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Challenge Program
Materials for Clean Fuels

Phil De Luna
Program Director

1916 — CANADA EVOLVES · THE NRC RESPONDS — TODAY

NATION BUILDING | WAR TIME | BOOM TIME | SPACE RACE | DIGITAL + GLOBAL | CLIMATE CHANGE

Advice

1928 Conduct applied and industrial R&D

1946 Conduct basic science, provide support for small and medium-sized enterprises (IRAP)

1986 Industry-oriented institutes

2000 Regional expansion and cluster initiatives

2012 Research and Technology Organization (RTO)

2016 + Renewed focus on excellence and engagement

2020 COVID-19

EVOLVING NRC ROLE

173
buildings located on

22
sites

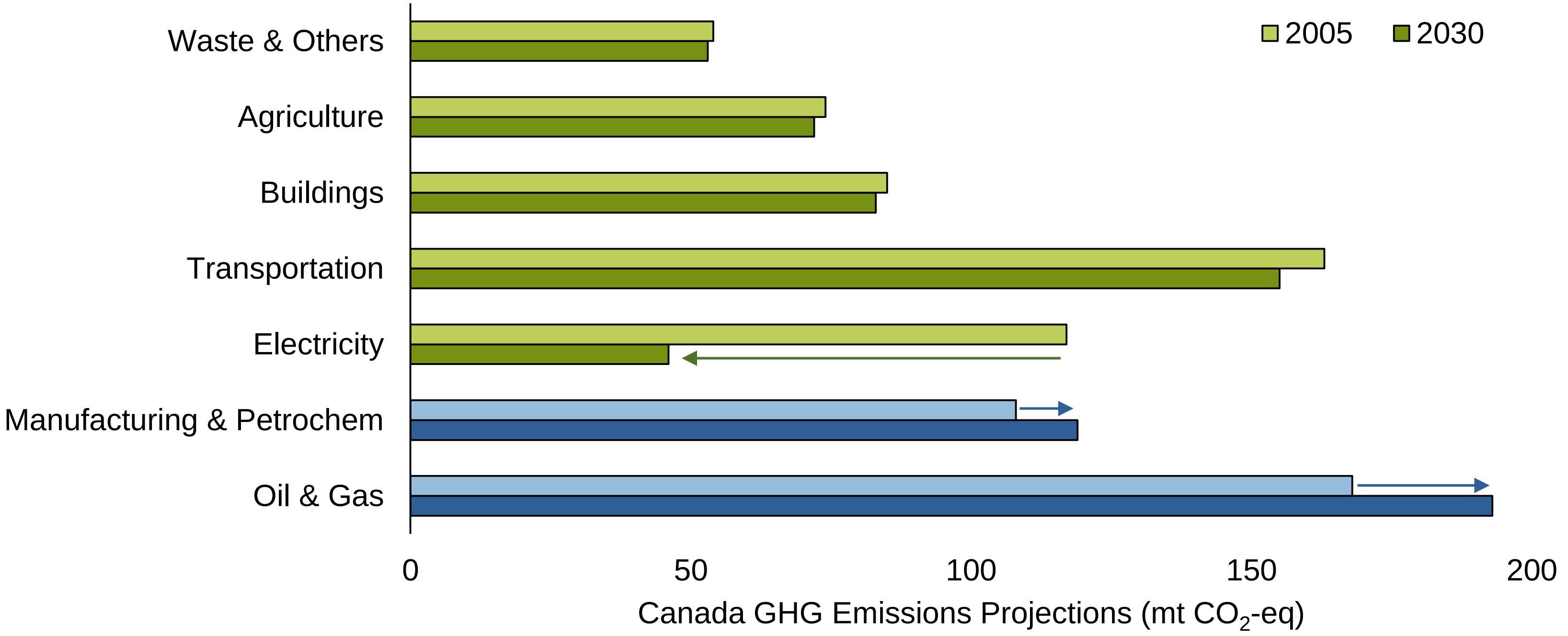
564,000 m²
of NRC facilities across Canada

3,700
scientists, engineers, technicians and other specialists, including

255
industrial technology advisors

Our Challenge

Develop **novel materials** needed for **clean energy systems** to meet Canada's **emissions reductions** commitments at **low cost**



Our 2050 Target

2007

65% GHG reduction by 2050

2016

80% GHG reduction by 2050

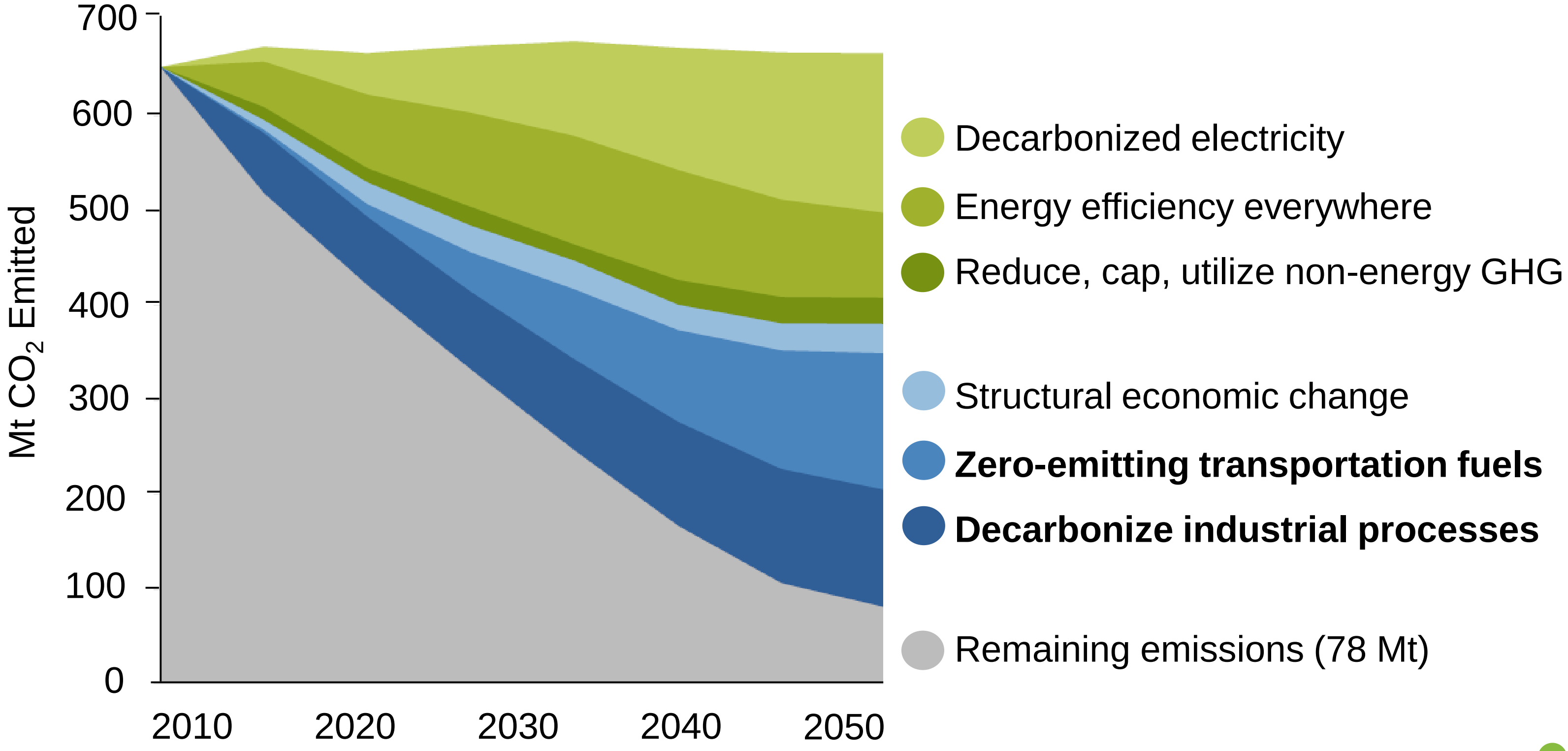
2019

100% GHG reduction by 2050

€9 billion long-term renewable hydrogen strategy

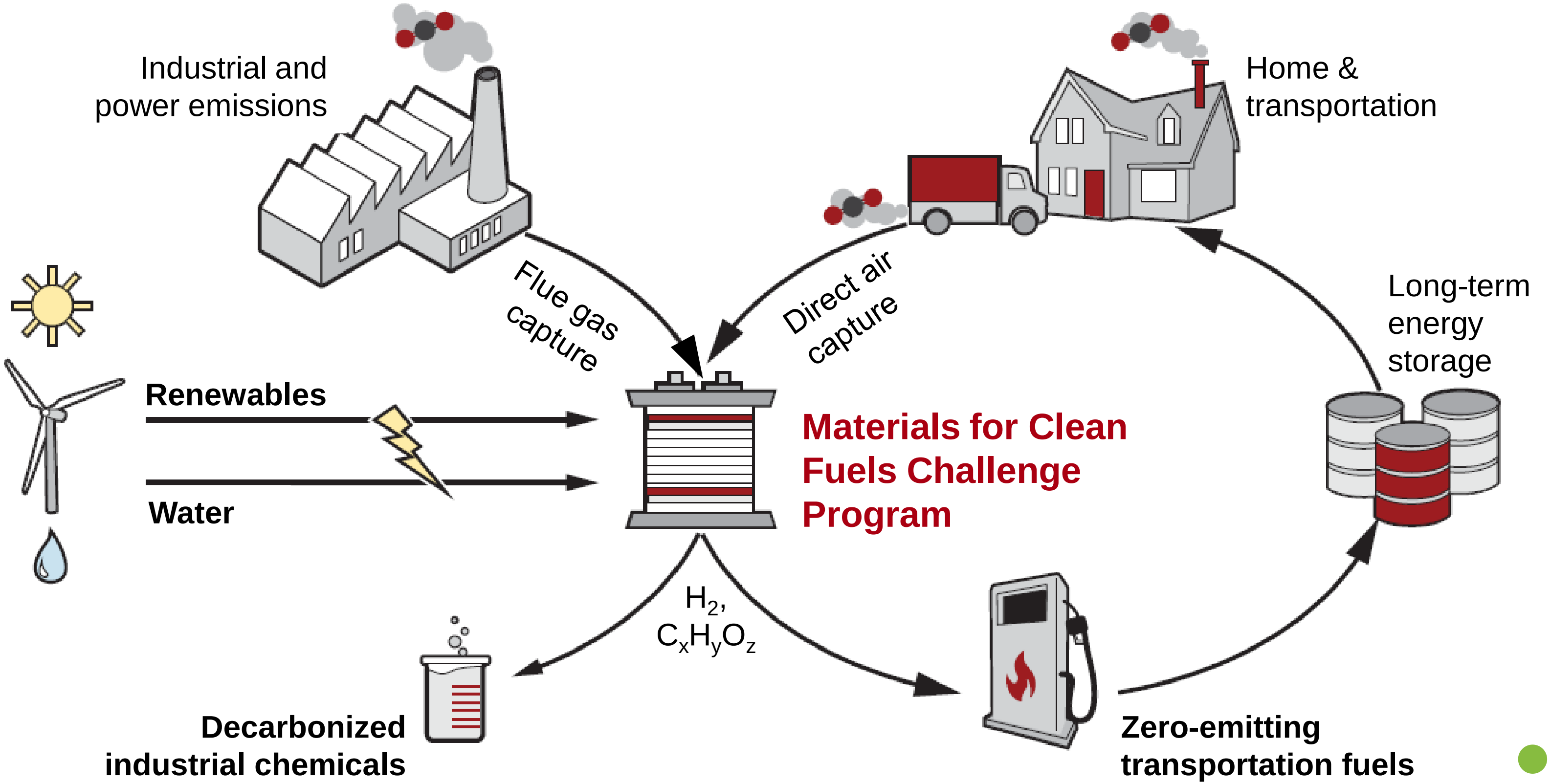
€100 million for innovation in CO_2 direct air capture

Pathways to Decarbonize Canada



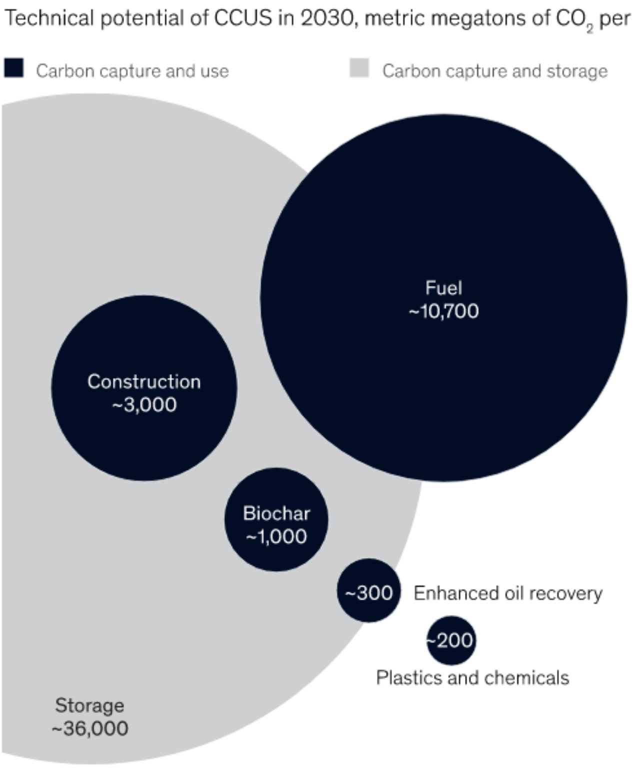
Source: Pathways to deep decarbonization Canada, 2015

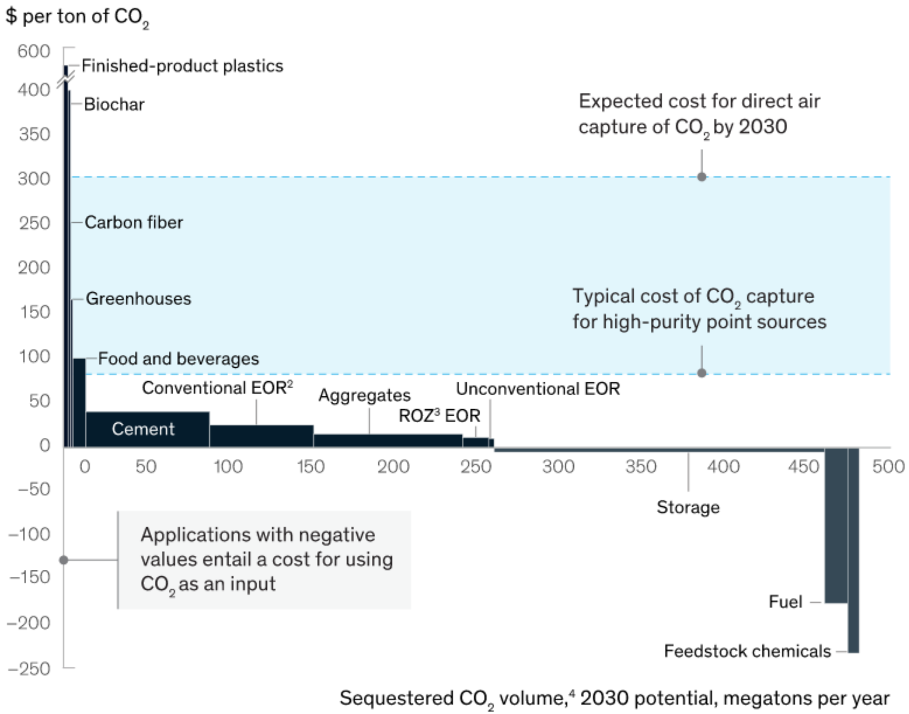
A Renewably Powered Chemical & Fuels Industry



Converting CO_2 Into Renewable Fuels and Chemicals

Source: McKinsey, June 30, 2020





Challenge Program

Goal | Develop innovative materials for renewable fuels & chemical feedstocks

Themes	CO_2 Conversion	Industrial H_2	Accelerated Materials Discovery
Activities	Materials Research & Development	Systems Prototyping & Scale	Technoeconomic Assessment & Commercialization

Outcomes | Economically viable processes for CO_2 conversion, H_2 production and future renewable fuels production

Evaluation | Publications, patents, # HQP, cost reduction against incumbents, spinoff companies, # new materials

Technology Focus Areas & Timeline

Artificial Intelligence & Robotics

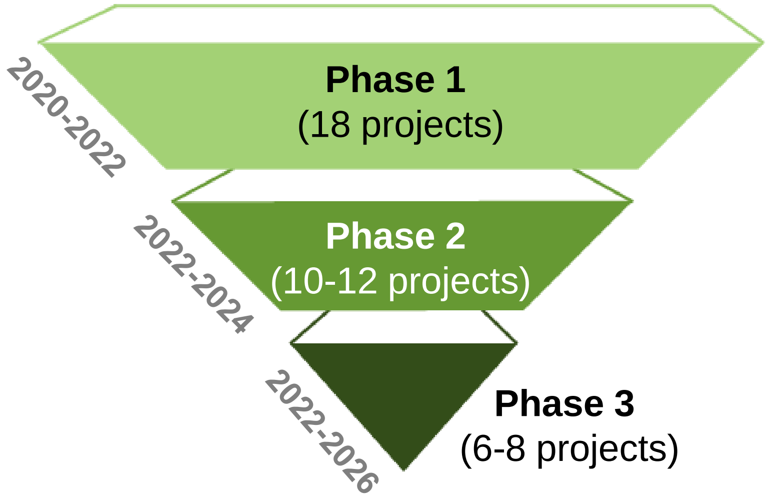
Catalyst Design & Synthesis

Membrane Design & Synthesis

Device Incorporation & Prototyping

Characterization & Spectroscopy

Technoeconomics & Life Cycle



Who We Are

7 Canada Research Chairs

11 Female Principal Investigators

14 Early Career Researchers

36 PIs in Total

Canadian

- University of Toronto
- McGill
- The University of British Columbia
- SFU Simon Fraser University
- Université de Sherbrooke
- McMaster University
- University of Calgary
- Polytechnique Montréal Université d'ingénierie
- uOttawa
- University of Alberta
- University of Waterloo

International

- HI ERN Helmholtz Institute Erlangen-Nürnberg
- Imperial College London
- Carnegie Mellon University
- University of Michigan
- NETL National Energy Technology Laboratory

SMEs

- EKONA
- Solistra
- I N MR
- SAF+ Consortium

NRC Research Activity to Date

10 Published Journal Articles

$366K Booked Revenue

$12M Grants & Contributions Awarded

CO_2 Conversion Projects

Electrocatalytic

- Anion exchange membranes for CO_2 conversion (**Ionomr / Simon Frasier University**)
- High-temperature SOECs for CO_2 conversion to methane (**University of Toronto**)
- In-situ and operando characterization of CO_2 electrocatalysts (**McMaster**)
- Direct conversion of CO_2 from direct air capture solutions (**University of British Columbia**)
- Self-driving labs for CO_2 membrane electrode assemblies (**University of British Columbia**)
- Specialty chemical electrosynthesis from CO_2 (**University of Toronto**)

CO_2 Conversion

Photocatalytic

- Solar dry reforming of CO_2 into fuels (**Solistra)**
- Solar fuels for carbon neutral transport (**University of Waterloo)**
- Scalable plasmonic catalysts for CO_2 conversion (**University of Ottawa**)

Thermocatalytic

- Direct conversion of CO_2 rich flue gas to syngas (**University of Sherbrooke**)
- CO_2 to jet fuel technology platform (**Ecole Polytechnique Montreal**)

Cross Platform

- Technoeconomic assessments and life cycle analysis of CO_2 conversion (**University of Calgary, University of Toronto, University of Alberta, University of Michigan, NETL**)

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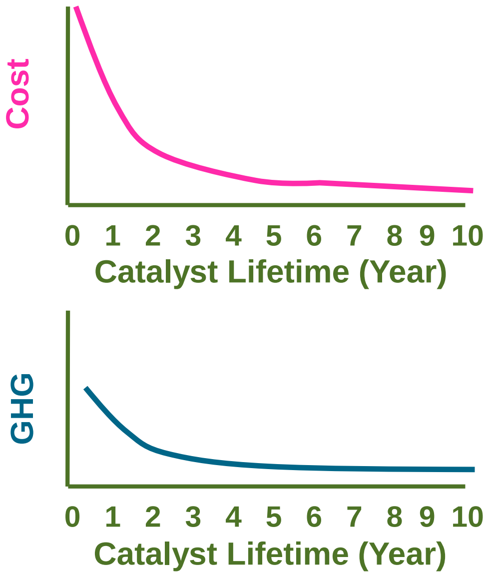
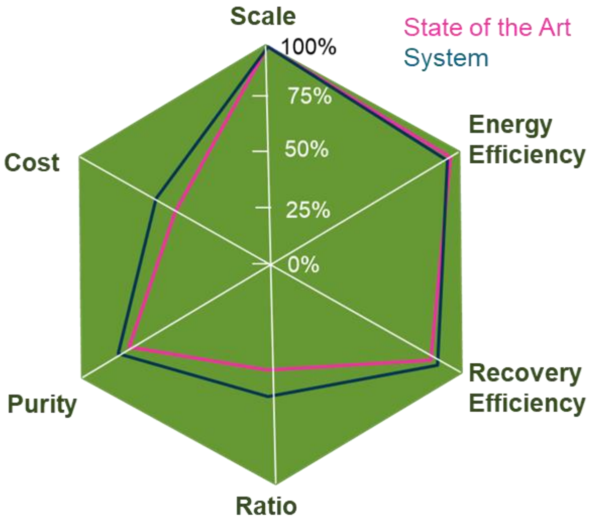
Technoeconomic and Lifecycle Assessments for CCUS





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Work in progress

THANK YOU

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