility will be the host site for Canada-US collaboration on leading-edge carbon capture technologies for applications in industry or in power generation.



Flaring & Venting

CanmetENERGY led a project at a refinery in Mexico, in which it identified ways to reduce GHGs by 1.3 MT annually/yr worth US\$100M of saleable products.



Advanced Refrigeration Technology

CoolSolution® technologies are in use in hundreds of arenas and supermarkets in Canada, reducing energy consumption by as much as 60%.



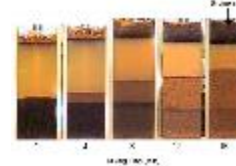
RETScreen International

By 2022, over 1M users expected worldwide; \$20B in direct user cost savings, \$100B in clean energy project investments, and over 50 MT/yr of GHG emission reductions.



Drake Landing Solar Community – Seasonal Thermal Storage

Developed a community in Alberta that heats 52 homes with solar energy. The project was the first of its kind in North America, fulfilling 98% of its space heating requirements, setting a world record.



Oil Sands Bitumen Froth Treatment

In collaboration with Shell Canada, the development of an improved froth treatment process led to a 10% reduction of energy use and water consumption which is now an industry standard.

Canada is committed to action.

- ✓ Strong vision.
- ✓ Outcome oriented RD&D.
- ✓ Support for breakthrough technologies.
- ✓ Strengthened relationships with international partners.
- ✓ Canadian energy solutions meeting global challenges.
- ✓ Strong coordination and alignment across the federal system.



2b

Innovation, Science and Economic Development Canada (ISED)



Andrew Noseworthy

Federal Co-Chair, Working Group on Clean Technology, Innovation and Jobs

Senior Advisor to the President (Energy and Strategic Initiatives), Atlantic Canada Opportunities Agency

Growing Canada's Future – Investing in Innovation

An

INCLUSIVE INNOVATION AGENDA

From IDEAS to SOLUTIONS
From SKILLS to GROWING FIRMS
From SCIENCE to TECHNOLOGIES
From CLEANTECH to a LOW CARBON FUTURE

Positioning Canada as a global centre for innovation where: growth is clean and inclusive; the middle-class prospers with greater quality jobs; and Canadian companies grow into world leaders

Strengthening industrial capabilities, expanding scientific discoveries, and building technological advantages

3 Priority Areas:

PEOPLE

TECHNOLOGIES

COMPANIES

Growing Canada's Future – Investing in Clean Growth

PAN-CANADIAN FRAMEWORK ON CLEAN GROWTH AND CLIMATE CHANGE

[Vancouver Declaration](#) outlined the path to a Pan-Canadian Framework on Clean Growth and Climate Change (PCF) and agreed to objectives:

GHG Reductions	Clean Economic Growth	Coordination across Canada	Engagement with Indigenous Peoples
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Four [working groups](#) struck to develop options for the PCF: 1) Mitigation; 2) Adaptation and Resilience; 3) Clean Technology, Innovation and Jobs; 4) Carbon Pricing

Together they form a [comprehensive, whole-of-government plan](#) to meet climate change objectives. [Clean growth and innovation](#) a key focus.

Growing Canada's Future – Investing in Clean Growth

WORKING GROUP ON CLEAN TECHNOLOGY, INNOVATION & JOBS

Report with options to Ministers November 18; release in late November

View that clean technology innovation important to climate change but can also create new economic opportunities

Key themes:

- Need for Strong Early Stage Innovation
- Technology Commercialization and Commercial Development are Essential
- Encourage Technology Adoption
- Value of Collaboration (Governments, Industry & Stakeholders)

Current Investment Tools

					<p>Industrial Technologies Office</p>	<p>Automotive Innovation Programs</p>
<p>NSERC investment programs and grants broadly encompass clean tech priorities like the Climate Change and Atmospheric Research Initiative, Discovery Frontier, and Strategic Partnership Grants</p>	<p>Sustainable Development Technology Canada (SDTC) finances the prototyping and pre-commercial demonstration of clean technology and next generation biofuel projects</p>	<p>National Research Council Canada (NRC) conducts research directly and its Industrial Research Assistance Program funds clean tech R&D and provides advisory services</p>	<p>Regional Development Agencies (RDAs) fund local clean tech projects from R&D and commercialization to promoting market access</p>	<p>Business Development Bank of Canada (BDC) offers financing and venture capital to commercialize clean tech</p>	<p>The ITO advances R&D through the Technology Demonstration Program and Strategic Aerospace and Defence Initiative</p>	<p>ISED's Auto Innovation Fund and complementary program, Auto Supplier Innovation Program, support auto firms and suppliers' large-scale R&D projects build innovative, greener, more fuel-efficient vehicles</p>

2c

Natural Sciences and Engineering Research Council of Canada (NSERC)



Bettina Hamelin

Vice-President

Research Partnerships

NSERC Vision – Make Canada a nation of discoverers and innovators.

- Canada's largest investor in academic and college research in the natural sciences and engineering – \$1.1B annually
- Supports talent pool of over 12,000 researchers and builds future talent pool - training and development of 30,000 students/trainees annually
- Industry/research sector partnerships leverage and complement academic and college research
- Strong interest from industry in this research capacity - \$200M annually in leveraged partner contributions

Impact on Clean Tech/Clean Energy Sector

- Investment in clean tech 2014-15 ~\$180M (includes climate change research)
- Investment in clean energy 2014-15, \$88.2M
- Third-largest Canadian investor in this area after AECL and NRCan
- Supports talent:
 - ~1,200 researchers active in this area across Canada in universities/colleges,
 - ~ 3,200 students being trained in this area

Building Academic and Industry Leadership

- Lithium ion batteries with longer lifetime (10 years), higher energy density and lower cost
 - Dr. Jeff Dahn and Tesla Motors Inc. **(IRC)**
- New numerical models to harness renewable energy resources cost-effectively
 - Dr. Eric Bibeau and Manitoba Hydro **(IRC)**
- Novel nanostructured nickel-carbon based materials to replace platinum-based materials in fuel cells
 - Dr. Gregory Jerkiewicz and Automotive Fuel Cell Cooperation, Ballard Power Systems Inc., Mantra Energy Alternatives Ltd, Nissan Motor Co Ltd, Norwegian University of Life Sciences, SFU, Universidade de Sao Paulo, Université de Poitiers, ZincNyx Energy Solutions Inc **(Discovery Frontiers)**



Building Pan-Canadian Networks

NSERC Wind Energy Strategic Network

- 25 researchers - 16 universities
- 14 Partners incl., Manitoba Hydro, Hydro-Québec, Nfld. & Lab. Hydro, SaskPower, Hélimax Energy, Atlantic Hydrogen, CANWEA, WEIC, CORUS
- Funding: \$6.6M million over 5 years (\$5M from NSERC)

Smart Net-Zero Energy Buildings Strategic Research Network

- 30 researchers - 15 universities
- 20 partners incl., Arctic Energy Alliance, Canadian Solar, Kott Group, s2e Technologies, City of Saskatoon, Halsall Engineers and Consultants, Toronto and Region Conservation, GazMétro
- Funding: \$ 5.14M from NSERC and \$3.7M (cash and in-kind) from partners

NSERC - R&D Partners



2d

National Research Council (NRC)



Andy Reynolds

General Manager

Energy, Mining and Environment

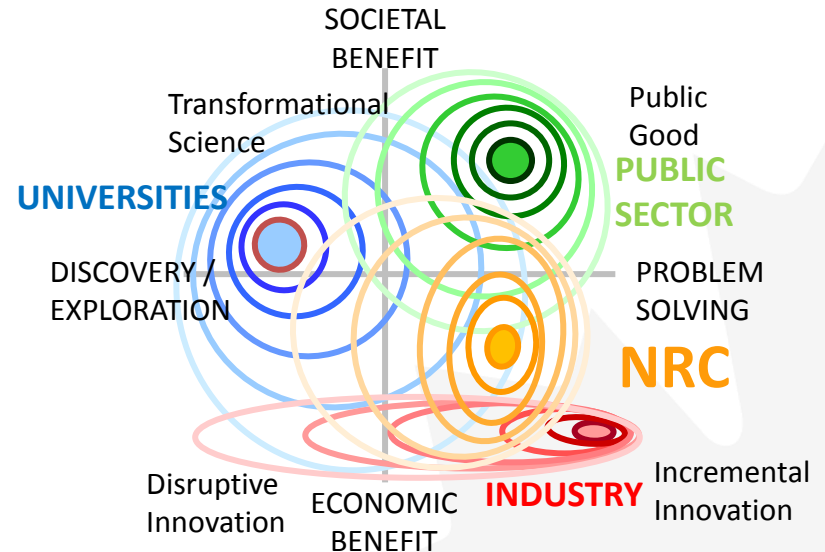
NRC's unique role in the innovation system



- NRC R&D Facilities
- ▼ IRAP Locations

VISION: To be the most effective research and technology organization in the world, stimulating sustainable domestic prosperity

MISION: NRC works with partners to develop and deploy solutions to meet Canada's current and future industrial and societal needs



100-YEAR RECORD
SCIENCE & INNOVATION
SUPPORT FOR CANADA

\$945M
TOTAL EXPENDITURES
IN 2015/16*

3,669 EMPLOYEES

\$168M
REVENUE IN 2015/16

*Includes \$302M in flow-through funding

Mission-oriented R&D: NRC program approach

Co-investment

Capabilities:
engineering, life
sciences, national
infrastructure, future
& platform tech

Strategy

Stakeholder
engagement along the
value chain to de-risk
technology
development and
deployment

Impact

Timely 5-8 yr
deployment
Public and private ROI
(social and economic)



Innovation support: Industrial Research Assistance Program (IRAP)

70-YEAR HISTORY

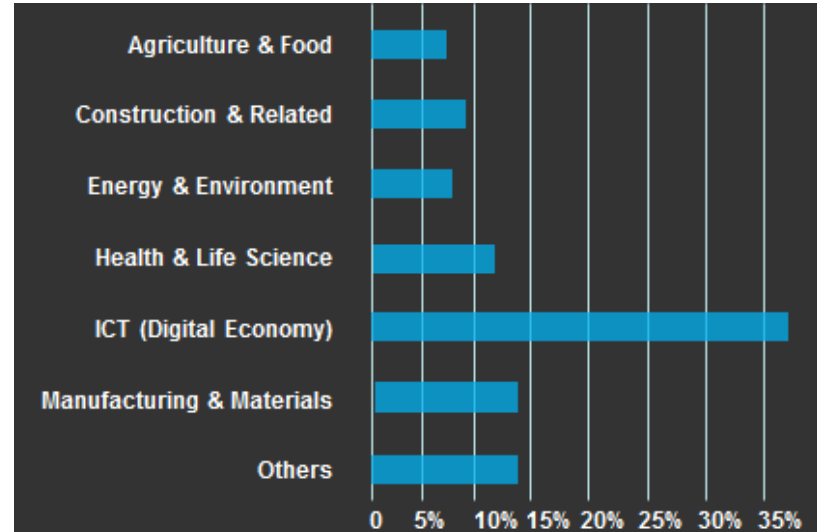
PROVEN TRACK RECORD SINCE 1946

255 INDUSTRIAL TECHNOLOGY ADVISORS (ITAs) IN THE FIELD

120 IRAP LOCATIONS ACROSS ALL PROVINCES

200 PARTNER ORGANIZATIONS

13,000+ CLIENTS ACROSS ALL SECTORS OF THE ECONOMY



\$291M BUDGET (2015/16)

\$235M FOR GRANTS & CONTRIBUTIONS

2,341 UNIQUE FUNDED CLIENTS (2015/16)

International networks: Opening key markets for Canadian partners

EUREKA 

innovation across borders

Publicly-funded intergovernmental network (40+ countries) uniquely structured to support grassroots-generated and market-driven ideas for innovative products, processes and services for civilian purposes

Canada's EUREKA Offices/Contacts

- ★ National Office at NRC HQ in Ottawa
- 5 Regional reps to advise SMEs on IRAP eligibility

- Helping Canadian SMEs forge cross-border partnerships to de-risk their innovation projects and gain access to:
 - ✓ R&D funding
 - ✓ technology
 - ✓ specialized know-how and facilities
 - ✓ new markets and business opportunities
- Since becoming an associate member in 2012, Canada's participation has generated 62 network projects valued at €56.8 million and 12 cluster projects valued at €151.9 million (\$305 million CAD total)

2e

Sustainable Development Technology Canada (SDTC)



Chris Boivin
Vice-President
Investments

SDTC– Driving Innovation and the Clean Economy

- **PURPOSE:** To fund the development and demonstration of new innovative technologies related to climate change, clean air, clean water and clean soil to make progress towards sustainable development;
- Foster and encourage innovative collaboration and partnering to channel and strengthen the Canadian capacity to develop and demonstrate Sustainable Development Technologies; and
- Ensure timely diffusion by funded recipients of new Technologies

15 YEARS OF EXPERIENCE FUNDING CLEAN TECHNOLOGY INNOVATION IN CANADA

4 OFFICES ACROSS CANADA

COMPANIES CAN APPLY FOR FUNDING AT ANYTIME

\$928 MILLION IN FUNDING ALLOCATED TO 320 PROJECTS OF WHICH 73 TECHNOLOGIES ARE COMMERCIALIZED

LEVERAGED \$2.5 BILLION IN ADDITIONAL FUNDING (>80% from private sector)



Funding helps de-risking technology in the development and demonstration stages, speeding adoption and commercialization.

	Level Technology Readiness Level (TRL)
1	Conceptual articulation
2	Technology and Applications described
3	Laboratory studies and analysis
4	Limited capability prototype validation in laboratory (pre-alpha version)
5	Full capability prototype validation in laboratory (alpha version)
6	Prototype validation in relevant environment (pre-beta version)
7	Actual system validation in a relevant environment (beta version)
8	Initial production and rollout
9	Full production mode

 **Earliest Funding Level**

 **Final Funding Level**

Supporting Projects Across All Sectors in Delivering Environmental and Economic Benefits

6.3 MT – REDUCTION OF ANNUAL GHG EMISSIONS

\$98 M – COSTS AVOIDED DUE TO CLEAN AIR, WATER AND SOIL

\$1.4 B – ANNUAL REVENUES GENERATED BY SDTC-SUPPORTED COMPANIES

9,200 – NEW JOBS ATTRIBUTABLE TO SDTC-SUPPORTED PROJECTS



SDTC's Portfolio of Companies



Forming Strategic Partnerships with Provinces



SDTC and Climate Change and Emissions Management Corporation (CCEMC) held a joint funding call in early 2016. This initiative will award up to \$40M to SMEs across Canada.



SDTC and AI-EES held a joint funding call in early 2016. This initiative will award up to \$8M towards clean water projects.



SDTC and OCE are partnering on the Target GHG Collaborative Technology Development Program, which is currently accepting applications.

3

Moderated Q&A Session

Reference Material

Contact Information

- **Natural Resources Canada - Mission Innovation Canada Secretariat**
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- **Innovation, Science and Economic Development Canada**
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- **Sustainable Development Technology Canada**
Chris Boivin, Vice-President, Investments
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Natural Resources Canada

Areas of Research: CanmetENERGY-Ottawa

Areas of Focus:

- **Clean Fossil Fuels**
 - Carbon capture and storage
 - Fluidized Bed Combustion
 - Gasification
 - Shale Gas
- **Renewables**
 - Solar Thermal
 - Wind Technology for Cold Climates
 - Marine Renewable Energy
 - Bioenergy and Biofuels
- **Buildings and Communities**
 - Energy Efficiency Buildings
 - Advanced Mechanical Systems
 - Renewables Integration
 - Smart Energy Networks
- **Industrial Processes**
 - Metallurgic coal
 - Solid biofuels for iron and steel manufacture
- **Transportation**
 - Renewable diesel and jet fuel
 - Transition Pathways to Electrified Transportation

Key Facilities:

- Direct Contact Steam Generation Pilot Test Facility
- Oxy- Fuel Pressurized Fluidized Bed Combustion System Pilot Test Facility
- Oxy-Fuel Vertical Combustor Research Facility
- Seasonal Building Envelope Test Hut Facility
- Fluidized Bed Fast Pyrolysis Pilot Plant
- Biofuels Process Development Unit
- Metallurgical Fuels Laboratory, including pilot-scale coke ovens
- Solid biofuels processing to pellets and torrefied wood

Areas of Research: CanmetENERGY-Varenes

Areas of Focus:

- **Buildings**
 - Building diagnostics, predictive controls
 - Cold climate heat pumps
 - Ejectors
 - Heat storage
 - Refrigerants
- **Industrial Systems**
 - Biorefinery
 - Data mining and process diagnostics
 - Waste heat
- **Renewables and Distributed Energy**
 - Photovoltaic technology integration and power systems
 - Smart grid
 - Virtual power plant and demand response
 - Microgrid applications
 - Active distribution network
- **RETScreen International**
 - Clean energy decision-making software
 - RETScreen Expert

Key Facilities:

- Analytical laboratories and pilot plants with test benches
- Analytical and experimental tools, such as climatic and psychrometric chambers, using state-of-the-art instrumentation
- Performing software for modeling, simulation and analyzes

Areas of Research: CanmetENERGY-Devon

Areas of Focus:

- **Environmental Impacts**
 - Mitigation technologies for impacts of oil and gas development on air, water and land
- **Oil Sands Spill Response**
 - Predicting behaviour of oil spilled in water
 - Technologies that can improve oil spill recovery
- **Non-Aqueous Extraction**
 - Technologies for the non-aqueous extraction of bitumen from oil sands with a goal to eliminate tailings, reduce water use, and increase energy efficiency
- **Partial Upgrading**
 - Goal to achieve 20% of in-situ production partially upgraded to improve quality and reduce the diluent requirement

Key Facilities:

- Pilot Plant Research Space
- Advanced Characterization Labs
- Hydrocarbon Specialized Analytical Labs
- Water Quality Labs
- Surface Characterization / Multi-phase Research Labs
- Process Simulation and Molecular Modelling Research Labs and CPU networks

Areas of Research: CanmetMATERIALS

Areas of Focus (*energy only*):

- Fuel efficiency in vehicles through lightweighting and materials technologies
- High-temperature, corrosion resistant materials for nuclear reactors and bioenergy systems
- New high-strength steels for pipeline (oil, gas, biofuel, CO₂) safety

Key Facilities:

- Pilot-Scale Rolling Mill
- Pilot-Scale Casting: High Pressure Die Casting and Vacuum Induction Melting
- Cray Supercomputer
- High-Temperature and High-Pressure Corrosion Laboratories

Natural Sciences and Engineering Research Council of Canada (NSERC)

Examples of NSERC Clean Energy Grants

Renewable Energy:

- BioFuel Net – a Networks of Centres of Excellence (NCE) (2012-17)
- BioIndustrial Innovation Canada (2008-15) (BIC is a Centre of Excellence for Commercialization and Research CECR)
- NSERC Wind Energy Strategic Network (2007-13)
- NSERC Solar Buildings Research Network (2005-2010)
- NSERC Photovoltaic Innovation Network (2009-2015)
- NSERC Biomaterials and Chemicals Strategic Network (2010 - 2015)
- NSERC/FPInnovations Industrial Research Chair in Forest Biorefinery

Nuclear:

- NSERC/UNENE Industrial Research Chair in Corrosion Control and Materials Performance in Nuclear Power Systems
- NSERC/UNENE/Nu-tech Precision Metals Industrial Research Chair in Nuclear Materials
- NSERC/UNENE Industrial Research Chair in Control, Instrumentation and Electrical Systems in Nuclear Power Plants
- NSERC/UNENE Industrial Research Chair in Nuclear Safety Analysis
- NSERC/Nuclear Waste Management Organization IRC in Nuclear Fuel and Waste Container Corrosion Under Waste Disposal Management Conditions
- NSERC/Candu Owners Group/AREVA Resources Canada, Cameco Corp. Industrial Research Chair in Effects of Ionizing Radiation on Non-Human Biota

Examples of NSERC Clean Energy Grants

Electricity:

- NSERC Energy Storage Strategic Network
- NSERC Smart Micro Grid Network
- NSERC Smart net-Zero Energy Buildings Strategic Network
- NSERC Industrial Research Chair for Colleges in Advanced Distribution System
- NSERC/Hydro-Québec Industrial Research Chair on the Integration of Renewable Energies and Distributed Generation into the Electric Grid
- NSERC/Hydro-Québec Industrial Research Chair in Interactive Information Infrastructure for the Power Grid
- NSERC / iCORE / Alberta Power Companies Industrial Research Chair in Power Quality
- NSERC /HydroQuébec Industrial Research Chair in Carbon Biogeochemistry in Boreal Aquatic Systems
- NSERC/Manitoba Hydro/Manitoba HVDC Research Center/RTDS Technologies/Teshmont Consultants/Electranix Corporation/TransGrid Solutions Inc. Industrial Research Chair in Power Systems Simulation

Hydrogen and Fuel Cells:

- Nickel Catalysts for Electrochemical Clean Energy (Ni Electro Can – an NSERC Discovery Frontier)
- Catalysis Research for Polymer Electrolyte Fuel Cells (funded under NSERC Automotive Partnership Canada)
- Development of Next Generation Heavy Duty Bus Fuel Cells with Enhanced Durability (funded under NSERC Automotive Partnership Canada)
- NSERC Hydrogen Canada Strategic Research Network (2008-2013)
- NSERC Solid Oxide Fuel Cells Strategic Research Network (2008-2013)

Examples of NSERC Clean Energy Grants

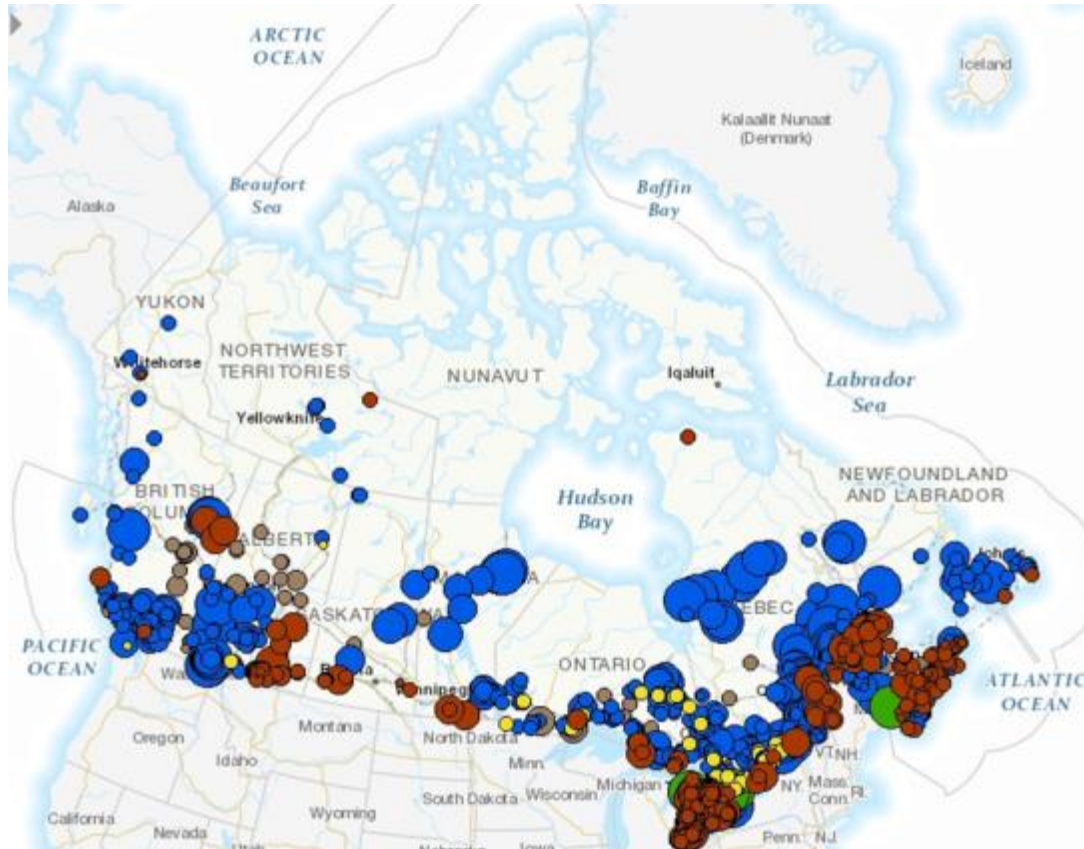
Fossil Fuels:

- NSERC Strategic Network for Cleaner Fossil Fuels
- NSERC/Capital Power/Oilsands Industrial Research Chair in Forest Land Reclamation
- NSERC/Syncrude Industrial Research Chair in Mine Closure Geochemistry
- NSERC/Syncrude Canada Ltd. Industrial Research Chair in Hydrogeological Characterization of Oil Sands Mine Closure Landforms
- NSERC Industrial Research Chair in Oil Sands Tailings Water Treatment
- NSERC Industrial Research Chair for Colleges in Peatland Restoration
- NSERC Industrial Research Chair in Energy and Environmental Systems Engineering

Additional Resources

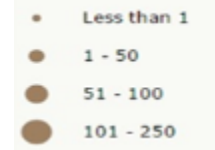


Map of Clean Energy Resources and Projects in Canada

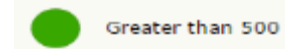


Generating Stations (MW)

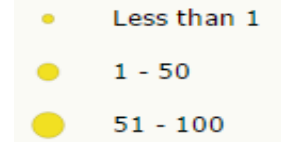
Biogas



Nuclear



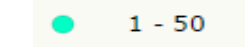
Solar



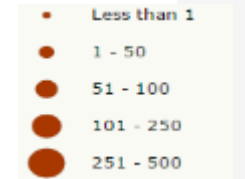
Hydro



Tidal



Wind



Atlas of Canada

Clean Energy Resources and Projects

<http://atlas.gc.ca/cep-rpep/en/>

Canada Clean Energy Test Centres

ENERGY STORAGE

- CanmetENERGY Ottawa
- Institut de recherche d'Hydro-Québec (IREQ)
- National Research Council Canada
- Wind Energy Institute of Canada

WIND ENERGY

- Anti-Icing Materials International Laboratory
- TechnoCentre éolien
- Wind Energy Institute of Canada

MARINE ENERGY

- Aquatron Laboratory
- Canadian Hydrokinetic Turbine Test Center
- Fundy Ocean Research Centre for Energy
- Marine Institute of Memorial University
- National Research Council Canada

SOLAR ENERGY (THERMAL AND VOLTAIC)

- Celestica Toronto Solar Test Lab
- Concordia University Solar Simulator
- National Solar Test Facility
- PV Field Test site
- CanmetENERGY Ottawa and Varennes

SMART GRID/MICRO GRID

- BCIT Smart Microgrid Program
- Canadian Solar Microgrid Testing Centre
- GE Grid IQ Innovation Centre
- Institut de recherche d'Hydro-Québec (IREQ)
- Schneider Electric Smart Grid Laboratory
- TechnoCentre Éolien

Canada Clean Energy Test Centres *(continued)*

RESIDENTIAL ENERGY SYSTEMS

- Building Envelope Test Hut (CE-BETH)
- Canadian Centre for Housing Technology (CCHT)
- Carleton Guarded Hot Box Laboratory
- Institut de recherche d'Hydro-Québec (IREQ)
- Natural Gas Technology Centre

INDUSTRIAL ENERGY

- Slot and energy recovery coke ovens for metallurgical coke production
- Tuyère test facility for supplementary fuels injection into blast furnaces

CLEAN FOSSIL FUELS

- CanmetENERGY Ottawa and Devon
- Carbon Capture Test Facility (CCTF) at SaskPower's Shand Power Station
- Carbon Management Canada Field Research Station
- Carbon Commercialization Centre (being designed and built in Alberta for Carbon XPrize)
- BCRI Technology Commercialization and Innovation Centre (to be commissioned by 2017 in BC)

NUCLEAR ENERGY

- CanmetMATERIALS
- Chalk River Laboratories
- McMaster University Pool Type Research Reactor
- SLOWPOKE Laboratory at l'École Polytechnique de Montréal
- SLOWPOKE Nuclear Reactor Facility at University of Alberta
- SLOWPOKE-2 Research Reactor at the Saskatchewan Research Council Analytical Laboratories
- SLOWPOKE-2 Research Reactor at the Royal Military College
- Reactor Materials Testing Laboratory at Queen's University
- University of Western Ontario Nuclear Power Plant Simulator
- University of Saskatchewan Tokamak

Canada

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