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TITANIUM recovers valuable minerals from oil sands waste

A new facility to recover valuable minerals from oil sands waste and prevent hydrocarbons from reaching oils sands tailings ponds is on the horizon. The project is a key component of net zero ambitions for one of the largest independent crude oil and natural gas producers in the world.

Calgary-based Titanium Corporation is working with Canadian Natural Resources Limited (Canadian Natural) on a commercial scale plant for their patented CVW (Creating Value from Waste) technology. In 2019, they completed front end engineering design at Canadian Natural's Horizon site and are now planning the next phase of the project.

The technology solution recovers bitumen, solvent, and high-value minerals, including titanium and zircon. By preventing solvent and bitumen release, methane emissions from mined oil sands operations can be reduced. The technology focuses on froth treatment tailings, which are estimated to be responsible for the majority of methane emissions from tailings ponds.

"It's a great opportunity to take a waste stream, one of the more complicated ones, and recover valuable minerals that would otherwise be lost—titanium, zircon, and eventually rare earths. It reduces the environmental footprint of tailings ponds and creates a whole new industry for Alberta, translating into economic growth, jobs, and diversification," said Scott Nelson, President & CEO, Titanium Corporation.

Zircon is used to make ceramic tiles, porcelain fixtures, solar panels, cosmetics, and many other products. Titanium is primarily used to make pigment which is an important component in paint, plastics, and paper. Titanium metal is used in the aerospace industry and in medical appliances, fibre optics, golf clubs, bicycles, and more.

Emissions Reduction Alberta (ERA) has committed \$10 million to the project to date; \$5 million for engineering design and \$5 million to support detailed engineering work for the commercial-scale plant.

Results from the project will benefit other large oil sands mines and will be shared and disseminated through Canada's Oil Sands Innovation Alliance (COSIA). The project is part of Canadian Natural's long-term aspirational target of net zero emissions in its oil sands operations.

"This technology is a true testament to entrepreneurs, industry, and government coming together to develop solutions that work," said Joy Romero, Vice President, Technology and Innovation, Canadian Natural. "It's a win-win when an innovative technology like this can help lower our GHG emissions and move us closer to net zero emissions in the oil sands, while at the same time, help us recover valuable minerals for sale."



DarkVision Technologies is developing downhole imaging technology used to get a clear picture of the inner workings of oil and gas wells.

DARKVISION goes downhole to improve integrity of wells

Defects in well casings, connections, and other downhole components can lead to significant business and environmental impacts for oil and gas operators. This includes everything from methane leaks to integrity problems and production issues. An experienced start-up, DarkVision Technologies, is looking to help operators save costs and reduce emissions by introducing an ultrasonic imaging technology, that builds on advancements recently made in the medical device sector.

DarkVision has developed an acoustic-based downhole imaging tool that offers operators a set of eyes inside their wells. The approach solves a well-known problem for industry working under conditions of high pressure and temperature. In addition to cost savings and environmental benefits the technology can increase production and improve the overall well integrity.

"We spent lots of time talking to operators and service companies. It became apparent that they needed to more effectively detect and measure defects in the inhospitable downhole environment. Our technology can withstand the temperatures, pressures, and constraints of the downhole environment and capture detailed imagery of what's going on in the well," said Stephen Robinson, DarkVision co-founder and CEO.

DarkVision launched the first version of the technology in 2017 and have been enhancing it to work at higher temperatures and higher pressures.

"That was the biggest challenge—making the technology work in such a challenging environment. We had to undertake every aspect of tech design ourselves from scratch, from hardware to visualization software," said Robinson.

ERA has committed \$3.2 million to the project through its Partnership Intake Program. The technology is being piloted across various Alberta sites owned by ConocoPhillips, Suncor, Cenovus, and other operators. They have also received funding from Sustainable Development Technology Canada (SDTC), IRAP-NRC, BDC Capital, and Evok Innovations.

"DarkVision has developed a highly differentiated technology that is gaining a significant amount of industry attention and has enormous potential," says Geoff Catherwood, partner in BDC Capital's Industrial, Clean & Energy (ICE) Fund. "Rarely do we find such an attractive combination of great technology, customer traction, and a top-notch founding team in this stage of a company."

Co-founded in 2013, DarkVision now employs 35 people with offices in Vancouver and Calgary. It saw rapid growth last year, growing revenues by 800 per cent from 2018. The company now has 32 different operators as customers, including majors like Encana, Chevron and Pioneer. They are currently exploring expanding into other markets, as the technology platform is broadly applicable to other industries such as inspecting water mains, pipelines, and boiler tubes.

COMMITTED TO ACTION

- ▶ ERA is a key partner in addressing Alberta's climate and economic priorities. We fund and de-risk late-stage technologies to reduce GHG emissions and help grow and create competitive industries in Alberta.

CONVENING RESOURCES FOR COLLABORATION

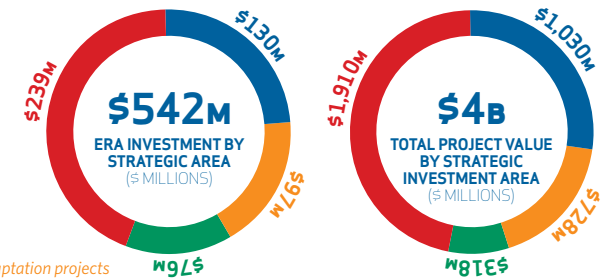
- ▶ The Government of Alberta provides grants to ERA. For 10 years, ERA has been investing revenues from the carbon price paid by Large Final Emitters (LFEs) to accelerate the development and adoption of innovative and clean technology solutions.
- ▶ We work with industry, government, and technology developers to make Alberta a hub for innovative ideas that reduce GHG emissions and improve economic competitiveness.
- ▶ We convene the resources—policy, regulatory, and business development tools—to be a catalyst and steward projects toward commercialization.
- ▶ With our stakeholders, we developed a Technology Roadmap that guides investment decisions and informs our portfolio mix.

FUNDING OPPORTUNITY	WHAT'S IT ABOUT?	ERA FUNDING	HIGHLIGHTS
GRAND CHALLENGE	Technologies to transform CO ₂ from waste to value	\$34M	2 projects awarded \$5M each in the final round
METHANE CHALLENGE	New methane detection and reduction technologies	\$30M	12 projects funded worth \$97M in total project value
OIL SANDS INNOVATION	Late-stage, GHG-reducing technologies to help Alberta's oil sands industry remain competitive	\$51M	7 projects funded worth \$537M in total project value
INDUSTRIAL EFFICIENCY CHALLENGE	Technologies to increase efficiencies for LFE industrial facilities	\$59M	9 projects funded worth \$258M in total project value
BEST CHALLENGE	GHG-reducing technologies in biotechnology, electricity and sustainable transportation	\$88M	15 projects funded worth \$394M in total project value
NATURAL GAS CHALLENGE	Unlocking innovation across Alberta's Natural Gas value chain	\$50M	Application deadline was December 19, 2019. Successful projects will be announced in 2020.

INVESTING IN A DIVERSE PORTFOLIO

163 Projects

- ▶ **Cleaner Oil & Gas** (55 Projects)
- ▶ **Low Emitting Electricity Supply & Demand** (24 Projects)
- ▶ **Food, Fibre, & Bioindustries*** (44 Projects)
- ▶ **Low Carbon Industrial Processes & Products** (40 Projects)



*In 2012, ERA provided funding for three adaptation projects in consultation with Alberta Environment and Parks.

CUMULATIVE PROJECT EMISSION REDUCTIONS

7.5 Mt CO₂e Total by 2020



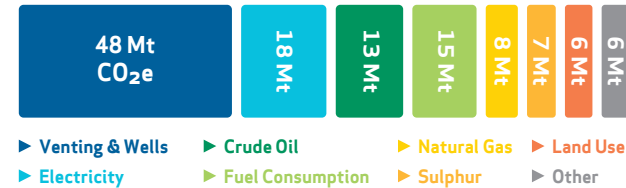
39.5 Mt CO₂e Total by 2030



Note: We have estimated emission reductions for all projects with approved funding commitments and executed funding agreements and assumed the projects will continue successfully and as planned. Should circumstances change for these projects, emission reduction estimates may change materially.

CUMULATIVE MARKET EMISSION REDUCTIONS

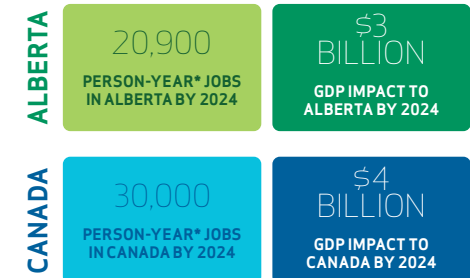
121 Mt CO₂e Total by 2030



ERA estimates our investments could result in emissions reductions of an average of 3.2 million tonnes of CO₂e per year. This is the equivalent of removing 679,000 cars off the road for one year.

LEVERAGING FUNDING AND CREATING JOBS

Technology is the engine of environmental and economic opportunity. For every ERA dollar we commit to advancing new technologies, over \$6 has been invested by funding partners.



*A person-year is equal to one-year of employment for one individual. Please note: economic impact is reported on a calendar year basis, not fiscal year.