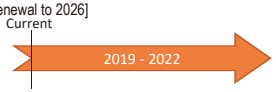
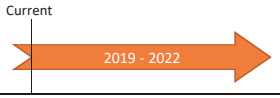
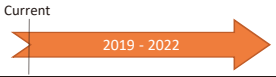
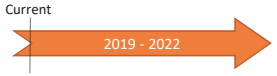
Country	Institute	Category	Related programs (with short summary)	Target / Goal Outcome	Lead person / Organization	Partnership (if any)	Related information
Canada	National Research Council Canada	Materials For Clean Fuels Challenge Program (H2 Production Thrust)	Emissions-free hydrogen production from natural gas decomposition combined with direct carbon fuel cell technology. [2019-2021, potential renewal to 2026] 	Demonstrate technology that utilizes natural gas to produce hydrogen and electricity within a cost of 30% of the incumbent steam methane reforming.	Dr. Wei Qu / NRC	(Domestic) Ekona Power / Prototype demonstration	https://nrc.canada.ca/en/node/1616
			Low-temperature ammonia electrosynthesis from N2 and water. [2019-2021, potential renewal to 2026] 	Discover a catalyst for electrochemical N2 reduction to ammonia as a liquid transport medium for H2.	Dr. Nima Shaigan & Dr. Claudie Roy / NRC	(Domestic) University of British Columbia (International) Imperial College London, UK / Materials development	https://nrc.canada.ca/en/node/1616
			High Performance Membrane Electrode Assemblies for Alkaline Solid Electrolyte Water Electrolysis (AEMWE). [2019-2021, potential renewal to 2026] 	The development and investigation of high performance membrane electrode assemblies for AEMWE.	Dr. Christina Bock / NRC	(International) Helmholtz-Institut Erlangen-Nürnberg for Renewable Energy, Germany / Materials development	https://nrc.canada.ca/en/node/1616
		Automotive Surface Transportation Research Centre	Materials assessment and quality control of fuel cell technologies for surface transport applications. [2013-2020] 	Development of methods, equipment and protocols for quality control of fuel cell components.	Eddy Zuppel / NRC	(Domestic) Canadian industry - Mercedez-Benz Cnada, Hydrogenics, etc. (International) Franhofer ISE, NREL, CEA, HySA	https://nrc.canada.ca/en/research-development/research-collaboration/programs/vehicle-propulsion-technologies-program
			Process development including membrane manufacturing and conditioning/additives impact for fuel cell technologies [2013-2020] 	Development of a high-throughput low-cost process to manufacture membranes for fuel cells	Eddy Zuppel / NRC	(Domestic) NRCan, Ballard (International) NREL, 3M, Solvay	https://nrc.canada.ca/en/research-development/research-collaboration/programs/vehicle-propulsion-technologies-program
			Systems-level analysis including hydrail, supply chain, refueling stations, and air filter stations for fuel cell vehicles. [2013-2020] 	Development of systems level analysis on Canada-specific use cases for hydrogen fuel cell technologies.	Eddy Zuppel / NRC	(Domestic) Canadian Nuclear Laboratories, Transport Canada, Metrolinx, NrCan	https://nrc.canada.ca/en/research-development/research-collaboration/programs/vehicle-propulsion-technologies-program
			Data Management and Analysis of Hydrogen Refueling Stations 	Develop core competencies in regard to the analysis of Hydrogen refueling station data, gain expertise in the applicable fueling protocols, and build data analysis template on the existing data	Eddy Zuppel / NRC	(Domestic) Natural Resources Canada, Transport Canada, Measurement Canada, HTEC	https://nrc.canada.ca/en/research-development/research-collaboration/programs/vehicle-propulsion-technologies-program
		Aerospace Research Center	Development of H2 combustion technology [2018-2020] 	Delivery of a leading edge H2 facility and collaboration working with collaborators for advancements in combustion technology	Mr. Nanthan Ramachandran	(Domestic) Canadian Engine OEM	https://nrc.canada.ca/en/research-development/research-collaboration/research-centres/aerospace-research-centre
			Enriched hydrogen turbulent flame behavious. [2018-2020] 	Fundamental understadning of hydrogen enriched flame and developing advanced modeling	Dr. Patrizio Vena / NRC	(Domestic) University of British Columbia	https://nrc.canada.ca/en/research-development/research-collaboration/research-centres/aerospace-research-centre
		Aerospace Research Center (EME Bioenergy Program)	Low Emission Burner development for turbine application. [2018-2021] 	The development of low emission combustion technology for turbine application of gaseous fuels with H2 enriched blends	Dr. Sean Yun / NRC	(International) Korean Institute of Machinery and Materials	https://nrc.canada.ca/en/research-development/research-collaboration/programs/bioenergy-systems-viable-stationary-applications-program

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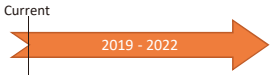
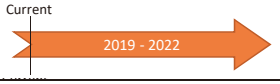
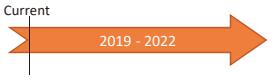
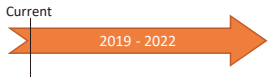
Canada	National Research Council Canada	Materials For Clean Fuels Challenge Program (CO2 Conversion Thrust)	Development of ion-exchange membranes tailored for electrochemical CO2 reduction reaction. [2019-2021, potential renewal to 2026] 	Develop ionomer materials to reduce the electrical resistance and overpotential for electrochemical CO2 reduction.	Dr. Ken Shi / NRC	(Domestic) Simon Fraser University, Ionomr Technologies	https://nrc.canada.ca/en/node/1616
			Electrochemical CO2 conversion to ethylene glycol using renewable electricity. [2019-2021, potential renewal to 2026] 	Develop catalysts that convert CO2 to ethylene glycol at current densities >100 mA/cm2 using gas diffusion electrodes	Dr. Claudie Roy / NRC	(Domestic) University of Toronto	https://nrc.canada.ca/en/node/1616
			CO2 conversion to syngas from bicarbonate solutions coupled with direct air capture. [2019-2021, potential renewal to 2026] 	Develop catalysts that convert CO2 to syngas directly from a basic capture solution at current densities >100 mA/cm2 using a bipolymer membrane	Dr. Ken Shi / NRC	(Domestic) University of British Columbia	https://nrc.canada.ca/en/node/1616
			In-situ/operando characterization of CO2 electrocatalysts under operating conditions. [2019-2021, potential renewal to 2026] 	Develop catalysts that convert CO2 to syngas directly from a basic capture solution at current densities >100 mA/cm2 using a bipolymer membrane	Dr. Robert Black / NRC	(Domestic) McMaster University	https://nrc.canada.ca/en/node/1616
		Aquatic and Crop Resource Development Research Centre	Algal carbon conversion of CO2 emissions into value added products through integrated algal biorefineries [2015-2018] 	Scaling-up algae cultivation technologies, identifying the most appropriate algae strains for industrial deployment, increasing the productivity and reducing energy costs of photobioreactors,	Dr. Stephen O'Leary / NRC	(Domestic) Pond Technologies, St. Mary's Cement, Canadian Natural Resources Limited	https://nrc.canada.ca/en/research-development/research-collaboration/programs/algal-carbon-conversion-program

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Canada	National Research Council Canada	Materials for Clean Fuels Challenge Program (AI-Accelerated Materails Discovery)	Artificial intelligence accelerated materials discovery for platinum-group-metal-free acid-stable oxygen evolution reaction catalysts. [2019-2021, potential renewal to 2026] Current 2019 - 2022	Utilize high-throughput computational simulation and artificial intelligence to screen for new mixed metal oxides for oxygen evolution reaction	Dr. Isaac Tambyln / NRC	(Domestic) University of Toronto (International) Carnegie Mellon Univeristy (USA) / algorithm and materials development	https://nrc.canada.ca/en/node/1616
			Automated robotics and unsupervised learning for the discovery of oxygen evolution reaction catalysts. [2019-2021, potential renewal to 2026] Current 2019 - 2022	Automated robotics and deep-learning platform to iteratively discover new materials for the oxygen evolution reaction	Dr. Isaac Tambyln / NRC	(Domestic) University of Toronto (USA) / platform and materials development	https://nrc.canada.ca/en/node/1616
		Energy Storage for Grid Security and Modernization	Next Generation Materials for Solid-State Batteries 2019 - 2022	To design and synthesize composite electrolyte materials and fabrication processes with greater flexibility and chemical stability along with processes	Dr. Yaser Abu-Lebdeh	Domestic (University of British Columbia)	https://nrc.canada.ca/en/research-development/research-collaboration/programs/energy-storage-grid-security-modernization-program
			Improved Vanadium Redox Flow Battery Performance 2019 - 2022	To understand and model phenomena occurring in the VRFB and their mechanisms from a fundamental perspective in order to improve specific materials and components.	Dr. Roberto Neagu		https://nrc.canada.ca/en/research-development/research-collaboration/programs/energy-storage-grid-security-modernization-program
			End of Life Lithium Ion Battery Options – Remanufacturing, Repurposing and Recycling 2019 - 2022	To develop testing standards and diagnostic tools for the remanufacture/repurpose of end of life batteries, investigate the potential for direct anode regeneration, develop novel elemental separation techniques of anode and cathode materials, and understand the economic and environmental impact of	Ben Yu / NRC		https://nrc.canada.ca/en/research-development/research-collaboration/programs/energy-storage-grid-security-modernization-program
			Energy Storage Model Development with IEA ECES Annex 32 2019 - 2022	The development of standardized, scientifically proven datasets / test cases and open-source models for energy storage systems	Darren Jang / NRC	(Domestic) Carleton University, University of Victoria (International) IEA ECES Member Countries	https://nrc.canada.ca/en/research-development/research-collaboration/programs/energy-storage-grid-security-modernization-program
		Bioenergy for Viable Stationary Systems	Low Emissions Burner Development for Turbine Applications Current 2018 - 2020	The development of a burning for turbine applications for the efficient combustion of gaseous fuels such as H2 enriched blends	Dr. Sean Yun	(International) Korean Institute of Machinery and Materials	https://nrc.canada.ca/en/research-development/research-collaboration/programs/bioenergy-systems-viable-stationary-applications-program
			Fuel switching of waste-derived gaseous fuels 2019 - 2022	Demonstration clean energy generation through production of gaseous fuels via gasification and bioelectrochemical treatment of solid and liquid wastes, respectively, for the application of fuel-switching in dual-fuel internal combustion engines.	Dr. James Butler	(Domestic) Ecole Polytechnique, Tomlinson Environmental Services	https://nrc.canada.ca/en/research-development/research-collaboration/programs/bioenergy-systems-viable-stationary-applications-program
			An integrated TEA/LCA platform to evaluate bioenergy production from different biomass sources 2019 - 2022	Integration of lifecycle analysis and technoeconomic platforms as a comprehensive decision making tool on the production of various gaseous and liquid biofuels from biomass sources, including residuals and MSW	Dr. Farid Bensebaa	(Domestic) Queen's Unviersity, Agriculture Canada, Environment and Climate Change Canada, Natural Resources Canada	https://nrc.canada.ca/en/research-development/research-collaboration/programs/bioenergy-systems-viable-stationary-applications-program
		Vehicle Propulsion Technolgies	Electric Vehicle Safety Studies Current 2016 - 2020	Provide policy makers and end users, from all departments involved in electric mobility platforms, as well as important external stakeholders, with state-of-the art information on the safety of EV batteries (commercial and prototype) and battery packs	Dr. Dean MacNeil	(Domestic) Natural Resources Canada, CSA	https://nrc.canada.ca/en/research-development/research-collaboration/programs/vehicle-propulsion-technologies-program

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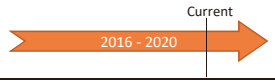
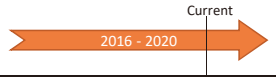
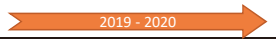
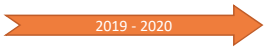
Canada	National Research Council Canada	Vehicle Propulsion Technolgies	Thermal Management Strategies for EV Batteries Combined with EV Simulations 	Demonstrate how an optimized battery thermal management system and powertrain components, can be utilized to: maximize the range of an EV over its lifetime; decrease costs through efficiencies; and increase lifetime through operating in ideal temperature ranges.	Dr. Dean MacNeil	(Domestic) Natural Resources Canada	https://nrc.canada.ca/en/research-development/research-collaboration/programs/vehicle-propulsion-technologies-program
			EV Batteries Fast-Charging Assessment for Canadian Low Temperature Climate 	Provide Canada-specific knowledge, data and techno-economics about EV batteries performance and fast charging capability at low temperature for different available and emerging battery technologies.	Dr. Alexis Laforgue	(Domestic) Natural Resources Canada	https://nrc.canada.ca/en/research-development/research-collaboration/programs/vehicle-propulsion-technologies-program
			Techno-Economic Studies and Field Trial of V2X in Canada 	The project aims at filling important knowledge gaps on the economic feasibility and technical implementation of using EV batteries (as a power source) in V2X, which encompasses Vehicle-to-home (V2H), Vehicle-to-building (V2B), and Vehicle-to-Grid (V2G) applications.	Dr. Ken Darcovich Dr. Yeong Yoo	(Domestic) Natural Resources Canada	https://nrc.canada.ca/en/research-development/research-collaboration/programs/vehicle-propulsion-technologies-program
			Development of Li-ion Battery Anode Formulations with High Canadian Content to Extend the Range of Electric Vehicles 	Develop the next generation of anode materials to enable higher-energy density and lower cost Li-ion batteries that will accelerate all-electric vehicles mass market penetration and reduce CO2 emissions from transportation.	Dr. Yaser Abu-Lebdeh	Natural Resources Canada, Mason Graphite, Nouveau Monde Graphite, NanoXplore, Mercedes-Benz Research & Development North America	https://nrc.canada.ca/en/research-development/research-collaboration/programs/vehicle-propulsion-technologies-program
			Electric Vehicle Fleet Demonstration 	Assess the performance of an electric taxi fleet through the collection and analysis of battery usage and operational parameters during chargning and driving activities.	Dr. Ken Darcovich	Transport Canada, Natural Resources Canada	https://nrc.canada.ca/en/research-development/research-collaboration/programs/vehicle-propulsion-technologies-
			Life Cycle Analyses of vehicle propulsion systems 		Dr. Miyuru Kannagara	Transport Canada	https://nrc.canada.ca/en/research-development/research-collaboration/programs/vehicle-propulsion-technologies-
			Test and Evaluation of the Bi-directional charging performance of a V2G-capable EV 	Test and evaluate the bi-directional charging performance of a V2G-capable EV	Dr. Yeong Yoo	Transport Canada	https://nrc.canada.ca/en/research-development/research-collaboration/programs/vehicle-propulsion-technologies-
			Electric Vehicle Battery Cell Testing 	Evaulate the durability of battereis for electric vehicles	Dr. Dean MacNeil	Transport Canada	https://nrc.canada.ca/en/research-development/research-collaboration/programs/vehicle-propulsion-technologies-
			Electric Vehicle Diagnostics and Propagation Testing 	To evaluate the potential for thermal propagation of an unspecified thermal event with an electric vehcile and its effect on the vehicle and vehicle occupants	Dr. Dean MacNeil	Transport Canada	https://nrc.canada.ca/en/research-development/research-collaboration/programs/vehicle-propulsion-technologies-program
		Aerospace Research Center	Expeirmental validation of novel vertical axis wind turbine design 	Demonstration of improved vertical axis wind turbine performance through experimental wind tunnel testing	Mr. Amin Fereidooni	(Domestic) Carleton University	https://nrc.canada.ca/en/research-development/research-collaboration/research-centres/aerospace-research-centre
			Hybrid Electric Aircraft Testbed 	NRC's first electric aircraft project. Involves the development of an airborne electric propulsion test-bed demonstrator that will be used to evaluate various hybrid-electric propulsion systems, configurations, and component technologies, as well as gather experimental data to inform evolving	Dr. Daniel Booth	(Domestic) Carleton University	https://nrc.canada.ca/en/research-development/research-collaboration/research-centres/aerospace-research-centre
			National Jet Fuel Combustion Project 	Evaluation of key fuel properties for new biofuels (alternative fuels) to reduce its certification time through combustion testing with international partners	Mr. Pervez Canteenwalla	(International) International consortium incldiung FAA, engine OEMs, more than 10 universities from USA, UK and DLR	https://nrc.canada.ca/en/research-development/research-collaboration/research-centres/aerospace-research-centre