Titanium Corporation's Submission to the Working Group on Clean Technology, Innovation and Jobs

Theme: Clean Technology, Innovation and Jobs

Title: Creating Value from Waste

Titanium Corporation has invented Creating Value from Waste™ (CVW™), a unique, yet practical suite of technologies that can remediate froth treatment tailings in the oil sands mining sector. CVW™ is a successful Sustainable Development Technology Canada (SDTC) portfolio technology that is well aligned with Government policy, fulfilling the fundamental objectives of protecting the environment and growing Canada's economy. Its implementation will generate near term investment and growth, substantial reductions in greenhouse (GHG), Volatile Organic Compound (VOC) and Secondary Organic Aerosol (SOA) emissions, create well paying jobs for Canadians, economic diversification with a new minerals export industry and new opportunities for indigenous peoples and businesses. (Slide 6 of the attached Environmental Sustainability presentation)

Development of Titanium's clean CVW™ technology was made possible through government funding assistance totaling over $13 million from SDTC, the National Research Council and Alberta's Energy Ministry, private capital investment of over $70 million, and the collaboration of oil sands firms as prospective adopters, in Titanium's successful R&D and demonstration piloting programs. Titanium also benefited from close collaboration with a number of Canadian universities, research firms and government agencies. Independent demonstration piloting and validation of Titanium's technology was conducted by Natural Resource Canada's experienced team at the world class CanmetENERGY oil sands research and test facilities in Devon, Alberta. (Slides 7-10 of the attached Environmental Sustainability Presentation)

A Recognized Canadian Developed Clean Technology

Titanium's "made-in-Canada" CVW™ technology has been recognized as a leading clean technology both in Canada and internationally (*Slide 5 of attached Environmental Sustainability presentation):*

- In June 2016, Titanium Corporation received the 2016 Environmental Innovation Award at the Global Petroleum Show, an international award recognizing Titanium's contribution to the advancement of environmental solutions in the oil and gas industry. Titanium was nominated for this prestigious award by Sustainable Development Technology Canada.
- In May, 2015, Titanium's technology was cited as a leading solution for oil sands froth treatment tailings by the Canadian Council of Academies expert report commissioned by Natural Resources Canada, entitled: "Technological Prospects for Reducing the Environmental Footprint of Canadian Oil Sands".

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- In June 2012, Canada's Oil Sands Innovation Alliance (COSIA) "Oil Sands Tailings Technology Deployment Roadmap" ranked Titanium's CVW™ in its top 20 prioritized technologies. COSIA's mission is to accelerate the adoption of technologies that improve environmental performance in Canada's oil sands and Titanium Corporation is an active and engaged COSIA Associate Member.

A Large Opportunity for Nationally Significant GHG Reductions

Titanium Corporation's ready-to-implement suite of innovative technologies would materially contribute to Canada's environmental objectives by sustainably recovering lost bitumen, solvent and minerals from froth tailings before they reach tailings ponds and the atmosphere.

Industry wide implementation of Titanium's technologies would achieve nationally significant environmental improvements when implemented across the oil sands mining industry (*Slides 3, 16 and 17 of the attached Environmental Sustainability Presentation):*

- GHG emissions from oil sands mines and tailings would be reduced by between 3 and 5 mega tonnes annually by:
    - Reducing fugitive methane emissions caused by fermentation in ponds of lost solvents (methanogenesis) which represent 80% of site wide fugitive GHG emissions
    - Producing over 10 million additional barrels of bitumen annually (currently lost in tailings ponds) reducing GHG emissions intensity by approximately 10%
    - Recovering waste heat, thereby avoiding GHG emissions from burning natural gas to reheat cold pond water
- Volatile Organic Compound emissions (VOCs) would be lowered by up to 70% or 60 kilotonnes annually, significantly reducing health-hazardous exposure, (Alberta reports Canada's highest VOC among all provinces and among the highest VOC's per capita of developed countries).
- Secondary Organic Aerosol emissions (SOAs) from pond/tailings hydrocarbons would be materially reduced. In May 2016, in the authoritative scientific journal "Nature", Canadian Government scientists identified "Oil sands operations as a large source of secondary organic aerosols". SOAs are air pollutants that are an important component of atmospheric particulate matter that affects health and climate.
- Conservation of up to 60 million m^3 annually of improved quality water which would be available to be recycled to processes that now use fresh river water.
- Up to 80% of radioactive materials (present in the sand fraction of froth treatment tailings and accumulate in tailings ponds) would be removed in the minerals process and managed in a safe and controlled manner.

- The environmental improvements to air, water and land would have a positive effect on the health and well-being of local communities, in particular the indigenous peoples who live, work, hunt and fish in close proximity to oil sands operations.

National & Regional Economic Benefits, Job Creation and a New Export Industry for Canada

Industry-wide implementation of CVW™ would provide highly significant economic benefits and job creation opportunities for Canada *(Slides 4, 18, 19 and 20 of attached Environmental Sustainability Presentation)*:

- With capital investment of about C$400 million per site, or about $2.4 billion industry-wide, implementation of Titanium's CVW™ would help drive near-term economic growth in Alberta and Canada.
- Implementing and operating Titanium's new technologies would create 6,000 new jobs during construction and over 700 well paying new permanent jobs.
- The tailings processing and minerals production facilities would be located in the Fort McMurray region, creating economic diversification and new opportunities for indigenous peoples and businesses as well as other local stakeholders.
- Over the life of these new projects, over $8 billion of additional government tax and royalty revenues would be generated for Canada and Alberta from the oil sands mining sector (plus additional tax revenue from individual taxpayers).
- A new minerals processing and export industry, with annual revenue potential of up to $400 million, would be created with opportunity to make Canada one of the world's largest suppliers of sustainable, low carbon, low cost heavy mineral products. Zircon and titanium are safe, inert minerals used in ceramics, coatings, metals, pharmaceuticals, health care and environmental products.

Attached is an Environmental Sustainability presentation which further describes the sustainability opportunities of implementing this innovative technology, developed for the benefit of Canadians.

Titanium Corporation's Submission to the Working Group on Clean Technology, Innovation and Jobs

The following section provides Titanium's perspective specifically to address certain questions from the Working Group on Clean Technology, Innovation and Job Creation.

1. Barriers to clean technology commercialization and adoption in the Canadian oil sands sector.

Titanium View: Commercialization and adoption of new clean technologies, particularly those developed by entrepreneurial clean tech firms, has been slow and challenging in the Canadian oil sands sector. This reflects the high capital intensity of new projects, long project lives which favour prudence over speed, the sensitivity of project returns to potential construction cost surprises (for first commercial projects in particular); operating underperformance and the general difficulties of an industry mega-enterprise working in close collaboration with SME entrepreneurs.

Therefore, we understand the industry has a strategic focus on production growth and plant reliability relative to achieving significant environmental improvements while simultaneously meeting shareholder expectations.

The slow pace and challenges of commercialization in the sector undermines private sector investor support for early stage clean technology investment, slowing the normal circle of success attracting more investment, more investment accelerating technological advances, technological advances improving cost and environmental competitiveness that has characterized many other sectors, operating in earlier stages of their life cycle.

A further challenge is the "race to be second". Given the higher risks and potentially higher costs and lower performance that first adopters of new clean technologies face, many sector participants have a natural preference to be a "fast second adopter", with commensurately lower risks and potentially higher returns. In other words, even where sector participants want to adopt new clean technology, they prefer to let their competitors work out the construction and operating bugs before making a commitment. In a highly competitive industry, this can slow adoption further.

Finally, the recent slow pace of commercialization reflects the protracted and severe decline in oil prices experienced since early 2014. With cash flows constrained, major lay-offs and cost reductions, the industry has cancelled and deferred capital projects, including attractive clean technology projects that offer real economic and environmental benefits. Uncertainty around new climate change rules, the provincial royalty review, new tailings management regulations and the plethora of announced funding programs has given industry good reason to pause and await greater clarity before making new clean technology investment decisions. In short, confidence, capital and regulatory clarity are all in short supply.

2. What more can governments do to make the oil sands sector a world leader in the adoption and commercialization of clean technologies?

Titanium View: Protecting the environment while growing the economy in the oil sands sector requires a thoughtful mix of policy measures and incentives applied in a co-ordinated fashion by both the federal and provincial governments. Properly framed, government policy can provide the clarity, confidence and capital support that can help catalyze commercialization, accelerate adoption and change the dynamic from the "race to be second" to the "race to be first" by providing clear and compelling advantages to first adopters.

Key incentives could include grant funding from the federal Government's Low Carbon Economy Fund and Clean Technology Fund, aligned with funding from Alberta's Climate Change and Emissions Management Corporation (CCEMC), provincial royalty credits for innovation, commercialization and economic diversification as well as provincial methane offsets and carbon offsets. Establishing clear, harmonized qualification criteria and streamlined application and approval processes can speed and ease the burden for clean tech proponents and their oil sands partners. Meaningful time-sensitive funding support can act as a catalyst for oil sands producers to commit to moving forward even in uncertain times. To change the dynamic from the "race to be second", we recommend providing first adopters of new clean technologies with meaningful one-time incentives. These must be significant enough to offset perceived first-time risks and to reward adopters if they are to be a powerful inducement to move first.

For rapid adoption and meaningful outcomes, the financial incentives cited above should be linked to policy measures such as rising carbon pricing, intensity reduction targets, best available technology strategies, environmental standards and a policy that includes all sources of GHG and other deleterious emissions (e.g. VOCs, SOAs) for which commercially demonstrated plants are not yet in operation. Implementing a comprehensive methane and GHG reduction policy that includes tailings pond fugitive emissions would incent adoption of commercial-ready technologies. It would also underline the government and industry commitment to being proactive on this emerging issue, strengthening the social license benefits of adoption.

Providing clarity on new environmental regulation, a harmonious and streamlined funding application process for new clean technology projects and strong financial incentives for first adopters will go a long way to initiating a virtuous circle of clean technology innovation, commercialization and adoption in the oil sands mining sector.

3. How can Indigenous peoples' involvement in, and benefits from, clean technology be improved?

Titanium's View: Inherent in their history and experience living and working in harmony with nature, indigenous peoples bring unique and valuable first hand perspectives to potential environmental impacts of developments on local communities, air, land and water. Their early consultation and involvement in developments, particularly clean technology, offers the opportunity to learn from this experience and design optimum solutions.

The implementation of clean technologies in consort and cooperation with indigenous peoples would improve effectiveness, while creating economic benefits, training programs and job opportunities for indigenous peoples, businesses and communities.

Programs that support clean technology development and implementation should include mechanisms and incentives for inclusion of indigenous peoples. As outlined above, Titanium's clean technology would provide opportunities for indigenous peoples and businesses to participate in new froth treatment tailings remediation operations and in the creation of a new minerals production and export industry in the Fort McMurray region.