



Natural Resources
Canada

Ressources naturelles
Canada

Clean Fuels Innovation Forum

October 29, 2024

CanmetENERGY—Ottawa

Travis Robinson

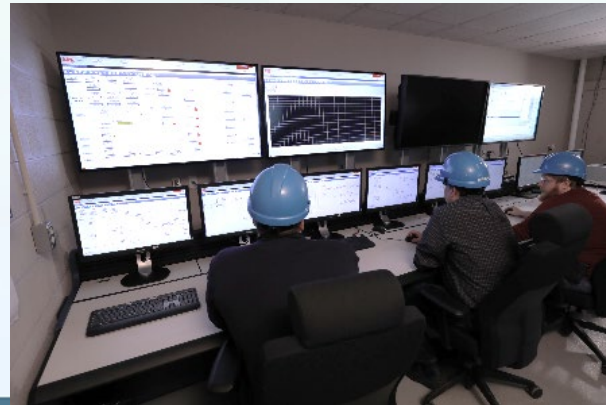


About CE-O

Mission Statement:

To lead the development of energy science and technology solutions for the environmental and economic benefit of Canadians. In pursuit of this mission, we:

- apply our scientific expertise and leverage our unique pilot-scale facilities
- accelerate the advancement of clean energy technologies, from the initial research stage through to commercialization
- collaborate with partners, including manufacturers, academia, planners, builders, and all levels of government



About CE-O



BIOENERGY



BUILT ENVIRONMENT



CARBON MANAGEMENT



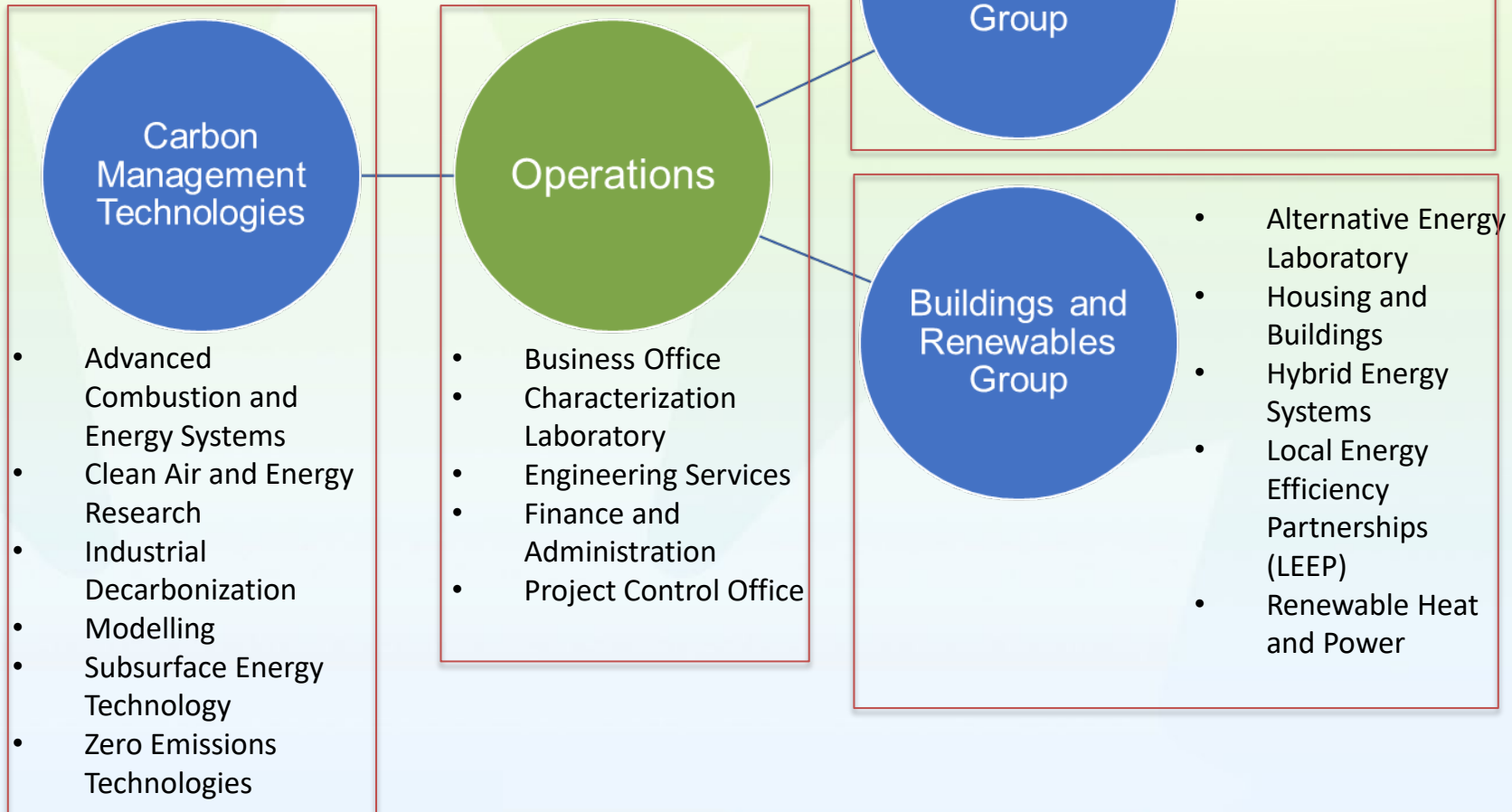
INDUSTRY



RENEWABLES,
ELECTRIFICATION &
TRANSPORTATION

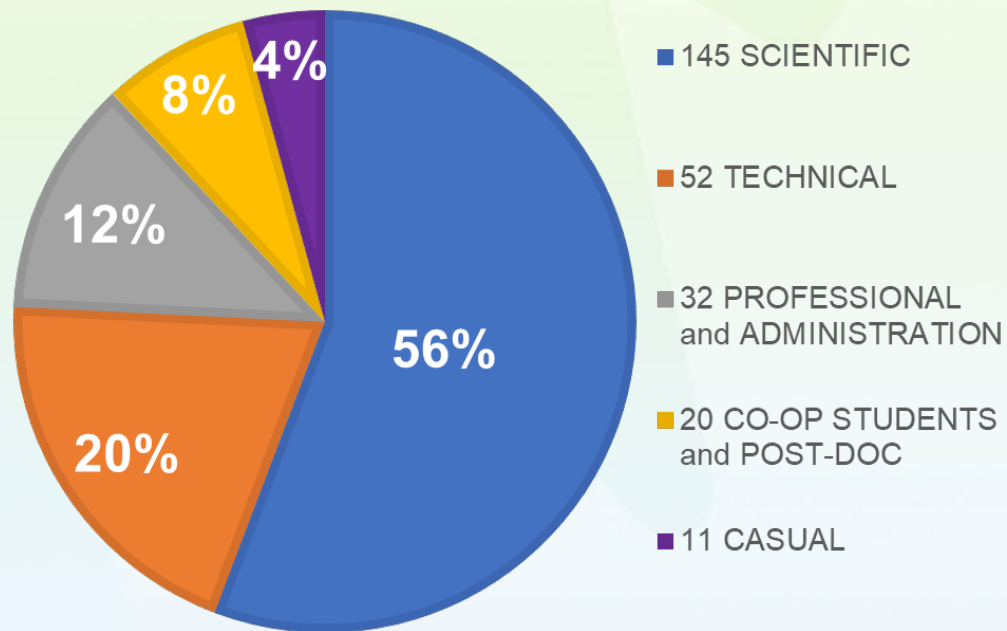


NORTHERN

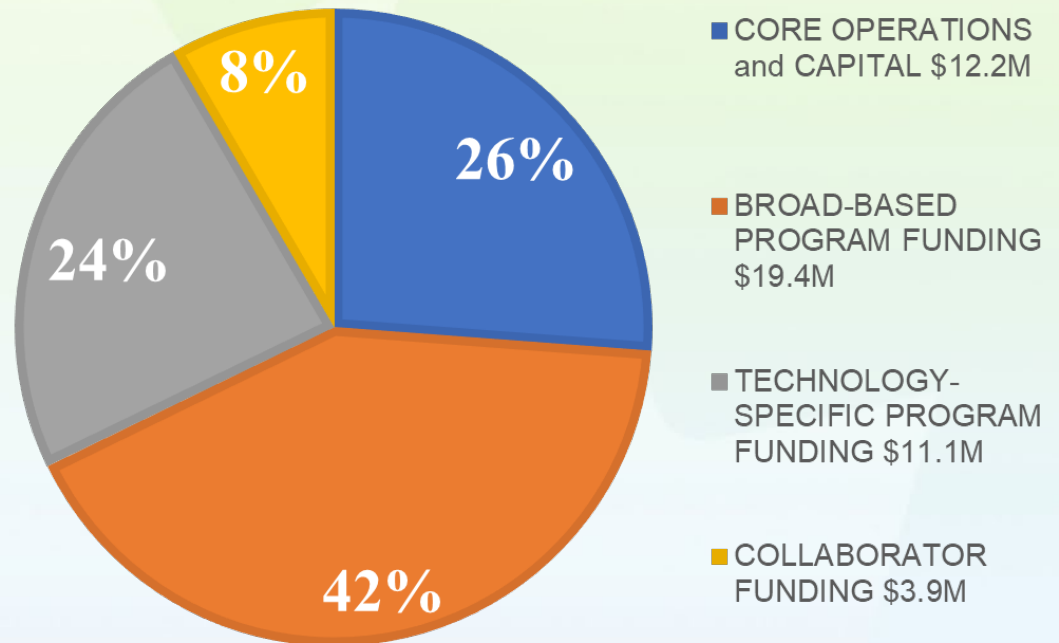


About CE-O

260 TOTAL EMPLOYEES



\$46.6M BUDGET FISCAL 2023/24
(PROJECTED)



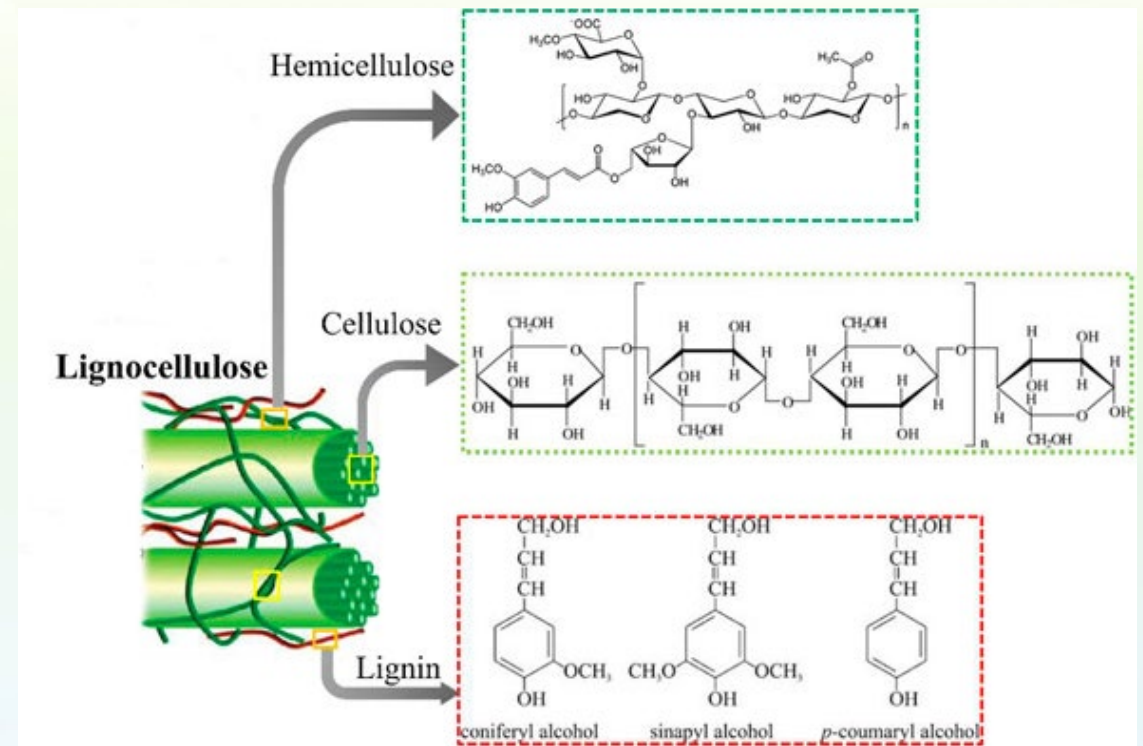
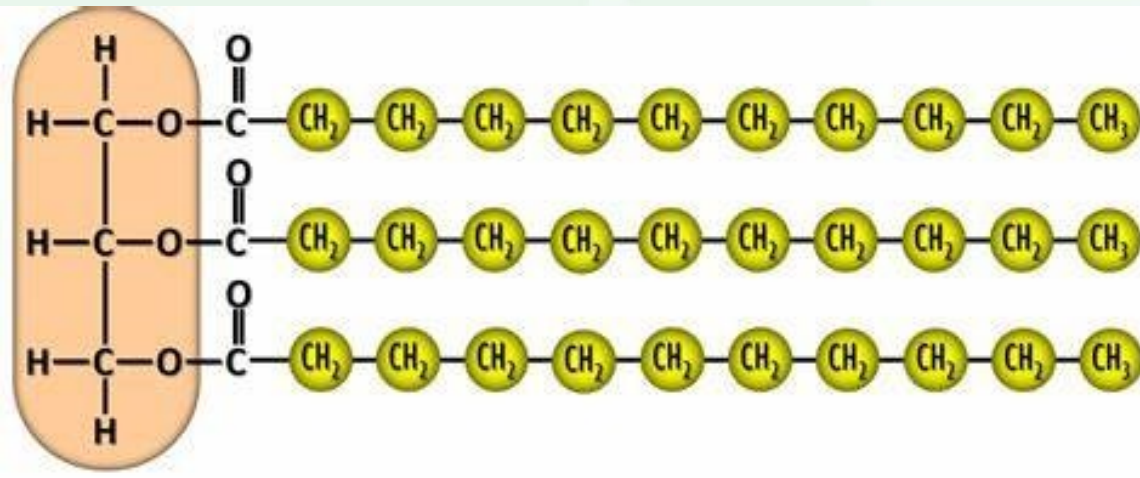
Clean Energy Technologies

- Clean Energy usually involves one or more of:
 - Electricity to fuels (e-fuels and e-biofuels), electrification of industrial processes
 - Biomass
 - Carbon Sequestration (geological storage, biochar, oxy-fire, chemical looping, systems analysis (source-sink))



Bioenergy Systems Group-Lignocellulose

- Research focussed on the utilization of “lignocellulosic” residues
- Biofuels for transportation almost exclusively produced from sugar, starchs, and lipids
- HEFA, FAME, Ethanol
- In nature these molecules are relatively scarce
- Food for people and livestock
- Land use e.g. Palm oil



-Lignocellulose (Lignin, cellulose, hemicelluloses) is abundant, but more difficult to convert (Recalcitrance)

Bioenergy Systems Group-Thermal conversion

Combustion, Gasification

- Complete destruction of the lignocellulosic structure
- Heat and Power
- Catalysis for hydrogen, methane, methanol, aliphatic hydrocarbons etc.
- CO2 sequestration, e-biofuels
- Gasification to make low ash fuel gas from high ash residue (NPEs in lime kiln), or make gas for engine-genset (electricity <10 MW)

Pyrolysis, Hydrothermal Liquefaction

- Partial destruction of the lignocellulosic structure
- Liquid range fragments
- Upgrading to hydrocarbons
- E-biofuels

Carbonization, Hydrothermal Carbonization, Torrefaction, Steam explosion

- Partial or complete destruction of the lignocellulosic structure
- Solid fuels, reductants, and materials
- Biochar sequestration
- Enhance digestibility, grindability, hydrophobicity



Research at CEO—Bioenergy Systems—Gaseous Biofuels

- Gaseous Biofuels for Industrial Decarbonization
- 6 in. ID. Bubbling fluid bed gasifier 150 kW
- Oxygen blown trials for synthetic applications
- Air blown trials for production of fuels gases
- Gas, char, and tar yields; Gas and tar composition
- Bed agglomeration
- Biochar sequestration, and tar valorization
- Simulation based analysis of synthetic applications



Second Floor Fluid Bed Gasification Lab



Research at CEO—Bioenergy Systems—BFIT



Screw reactor
(above), Fluid
Bed Fast
Pyrolysis (right)



- Biofuels for Industry and Transportation
- Production of biocrudes and bio-carbons
- Fluid-bed fast pyrolysis ~12-15 L per trial
- Hydrothermal carbonization currently 10s of grams planned upgrade to 4 L vessel capable of hydrothermal liquefaction process conditions
- Screw reactor ~1-5 kg/hour operation up to 800°C
- Specialized characterization techniques for biocrudes

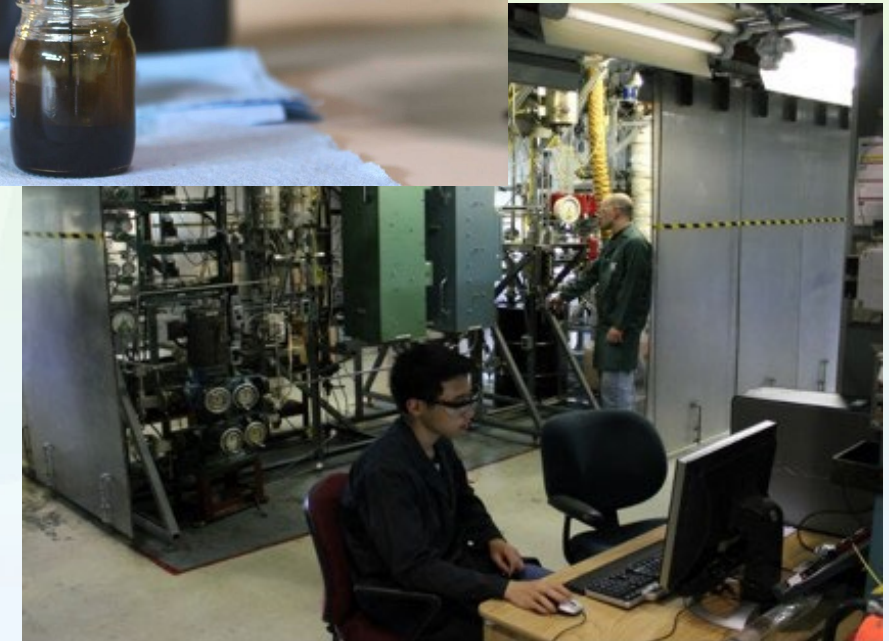
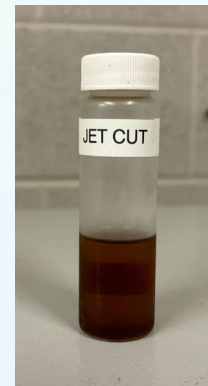
Research at CEO—Bioenergy Systems—SAF

- Low-C SAF and Diesel from Bio-intermediates
- Past experience converting fats, oils, and tall oil
- Current focus lignocellulosic biocrudes
- Gram scale fixed bed reactors
- 1-3 kg/hour process demonstration unit (PDU)
- Various ancillary equipment e.g. short path distillation
- Catalyst development



Forestry
Residue
Biocrude

Upgraded
Biocrude



Process Demonstration Unit



Research at CE-O

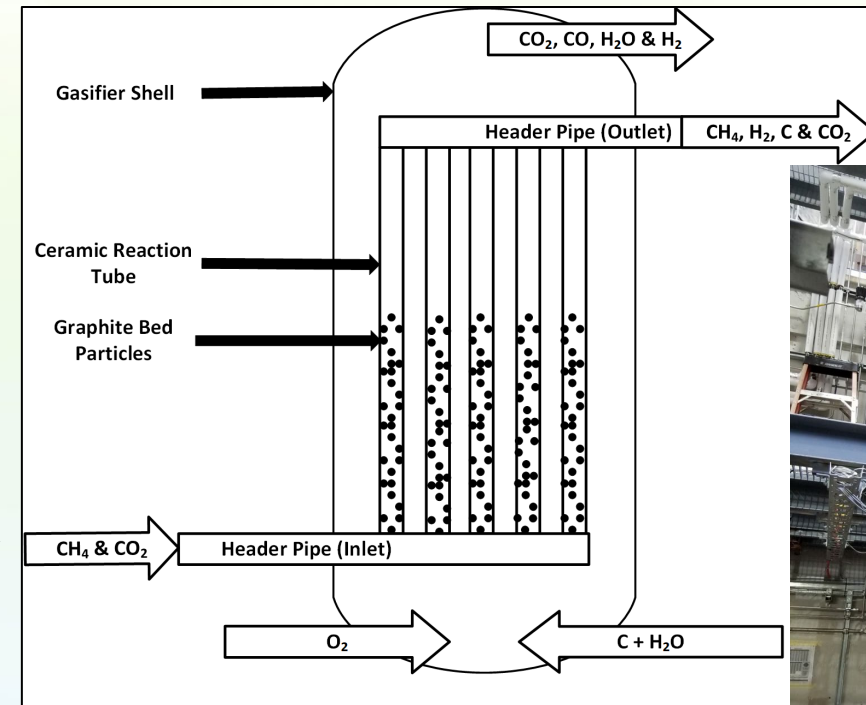
Project Name: Integrated Fluid Bed Pyrolysis & Solid Carbon Steam Reforming for H₂ Production

Project Summary:

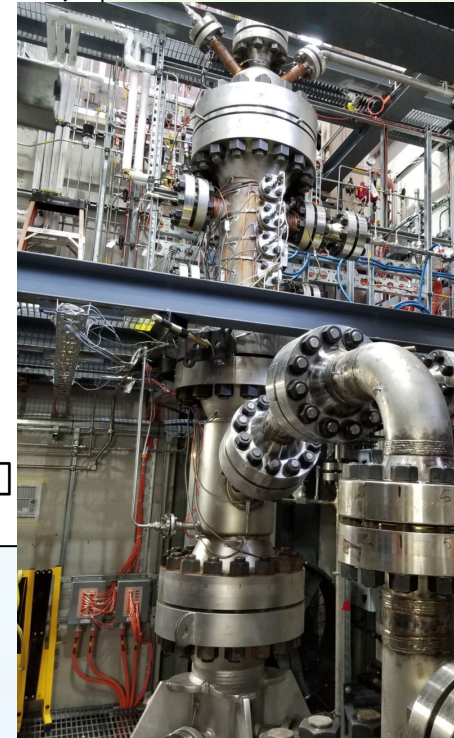
- This work aims to develop, in parallel, and integrate non-catalytic fluid bed pyrolysis and solid carbon steam reforming.
- Pyrolysis reactors are externally heated by way of gasification of carbon black.
- Output of the pyrolyzer is H₂ and carbon black that is fed to the gasifier and subsequently converted into a syngas suitable for feeding into a water-gas shift reactor to improve overall hydrogen yield.

Project Highlights:

- US Patent Filed May 30, 2024 - Ser. #: 63/653,422
- Successful combustion of carbon black with complete fuel conversion, current focus of burner development program is gasification operation.



Proposed integrated unit arrangement.



CE-O's High-Pressure, Oxy-Fired, Combustor & Gasifier System.

More research at CEO

- Production of E-diesel from CO₂
- Production of chemical fuels via CO₂ hydrogenation
- Low-energy demand processes for converting CO₂ to chemical fuels
- Production of hydrogen via metal fuels combustion
- Generating Metal Oxide Fuels for hydrogen purification
- NCAF project (CCUS infrastructure optimization)



Direct Contact Steam Generator

Contact List

Project Name/Technology Area	Contact Name	Contact Email
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