Presentation of available Roadmaps

in CANADA

28th IETS ExCo in Paris, France, May 14-15th 2019
WE ARE GUIDED BY THE CLEAN GROWTH POLICY LANDSCAPE

Pan Canadian Framework
F/P/T Engagement

4 Pillars
• Pricing carbon pollution
• Reduce emissions across economy
• Adapt to climate change and build resilience
• Accelerate innovation, support clean technology and create jobs

Generation Energy
National Dialogue

4 Pathways
• Wasting less energy
• Switching to clean power
• Using more renewable fuels
• Producing cleaner oil and gas

International
Commitments
Canadian leadership

Minister of Natural
Resources Mandate Letter
Department priorities

News and highlights on industrial R,D&D in Canada, and Development of National Support Group, 28th ExCo, May 2019
Federal Canadian Clean Technology Initiative

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**Innovation, Science and Economic Development Canada**

- **Accelerated Growth Service**
- **Venture Capital Catalyst Initiative (BDC - $400M)**
- **Regional Development Agencies**
  - NRC - IRAP
  - Superclusters (ISED - $950M)
- **Innovative Solutions Canada (ISED - $50M)**
- **Strategic Innovation Fund (ISED - $1.26B)**
- **Clean Tech Economic Strategy Table (NRCan/ISED)**
- **Sustainable Development Technology Canada ($400M)**
- **BDC/EDC new equity financing, working capital and project finance ($1.4B)**

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**Clean Growth Hub ($12M) Part of Innovation Canada**

(NRCan/ISED) ‘No wrong door’ service through: (1) Program Coordination; (2) Horizontal Policy; and (3) Stakeholder Engagement.

Key user of NRCan/ISED Clean Technology Data Strategy ($14.5M) outputs.

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**International Activities**

- **Invest in Canada Hub** Attract foreign direct investment to Canada: all sectors
- **Trade Commissioner Service** Programs and clean tech Trade Commissioners in Canada and abroad
- **International Joint Committees on S&T (GAC, NRCan, ISED)** Export Development Canada / Canadian Commercial Corporation
- **Mission Innovation (NRCan)**
- **NRC – IRAP EUREKA Network**

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**Pan-Canadian Framework on Clean Growth and Climate Change**

(ECCO) Coordination of key financing pools in support of PCF implementation. Focus on PT engagement, GHG mitigation.

- **Canada Infrastructure Bank**
- **Green Infrastructure**
- **Low Carbon Economy Fund**
- **Greening Government Operations**

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**Natural Resources and Other Clean Technology Investment Programs**

- **Impact Canada Fund: Clean Technology Stream (NRCan - $75M)**
- **Clean Growth in the Natural Resources Program (NRCan - $155M)**
- **Agriculture Clean Tech Adoption Program (AAFC - $25M)**
- **Fisheries Clean Tech Adoption Program (DFO - $20M)**

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**PCF Implementation**

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**Specific clean tech support**

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**Broad innovation support**
Canadian planned measures for GHG mitigation strategy in industry

– A Roadmap Example

28th IETS ExCo in Paris, France, May 14-15th 2019
Eco-Efficient Processes for Deep Decarbonization of the Industrial Sector
Context

Vision

• Provide new process designs and science-based evidences to support industry and governments in their investments and programme toward a Canadian low-carbon industry

Untapped potential

• Industrial processes waste lots of energy, do not use state-of-the-art technologies and operate below their optimal conditions
• High-impact low-carbon technologies (electrification, residual biomass) are underutilized
• Changes in traditional markets and resources (smart grid, CO₂-to-products) offer new opportunities

System perspective

• Lack of systems level thinking to support:
  o Effective integration of new technologies into processes
  o Assessment and comparison of decarbonization strategies under constraints
A Roadmap to Deep Decarbonization in Industry: A Canadian viewpoint

Eco-Efficient Industrial Processes

1. Highly energy-efficient processes
   - Process operation improvements
   - Process design optimization
   - Integration of transformative technologies and new products

2. Increase use of low-carbon energy sources and process electrification
   - Pathways for fuel switching
   - Develop new CHP process applications
   - Process electrification and interactions with smart grids
   - CCU design and integration with large-emitting processes
   - Assessment of CCU pathways in Canadian industries context

3. Carbon Capture and Utilization (CCU)

Energy- and GHG-intensive industries:
Pulp and paper, oil and gas, cement, steel and other metals

4. Arbitrage between available decarbonization strategies
Stream 1: Energy Reduction at Source

Objectives:

- Develop pathways toward next generation of highly energy-efficient, low-emitting and flexible industrial processes:
  - Develop advanced operating strategies and algorithms
  - Improve current designs
  - Integrate transformative technologies
  - Adapt processes for new products and feedstocks

How:

- Exergy analysis, Process modeling, Simulation and optimization considering different technical, economical, and environmental analyses

Outputs:

- Solutions to modify processes for new products and deep GHG reductions
- Effective integration of novel technologies in large emitting processes
- Increase flexibilities of process operations to diversify production and feedstocks
- Debottleneck processes to increase throughput
- Science-based policy support

Pulp and paper, oil and gas, cement, steel, and other metals
Stream 2A: Fuel Switching and CHP Systems

- **Objectives:** Maximize the use of low carbon fuels, especially **low grade forest biomass**, for fossil fuel reduction in industrial processes

- **Outputs:**
  - Detailed mapping of availability and potential usage of biomass in industrial processes
  - Estimation of potential impacts for Canada (GHG mitigation, required investment, economic benefits, etc.)
  - Demonstration of cost-effective implementation in unconventional applications, including CHP
  - Scientific knowledge about impacts of various fuel substitution pathways
    - **Cogeneration** systems (existing or new applications)
    - Process steam production in biomass boilers (4 MT/yr remaining potential only in P&P mills)
    - Fuel substitution in oven, dryers, kilns and furnaces (syngas, pellets, biocoke, etc.)
  - New revenue streams for the forest industry and local communities
  - Support policy development and programs
Stream 2B: Process Electrification and Enhanced Interaction with Smart Grids

- **Objectives**: Develop effective transition pathways for process electrification and demand response
  - Adaptation and interactions with smart grids (exploiting process flexibilities, product and heat/cold storage, etc.)
  - Screening and effective integration of electrification technologies suitable for industrial application (heat pumps, MVR, membranes...)

- **Outputs**:
  - Evaluation of GHG mitigation potential for various pathways and technologies, considering available renewable electricity
  - Estimation of the electric grid mix for each province, over the next 50 years
  - Identification of flexible loads for each industrial sector, and evaluation of demand response potential in each province
  - Demonstration of the most promising pathways and related technologies
  - Development of recommendations for policy and programs, as well as for industrial decision-makers
Stream 3: Carbon capture and utilization (CCU)

- **Objectives:**
  - Assess CCU pathways from energy, technical, economic and environmental standpoints, and identify most promising ones in the Canadian context

- **Outputs:**
  - **Mapping** of major point sources of CO₂ from industrial processes in Canada
  - **CCU pathways assessed** in the Canadian context:
    - Energy, GHG and economic benefits
    - Market opportunities
  - Comparative analysis of promising CO₂ conversion pathways with conventional production routes
  - **Science-based evidences** to support government and industries in their investments and programs for large CO₂ reductions through CCU
Stream 3: Carbon capture and utilization (CCU)

- There is a wide range of capture and utilization technologies
  ➔ Each having its own transformation route, energy requirement, performance, state of development, advantages and drawbacks.

- Beside technology, several other aspects must be considered
  ➔ Decision is multi-criteria and depends on specific context (industry, CO₂ concentration, local energy mix, environment, economics, market, priorities).

Conversion routes
- Mineralisation
- Chemical conversion
- Biological conversion

Direct routes
- Food and beverages
- Industrial gas
- Refrigerant
- Working fluid
- Solvent
- pH control
- Enhanced oil recovery (EOR)
- Enhanced coal bed methane recovery (ECBM)
**Achieving the Vision (cont’d)**

<table>
<thead>
<tr>
<th>Project</th>
<th>Activities</th>
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| Eco-Efficient Processes for Deep Decarbonisation of the Industrial Sector | 4. Arbitrage between available decarbonization strategies  
System level analysis of competing strategies to determine the marginal GHG abatement cost of various alternatives |
Thank you for your time and attention!

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