NRC capabilities in clean energy and resources
Meeting Canada’s innovation challenges

Energy and Canada’s low carbon future

- Cleaner and more efficient energy for communities and industry
- Convenient transportation fueled by zero-emission vehicles
- Healthier, comfortable, net zero homes
- Resilient infrastructure and ecosystems to withstand climate change
- Land use and conservation that sequesters carbon and adapts to climate change

TARGET

- By 2030: 30% reduction below 2005 greenhouse gas emissions

2016: hottest year on record for 3rd consecutive year

Energy production and use account for 80% of Canada’s greenhouse gas emissions

Image courtesy of NASA.

Energy and Canada’s low carbon future

TARGET

- By 2030: 30% reduction below 2005 greenhouse gas emissions
NRC: Clean energy agenda

**ENERGY STORAGE**
- **Advance** new energy storage technology for stationary and transportation applications
- **Certify** and integrate sustainable fuels

**BIOENERGY and LOW CARBON FUELS**
- **Improve** biomass conversion and biofuel upgrading

**CLEANER TRANSPORTATION**
- **Reduce** fuel consumption and greenhouse gas emissions in air, surface and marine vehicles
- **Advance** electric transportation

**ENERGY CONVERSION PROCESSES and LOW-EMISSIONS**
- **Increase** energy efficiency
- **Advance** emission reduction strategies and measurements

**SMART BUILDINGS**
- **Increase** deployment, economic performance
- **Reduce** greenhouse gas of energy retrofit technologies for commercial and institutional buildings
## Energy storage

### Materials and storage technologies
- Battery raw materials processing and upgrading analysis and optimisation (lithium, graphite, vanadium, silicon)
- Development of new and optimized materials (anode/cathode/electrolytes)
- Electrochemical materials development and validation (polymers, ceramics, catalysts)
- Analysis of safety and failure modes and effects
- Graphene nanomaterials, characterisation, reference materials and standards

### Component and system validation
- Third party validation of materials, cells, packs, modules and systems
- Development of codes, standards and testing protocols
- Failure and abuse testing: full-scale and component
- Accelerated testing and stressor analysis

### Technical and market analysis
- Techno-economic assessment of smart grid technologies
- Codes and standards development and support, including technological and metrological support for electrical standards
- Technology analysis and roadmap development
- Component and system cost analysis

### Systems and grid integration
- Demonstration support including factory acceptance and site acceptance test development and deployment
- Systems modeling and optimization
- Optimal dispatch scenarios and analysis
- Safety analysis including failure modes and effects analysis, and hazard and operability
- Communication, controls, and data acquisition design and deployment
- Self-managing and self-healing power apparatus, including health monitoring and precision fault location
- Vehicle-to-grid and charging infrastructure
### Bioenergy and low-carbon fuels

#### Cleaner combustion
- Adapting conventional power generation technology to work with fossil fuel derivatives, including gasified coal, biomass and municipal waste
- Solving biofuel power plant compatibility issues
- Enhancing performance of reciprocating and gas turbine engines and components to enhance fuel flexibility, improve operability, optimise systems and reduce emissions
- Combustion and integration of fuels with conversion systems for Combined Heat and Power (CHP) and mobile applications

#### Biomass conversion
- Pre-treatment and biomass conversion technologies (microbial processes, torrefaction, pyrolysis and gasification) to reduce cost and enhance conversion efficiency and energy density
- Optimizing processes for biofuel upgrading

#### Low carbon fuels
- Ground-based and in-flight fuel testing
- Static engine testing and engine test cells
- Engine qualification testing
- Modifications to components and fuel systems
- Assessment of materials and coating compatibility with alternative fuels
- Techno-economic assessment of smart grid technologies
- Codes and standards development and support, including technological and metrological support for electrical standards
- Technology analysis and roadmap development
- Component and system cost analysis

#### Testing and demonstration
- Design, develop, demonstrate, deploy new value-added bio-refining products and processes
- Small- and pilot-scale fermentation and bioconversion pilot plants
- Biomass combined heat and power testing and training hub for remote communities
- Demonstrate new, cleaner low-emission combustors from technology readiness level 3 to 6
- Techno-economics and codes and standards support
- Flew first civil jet powered by 100% unblended biofuel
- Qualification of new fuels from bench-scale to full-scale engine testing
## Cleaner transportation

### Alternative fuels and emission control
- Qualification of alternative fuels
- Combustion and fuel nozzle development and evaluation
- Engine and turbomachinery aerodynamics
- Technologies and materials to reduce friction losses
- Selective catalytic reduction component development
- Catalyst material and catalyst support development
- Numerical simulation and modeling of engine systems

### Electrification
- More electric aircraft and hybrid propulsion
- Battery raw materials processing, optimization, validation
- Battery components development and validation
- Battery safety and failure modes analysis for impact of duty cycles on lifetime
- Numerical simulation and modeling of lithium battery cells and packs
- Hydrogen fuel cell vehicle component manufacturing
- Manufacturing and materials for low cost electric motors

### Lightweighting
- Aluminium and hybrid components and structures: specialised aluminium forming, assembling, corrosion control and performance validation
- Plastic and bioplastic formulation, compounding and processing
- Conventional and advanced composite and bio-composite formulation development and manufacturing

### Performance and certification testing
- Aircraft and surface vehicle drag reduction
- Reducing fuel burn
- Wind tunnels and engine test facilities
- Developing and validating technologies to meet environmental, safety, cost-reduction, performance, and fuel flexibility requirements
- Validation and safety-testing services to ease the adoption of new electrification technologies
- Vehicle level integration and testing
Clean hydrogen

- Custom H₂-certified facility
- Codes and standards expertise and support
- Catalyst and membrane materials development, design, testing
- Electrochemical energy conversion: H₂, fuel cells, electrolyzers
- H₂ storage

Process efficiency

- Process development and optimization: sensors and materials to improve mining process efficiency
- Microbial electrochemical technology (MET): produce direct current from biodegradable materials for energy neutral / energy positive wastewater treatment

Emissions measurement

- Measurement methods and standards for black carbon (BC) and other emissions for aviation, marine, on-road, upstream oil and gas sectors
- Support development of new emission certification standards
- Ground-based and airborne monitoring of environmental and air pollutants
- Algae cultivation using industrial CO₂ emissions as feedstock and processing of algal biomass into sustainable products including biofuels
## Smart buildings

### Functional materials
- Site-built wall and floor assemblies with improved wood-based products
- Renewable, biocompatible, biodegradable value-added nano materials
- Solid state lighting (LED) metrology: Enabler for high energy efficiency lighting solution, to achieve significant energy savings while providing critical lighting solutions to green infrastructure

### Building envelope
- Façade technologies to make buildings more thermally efficient while harvesting energy, managing solar load and performing requirements for natural light, durability and moisture management
- Low energy solutions and technologies
- Human factors research to define control strategies for improved energy efficiency and organizational productivity
- 3D image metrology to enhance processes and minimise waste and to evaluate building structures for repair to extend service life

### Codes and standards
- Codes and standards advice and support: National Energy Code of Canada for Buildings, setting out technical requirements for the energy efficient design and construction of new buildings
- Development of detection (e.g. nanoparticles in water and food supply) and characterization tools, reference materials
- Standards development assistance to facilitate environment, health and safety, and regulatory work as well as commercial development

### ICT and grid integration
- Intelligent environmental control
- Interactive platforms standardised communication and management solutions
- Connecting and integrating building energy systems, vehicle charging stations and smart grid
- Components targeting high data-density, short reach applications to alleviate congestion in access networks and data centres
- Grid impact analysis, big data analytics (smart meters, network analysis), systems modeling and integration

### Clean energy and resources
NRC collaboration platform locations

Boucherville, QC
- Modelling and simulation
- Advanced materials
- Advanced sensing facilities
- NEW (Battery pilot manufacturing line)

St. Mary’s, ON
- Algal carbon conversion (ACC) algal biorefinery

Vancouver, BC
- H₂ certified gas safety labs
- Functional materials development and characterisation
- Electrochemical energy storage and conversion devices diagnostic and testing labs
- Multi-scale modeling and simulation
- NEW (CHP training and demonstration hub)

Ketch Harbour, NS
- Marine research station

Montreal, QC
- Advanced manufacturing
- Lightweight materials

Montreal – Royalmount, QC
- Biomining manufacturing pilot plant
- Biorefinery pilot plant
- Genomics analysis

Halifax, NS
- Photobioreactors, fermentation bioreactors, bioprocessing facilities

Montreal – Royalmount, QC
- Advanced manufacturing
- Lightweight materials

Montreal, QC
- Advanced manufacturing
- Lightweight materials

Ottawa, ON
- Big data analytics
- Battery safety and testing labs
- Canadian Photonics Fabrication Centre
- Flight research lab
- Testbed for aviation piston engine research
- Gas turbine research facility
- Large-scale wind tunnels
- Syngas facility (high pressure hydrogen enriched synthesized gas)
- Metrology and measurement facilities
- Intelligent building operations facilities
- Dynamic building envelope facilities
- Canadian centre for housing technology
- NEW (Net-zero energy-ready homes)
- NEW (Large-scale battery performance and abuse testing lab)
For further information on how the NRC can support your clean energy and resources needs, contact:

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