

PTAC Collaborative Energy Innovation Map 2017

Oil and Gas Sector Context

Global Ranks

Canada ranks as (2015):

- 3rd largest crude oil reserves
- 5th largest natural gas producer

Project Oil and Gas Investment
Trillions of US Dollars, 2016-2040

Source: IEA / National Post

Imports (2015)

Crude Petroleum	\$16.8B
Petroleum Products	\$9.5B
Crude Bituminous Substances n.e.s.	\$0.1B
Natural Gas	\$2.8B

Exports (2015)

Crude Petroleum	\$64.1B
Refined Petroleum Products	\$10.2B
Natural Gas	\$10.0B
Butane and Propane Gas	\$1.4B

Key Metrics

Sector GDP (2013): \$105.6B
 Business R&D expenditure (2013): \$1.4B
 Oil and Gas sector BERD/GDP: 1.3%
 Canada BERD/GDP (2014): 0.8%

440,000 jobs (2015)
 Inc: 190,000 direct jobs

\$17B/yr government revenues (2015)

\$36B investment in capital (2016)
 Down \$4.5B (55%) since 2014

\$118 oil and gas equity capital raised on the TSX (2014)

Energy R&D Context

Total spent on technologies: \$2,042M

Source: Statcan / Globe and Mail

Breakdown of Canada's industrial energy research and development expenditures by area of technology (2013):

- Fossil Fuels: \$1,490M
- Renewable Energy: \$1,200M
- Electric: \$85M
- Energy efficiency: \$1,280M
- Nuclear fusion and fission: \$1,100M

Sub-breakdown of Energy Efficiency:

- Industry: \$77M
- Transportation: \$17M
- Other energy efficiency: \$21M

PTAC Technology Areas of Project Focus

- 1. Improve Oil and Gas Recovery**
 - CO2 Enhanced Hydrocarbon Recovery
 - Coalbed Methane, Shale Gas, Tight Gas, Gas Hydrates, and other Unconventional Gas
 - Conventional Heavy Oil, Cold Heavy Oil Production with Sands
 - Conventional Oil and Gas Recovery
 - Development of Arctic Resources
 - Development of Remote Resources
 - Enhanced Oil and Gas Recovery
 - Enhanced Oil Sands Recovery
 - Emerging Technologies to Recover Oil Sands from Deposits with Existing Zero Recovery
 - Tight Oil, Shale Oil, and other Unconventional Oil
- 2. Reduce Capital, Operating, and G&A Costs**
 - Automation
 - Capital Cost Optimization
 - Cost Reduction Using Emerging Drilling and Completion Technologies
 - Cost Reduction Using Surface Facilities
 - Eco-Efficiency and Energy Efficiency Technologies
 - Reduce Operating Costs Related to Energy and Chemical Consumption
 - Technologies to Reduce Waste Energy
- 3. Improve Value-Added Products**
 - Gasification
 - Hydrocarbon Upgrading
 - Hydrogen Generation
 - Integration Petrochemicals, Refining, and Value-Added Opportunities
 - Pipeline Transportation
 - Transportation
- 4. Manage Environmental Impacts**
 - Air Quality
 - Alternative Energy
 - Ecological
 - Emission Reduction / Eco-Efficiency
 - Energy Efficiency
 - Resource Access
 - Soil and Groundwater
 - Water
 - Wetland Abandonment
- 5. Additional PTAC Technical Areas**
 - e-Business
 - Genomics
 - Geomatics
 - Geosciences
 - Health and Safety
 - Instrumentation/Measurement
 - Nano Technology
 - Operations
 - Photonics
 - Production Engineering
 - Remote Sensing
 - Reservoir Engineering
 - Security
 - Telecommunications

GOALS

Vision

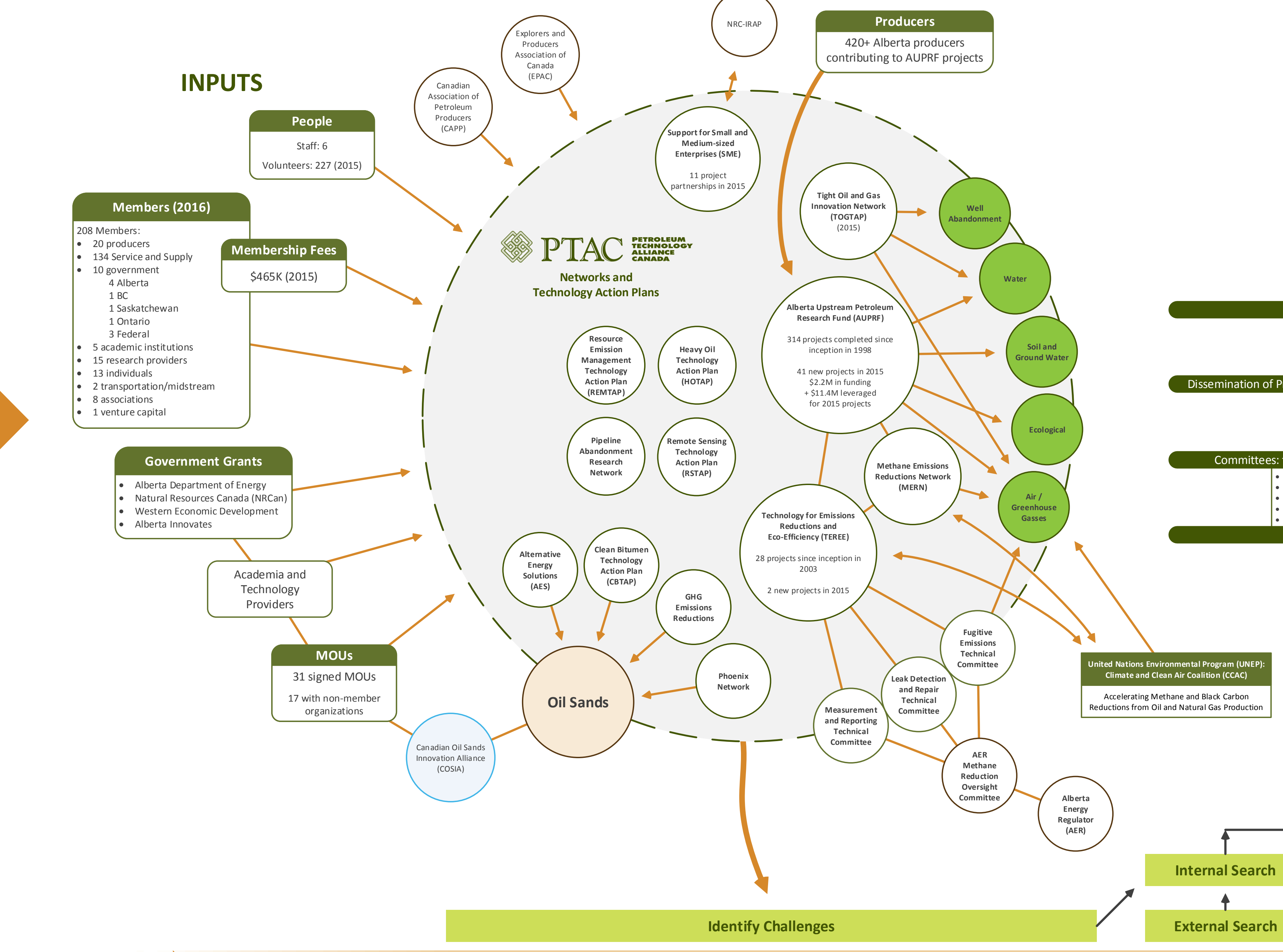
Help Canada become a global hydrocarbon energy technology leader

Mission

Facilitate innovation, collaborative research and technology development, demonstration and deployment for a responsible Canadian hydrocarbon energy industry.

PRIORITY AREAS

1. Improve Oil and Gas Recovery
2. Reduce Capital, Operating, and G&A Costs
3. Improve Value Added Products
4. Manage Environmental Impacts



500+ projects completed since PTAC's inception

Improving Value Added Products: 11%
 Improve Oil & Gas Recovery: 9%
 Reducing Capital, Operating, and G&A Costs: 39%
 Managing Environmental Impacts: 41%

Projects: 90 active projects in 2016

Dissemination of Project Results: 30 events hosted with 1200+ participants

Committees: facilitated 25 technical steering committees (2015)

Committee members: 250+

Project Revenues

Projects represent 85% of PTAC's revenues

Value Creation Examples

Soil Remediation Guidelines for Boron (2016)

- Re-evaluated safe concentrations of Boron in soil
- Improves soil conservation, reduces investigation time, and prevents unwarranted landfill disposal
- Adopted by Alberta Environment and Parks

Risk-based Metal Soil Quality Guidelines (2015)

- Developed new guidelines for molybdenum, cobalt, antimony, and beryllium
- New guidelines currently being vetted

Green Zone Risk Assessment (2014)

- Prevents unwarranted landfill disposal and improves soil conservation
- Adopted by Alberta Environment and Parks

Subsoil Salinity Tool (SST) (2014)

- Minimizes remedial costs and improves conservation of salt-impacted soils
- Adopted by Alberta Environment and Parks

Barite Soil Guidelines (2009)

- Re-evaluated safe concentrations of barite in soil
- Improves soil conservation, reduces remedial costs, and allows for timely site closure
- Adopted by Alberta Environment and Parks and BC Ministry of the Environment

FEDERAL OBJECTIVES

- 1. ECONOMIC RESULTS**
 - Create 100,000 middle class jobs in two years by the end of 2017-18
 - Develop an economic growth strategy (Advisory Council on Economic Growth)
 - Develop a new Innovation Strategy by Budget 2017
 - Increase R&D expenditures as a % of the Canadian economy to reach the OECD average of 2.4% (from 1.6% currently)
 - Review federal support for fundamental science by Budget 2017
 - Help 1000 high-impact firms scale up in global markets
 - Deepen trade relationships with large emerging markets, like China and India
 - Develop a new Defence Strategy
 - Revise the tax system to eliminate poorly targeted and inefficient measures
 - Return to balanced budgets in about five years
- 2. SOCIAL RESULTS**
 - Strengthen Canada's Middle Class through investments in education, infrastructure (public transit, water, housing, etc.) and lower taxes, and increase support for seniors, veterans and new immigrants
 - Negotiate a new multi-year Health Accord with Provinces/Territories
 - Improve the socio-economic conditions of Indigenous people over five years (at a cost of \$8.4B)
 - Develop a new approach to governing: open, inclusive, diverse, consultative, and results-driven
 - Reduce youth unemployment (currently 13.3%)
- 3. ENVIRONMENTAL RESULTS**
 - Transition to a low carbon economy by limiting global temperature increases to less than 2 degrees Celsius (Paris agreement - COP21)
 - Develop a pan-Canadian Framework on Clean Growth and Climate Change
 - Reduce Canada's GHG emissions from 726 megatonnes currently to 622 MT within five years and to 525 MT in 2030 (these are minimum targets)
 - Develop a Canada Energy Strategy
 - Phase out subsidies for the fossil fuel industry
 - "Mission Innovation": double investments in clean energy research by 2020