The Disruptors: Overview

Blockchain makes Inroads in Energy

Distributed ledger technology, commonly known as the blockchain, is expanding beyond its currency origins into the electricity sector and – to a lesser extent – the oil and gas industry.

Carbon Alchemy: from Liability to Asset

Research and development of technologies that convert CO_2 into valuable materials is accelerating and enabling the emergence of a "CO_2 economy" that may create jobs and lower emissions.

One Clean Fuel Standard to Rule them All

The Government of Canada proposes an economy-wide Clean Fuel Standard in an effort to steer toward a lower-carbon future.

Climate Risk Disclosure goes Mainstream

Mounting pressure on energy companies to disclose financial risks resulting from global climate change policies is likely to divert investment away from carbon-intensive assets.

Energy Digitization

Enhanced data analytic capabilities and connectivity are accelerating a new range of digital applications in the energy sector, leading to potential cost reductions and efficiency increases.

Methane Hydrate Potential

Foreign governments are racing to make methane hydrates commercially exploitable by 2025, building reservoirs of natural gas to meet global energy demand for the next thousand years.

Micro-Generation Hits the Accelerator

Alongside peer-to-peer networks, the exponential growth of micro-generation both threatens to undermine and create new opportunities for traditional utilities.

Plastics Clampdown

The EU is leading the charge on a plastics clampdown that, if replicated, could fundamentally reshape the plastics economy – and demand for petrochemical feedstock.

Indigenous Rights Redux

The upcoming development of the Recognition and Implementation of Rights Framework marks another step in the Government of Canada's commitment to reconciliation.

Social	Technological	Ecological	Economic	Political

Blockchain makes Inroads in Energy

Distributed ledger technology, commonly known as blockchain, is expanding beyond its currency origins into the electricity sector and – to a lesser extent – the oil and gas industry.

BACKGROUND

- **Blockchain** stores encrypted information across a network of connected, anonymous computers. The network validates the transactions, building 'blocks' of information that are then permanently entered in the **ledger**.
- The **distributed nature** of the ledger allows everyone on the network to verify transactions, while protecting data from potential retroactive editing or hacking.
- The technology is starting to make inroads in the **electricity sector**, with a number of start-ups using it to develop **peer-to-peer electricity trading systems** in New Zealand, the United States, and the Netherlands.
- In these peer-to-peer models, **micro-generators** can trade excess electricity **among each other**, instead of selling it back to the grid.
- The **oil and gas industry** is keeping an open mind about blockchain, mostly adopting a wait-and see approach.
- In November 2017, British Petroleum (BP) joined a **consortium** with other major oil and gas companies, trading houses, and banks to co-develop a **blockchain-based digital platform** for trading energy commodities.

RELEVANCE

- Arguably, the **major benefit** of blockchain for the oil and gas sector is the **streamlining** of 'back-office' functions, particularly supply chain, procurement, and finance.
    - Blockchain can help the move away from cumbersome paper contracts that cause reconciliation and tracking issues among contractors, sub-contractors, and suppliers to the **authenticated transfer** of electronic smart documents, creating a more **seamless supply chain**.
- Blockchain is ideal for **records management** activities such as land transactions, commodity sales, service contracts, and sourcing contracts.
- Blockchain can also provide a **trading platform** for both the electricity sector and the oil and gas industry, creating new opportunities and challenges on the way.
    - Automated code-based processes (smart contracts) create a transaction model that forgoes the need for third-party intermediaries, reducing transaction costs associated with contracting.
- Some **regulators** have warned that the emergence of **decentralized trading platforms** could fragment and distort **price signals** for wholesale electricity and other commodities. So far, however, the impact of blockchain on traded markets has been too small to warrant regulatory interventions. Companies could share data with regulators in real-time, to maximize visibility and enhance **compliance** with regulatory frameworks.

MOVING FORWARD

- **Explore the application of blockchain** for regulatory compliance.
- **Assess** whether Alberta's current **electricity regulatory framework** enables the emergence of micro, peer-to-peer electricity grids.
- **Encourage testing (e.g. pilots) of blockchain** to realize savings in back-office functions in oil and gas.

Carbon Alchemy: from Liability to Asset

Research and development of technologies that convert CO_2 into valuable materials is accelerating and enabling the emergence of a "CO_2 economy" that may create jobs and lower emissions.

BACKGROUND

- In 2014, the Intergovernmental Panel on Climate Change concluded that realizing a **2°C scenario** may be impossible without carbon capture and storage.
- While **storage** permanently sequesters CO_2 in the ground, **utilization** is the application of CO_2 in commercially valuable ways. Currently, **enhanced oil recovery** is the most widespread commercial application of CO_2.
- The uptake of carbon capture and storage remains **limited**, due partly to its **capital-intensive** requirements – estimated at US$65-75 per ton for the power sector and US$55-125 for refining.
- Due to the **early stage of technological development**, there is neither an accepted methodology nor sufficient data to evaluate the economic and environmental benefits of CO_2 conversion. Most conversion technologies are estimated to be one to five years away from commercialization.

RELEVANCE

- **CO_2 utilization** can advance the uptake of carbon capture by providing a **revenue stream** that can reduce or even offset the life-cycle cost of carbon capture and help energy-intensive industries **hedge** against increasingly stringent carbon levies.
- **Carbon conversion technologies** have the potential to significantly **expand market demand** for carbon dioxide by using waste carbon dioxide as an industrial feedstock. The most **promising areas** for CO_2 conversion are building materials, chemical intermediates, polymers, and synthetic fuels.
- Early conversion projects are showing promise:
    - Carmaker **Audi** has partnered with Sunfire to develop synthetic diesel from CO_2, water, and renewable energy. Audi believes that the price of this fuel can come down to C$1.6-2.4 as production reaches scale, comparable to the price of conventional diesel in Europe.
    - Alberta's **Quest Carbon Capture Project** is financially viable at a cost of C$45/ton of CO_2.
- **Industrial carbon capture** is arguably the low-hanging fruit among all project opportunities, because many industrial processes already produce relatively CO_2 streams (on which CO_2 conversion relies). While it may be uneconomic for any individual facility to consider carbon capture, creating a **network** of smaller emitters with centralized infrastructure could help de-risk investment decisions.
- Deploying carbon conversion technologies in Alberta could help create a "**CO_2-based economy**" that creates jobs, reduces emissions, and complements energy-intensive industries from where CO_2 is drawn.

MOVING FORWARD

- **Explore opportunities** for the development of CO_2 industrial clusters, where several emitters share carbon dioxide capture infrastructure that feeds carbon conversion facilities.
- **Support the acceleration** of field-testing and commercialization of CO_2 conversion in Alberta.

One Clean Fuel Standard to Rule them All

The Government of Canada proposes an economy-wide Clean Fuel Standard in an effort to steer toward a lower-carbon future.

BACKGROUND

- On December 13, 2017 Environment and Climate Change Canada released its draft *Regulatory Framework for the Canada Clean Fuel Standard* (**the "Standard"**), with the objective to drive annual reductions of 30 megatons of greenhouse gas emissions (GHGs) by 2030. Final regulations are expected by mid-2019.
- The policy will require producers (or distributors) to **gradually reduce the carbon intensity** of the fuels they supply for the transportation, building, and industrial sectors. Reductions are yet to be determined, but they are likely to become more stringent with time.
- The Standard will **measure and set reductions** for the life cycle (or "well-to-wheel") emissions associated with each regulated fuel. The policy will not differentiate among crude oil types or their origin for petroleum-based fuels, but will do so for renewable fuels and other low carbon fuels.
- The policy will allow **companies to comply in ways best suited to them**, including process improvements, blending renewable content into higher-carbon fuels, switching from fossil fuels to electricity or hydrogen, or purchasing compliance credits.

RELEVANCE

- Canada will be the **first jurisdiction** in the world to adopt a fuel standard across the transportation, building, and industrial sectors.
- The Standard is expected to **shift economic activity** towards the renewable sector.
- As the regulated parties for liquid fuel products, **refiners and fuel suppliers will bear the cost** of meeting regulatory requirements. However, refiners in a position to improve processes or capture emissions in excess of yearly emission targets may be able to produce a revenue stream through **credit generation**.
- The Standard will provide **strong market conditions for growth of the renewable fuels industry**, but it may not provide for investments in the development of a domestic industry to obviate for increasing imports from places with established biofuel capacity, like the United States and Brazil.
- The policy may **negatively impact competitiveness** in emission-intensive and trade-exposed industries, as:
    - Alberta's oil and gas industry consumes a significant amount of natural gas and opportunities for fuel switching are limited; and
    - Standard compliance would not only increase production costs, but also result in capital outflow away from Alberta as companies will likely need to purchase credits from outside the province.
- It is not clear whether and the extent to which the Standard overlaps with provincial policies, particularly Alberta's *Carbon Competitiveness Incentive Regulation*.

MOVING FORWARD

- With input from Alberta Energy, the **Alberta Climate Change Office continues to outline issues around competitiveness**, including stringency of the Standard, interaction with Alberta's policies, effect on emission-intensive and trade-exposed industries, and outflow of capital.

Climate Risk Disclosure goes Mainstream

Mounting pressure on energy companies to disclose financial risks resulting from global climate change policies is likely to divert investment away from carbon-intensive assets.

BACKGROUND

- Increasingly, institutional investors are using **shareholder action** and **direct engagement** to demand companies **disclose** the financial risks they face from increasingly stringent global climate change policies.
- **Standard disclosures** require companies to assess the financial impacts of policies aimed at limiting the increase in global temperatures to 2°C above pre-industrial levels (Paris Agreement target).
- Jurisdictions like the European Union have already adopted **climate-related disclosure requirements** for public companies. Support for **voluntary disclosure frameworks** is growing among large Canadian pension funds and oil sands investors, with some well-publicized exceptions (like JP Morgan Chase).
- Since the Task Force on **Climate-related Financial Disclosures** released its voluntary, industry-led recommendations (June 2017), over 250 international companies and countries have endorsed them.
- Climate finance experts warn that companies' disclosure of risks to their business from climate change policies could become **mandatory** in a few years, as investor pressure gathers pace.
- The Government of Canada has launched the **Expert Panel on Sustainable Finance** to build on the recent Canadian Securities Administrators consultation, which found that all participants (i.e., investors) were dissatisfied with the state of climate change-related disclosure in Canada.
- In Alberta, only one oil sands company has **disclosed** its climate-related risks so far, showing investors that it has a strategy in place to adapt to potentially different futures.

RELEVANCE

- **Fossil fuels** are likely to remain a significant part of the world's energy mix under a 2°C scenario. Even with falling global oil demand, **new investments are necessary** to compensate for falling oil production.
- **Increasingly stringent climate policies** are likely to shift investments away from higher-cost and carbon-intensive oil in a 2°C scenario, as **falling oil demand** depresses prices.
- Although the **oil sands** are not subject to production declines, they tend to be one of the lowest-priced crudes in the world, with a relatively **high cost structure** for new projects. As a result, they are arguably amongst the **most exposed** to climate policy.
- The relative **size** of the top five oil sands companies (Suncor, CNRL, Imperial, Husky, and Cenovus) means that any financial difficulty they may experience is likely to have significant **ripple effects** on Alberta's economy and environment.

MOVING FORWARD

- Support ongoing **Department work in the area of climate-risk evaluations** for Alberta-based energy companies. This could include analytics in the area of corporate mapping, investment, and asset evaluations.
- Assess the **impact of Climate-related Financial Disclosures** for Alberta oil sands companies.

Energy Digitization

Enhanced data analytic capabilities and connectivity are accelerating a new range of digital applications in the energy sector, leading to potential cost reductions and efficiency increases.

BACKGROUND

- **Digitization** (the process of converting information into a computer-readable format) **and predictive technologies** (the use of extremely large data sets, or big data, to reveal patterns, trends, and associations) are being used increasingly in the oil and gas sector.
- Digitization is already improving the safety, productivity, accessibility, and sustainability of **energy systems** with global energy producers automating all aspects of oil and gas exploration and production
- Alberta's oil and gas sector is applying **artificial intelligence**, **machine learning**, and **deep learning** in areas of Industrial robotics (fleet management), Automated Oil Well Data, Industrial Internet-of-Things (IoT) technologies, and the use of in-line inspection tools.
- Digital technologies continue to **change rapidly**, with many **unknowns** about how technology, behaviour, and policy will evolve over time and how these dynamics will impact energy systems into the future.

RELEVANCE

- While digitalization is already improving the safety, productivity, accessibility, and sustainability of energy systems, it is also raising new security and privacy risks, changing markets, and creating new business models.
- Digitalization has the potential to **significantly reshape road transport** through electrification, automation, and connectivity. Implications are unknown: over the long-term, energy use could halve through efficiency gains, or conversely, double as a result of increased travel.
- Accelerating digitalization could **boost technically recoverable resources** globally by 10 per cent and decrease production costs between 10-20 per cent through enhanced modelling, process optimization, automation, and predictive maintenance.
    - In the **power sector**, digitization has the potential to save 5 per cent of total annual power generation costs (US$80 billion per year) through reduced operating costs and increased grid efficiency.
    - In the **buildings sector**, digitalization could cut energy use by approximately 10 per cent by using real-time data to improve operational efficiency.
    - **Data centers** worldwide consumed around 416 terawatt hours of electricity in 2016, or about 1 per cent of total energy demand.
- The **electricity sector** could be the most significantly impacted sector, with digitalization enabling interrelated opportunities in the area of smart transportation systems.

MOVING FORWARD

- **Explore policy development and frameworks** that can accommodate new technologies. This includes pilot projects, participation on inter-agency discussions on digitization, and public access to oil and gas datasets to facilitate predictive analytics.
- **Incorporate digital resilience by design** into technology and innovation, including experimentation through research and development (e.g., applied/pilot-scale demonstration).

Methane Hydrate Potential

Foreign governments are racing to make methane hydrates commercially exploitable by 2025, building reservoirs of natural gas to meet global energy demand for the next thousand years.

BACKGROUND

- **Methane hydrates** are super-concentrated forms of natural gas that are bonded in ice-like crystals.
- The 2,800 trillion cubic meters of methane hydrates distributed worldwide in ocean sediments and permafrost are estimated to contain more **organic carbon** than all of the world's oil, gas, and coal combined.
- Methane hydrates were initially considered **dangerous** and avoided because they are explosively unstable and can result in uncontrolled well blowouts if encountered during well drilling.
    - Extraction of natural gas from **land-based** hydrates can cause significant land subsidence, but no identified hazard has been associated with exploitation from **ocean-based** sources to date, making ocean extraction the preferred method to date.

RELEVANCE

- If fully developed, methane hydrates could **provide as much energy** worldwide as natural gas does today.
- **Commercial extraction** of methane hydrates could result in **energy self-sufficiency** for the United States and for large, energy importing (Asian) economies, reducing and/or eliminating the need for natural gas imports.
    - In 2013 **Japan** achieved the world's first ever extraction of natural gas from an offshore hydrate deposit. In May 2017, Japan conducted its second, extended duration production test, where there is enough recoverable natural gas to meet Japan's needs for decades. The Japanese Government aims to launch private sector, commercial production of methane hydrates by 2023-2027.
    - Similar trials were explored in **China** in 2017. China's primary goal is to establish commercial extraction in the South China Sea by 2030, where there is sufficient natural gas to meet all of China's energy needs for approximately 26 years.
    - In May 2017 the **United States** commenced drilling a gas hydrate deposit located in the Gulf of Mexico. The American continental shelf is estimated to contain 51,338 trillion cubic feet of in-place gas hydrate resources, enough to meet all American energy needs for approximately 50 years.
    - **India** (in collaboration with the USA and Japan) and **South Korea** are also actively pursuing commercial extraction of gas hydrates.

MOVING FORWARD

- **Explore opportunities for domestic natural gas production** given the emerging production of methane hydrates in Asia and the United States.
- **Monitor trends and impacts** of methane hydrate production in key Alberta export markets (e.g., US Gulf Coast).

Micro-Generation Hits the Accelerator

Alongside peer-to-peer networks, the exponential growth of micro-generation both threatens to undermine and create new opportunities for traditional utilities.

BACKGROUND

- The combination of declining prices and regulatory incentives has contributed to a **seven-fold increase in Alberta's micro-generation capacity over the past five years**, from about 3.5 megawatts in 2013 to 26.5 megawatts in 2018. About 90% of this capacity is solar.
- Micro-generation is a **niche market** in Alberta, at 0.1% of total electricity generation capacity in 2018.
- Experience from other jurisdictions suggest that micro-generation might follow the S-curve adoption model, whereby **exponential growth follows a relatively slow initial adoption period**.
- **New technologies** like rooftop solar tiles and photovoltaic windows are now becoming commercially available, further broadening the potential of distributed generation and accelerating its uptake.
- A number of companies world-wide are building on micro-generation to create small **peer-to-peer markets**, where micro generators can buy and sell solar energy to and from each other through the **blockchain**, bypassing central procurers or intermediaries.

RELEVANCE

- The growth of micro-generation is likely to **reduce electricity demand from central generation**, particularly in the middle of the day. When the sun goes down in the evening peak demand, the resulting sharp increase in the residential load profile can make voltage and frequency management more difficult.
- As micro-generation grows, the **need for storage** will become increasingly acute. Without storage, too much electricity can enter the grid on sunny or windy days with reduced demand, creating system imbalances.
- In an industry structured around marginal cost, renewable micro-generation has a **disruptive punch** above its weight: when fewer people rely on the grid, there are fewer left to share the costs.
    - As utilities raise prices to remaining customers, more are likely to **leave the grid**.
    - **Lower-income users** might get caught between increasingly unaffordable electricity prices and high upfront costs for private solar.
- Utilities' **revenue models** might see a smaller share of income derived from centrally-generated electricity.
- **New revenue streams** might come from owning, licensing, and/or operating distributed energy sources, brokering transactions amongst micro-generators, and grid stabilization through utility-scale batteries.

MOVING FORWARD

- **Monitor the need** for utility-scale energy storage and demand response for grid stabilization.
- **Implement smart grid solutions** to allow for the real-time management of the flow of electricity.
- **Assess current policies/develop tools** to deal with the potential of electricity poverty.

Plastics Clampdown

The EU is leading the charge on a plastics clampdown that, if replicated, could fundamentally reshape the plastics economy – and demand for petrochemical feedstock.

BACKGROUND

- **Public concern** on plastic pollution and the potential health risks of certain plastics have prompted action by an increasing number of jurisdictions.
- In 2018, the European Union's (EU) Commission adopted a strategy to enable a "**circular plastics economy**" that reduces litter, recovers waste through recycling (particularly packaging), and incents the use of alternatives to fossil fuel feedstock.
- While the EU's strategy is arguably unique in the scope of its ambitions, **plastics policies continue to emerge** in both industrialized and industrializing countries. Examples include Taiwan (phase out of all plastics by 2030), China (ban on plastic waste imports), and India (ban on plastic bags in half of Indian states).
- Independent of government action, a number of **plastics-free experiments** are starting to emerge in the private and non-for-profit sectors. In February 2018, for example, an Amsterdam store opened the world's first plastic-free aisle, with plans for a national roll-out.

RELEVANCE

- **Plastics use has increased** twenty-fold in the past 50 years and is expected to quadruple in the next 30 years, reaching almost 1.2 billion tons by 2050.
- The International Energy Agency (IEA) expects the **petrochemical industry** to represent the largest source of additional oil consumption through 2040, adding nearly 6 million barrels/day shared between naphtha, ethane, and liquefied petroleum gas (propane/butane).
- Oil companies are increasingly **eyeing the petrochemical market for growth**, as electric cars and fuel standards threaten to trim demand for gasoline. At the same time, global use of **methane** in the chemical industry is expected to grow by over 200 billion cubic meters to 2040 – about 14 per cent of additional gas consumption.
- Uncoordinated global action on plastics is likely to become **more common and stringent** due to the convergence of **three main dynamics**: increasing efforts to fight pollution in industrializing, high-growth areas; concerns over contaminants; and tougher stringent carbon emission regimes.
- IEA estimates that a 15-30 per cent global increase in **recycling** and the **light-weighting** of plastic products could eliminate 1.5 million barrels/day of oil demand by 2040.
- Additional fossil fuel demand erosion could come from the **substitution** of traditional oil- and gas-based feedstocks with plant-based alternatives. While bioplastics currently represent 1 per cent of the market, global bioplastic production is expected to rise by 50 per cent by 2022.

MOVING FORWARD

- **Stress-test petrochemical investments** against a potential flattening or a reduction in the demand for plastics used in packaging – **explore investments** in chemicals destined to other uses.
- **Explore opportunities** to produce carbon dioxide- and bio-based plastics, as well as opportunities to produce biofuels and biochemical from non-recyclable waste.

Indigenous Rights Redux

The upcoming development of the Recognition and Implementation of Rights Framework marks another step in the Government of Canada's commitment to reconciliation.

BACKGROUND

- On February 14, 2018 Prime Minister Trudeau announced the launch of a **national engagement** to help deliver a Recognition and Implementation of Rights Framework ("**The Framework"**) in late 2018.
- The Framework currently lacks detail beyond its stated **objective** of renewing the relationship between government and indigenous peoples, based on the Crown's recognition of indigenous rights.
- The **Framework impetus** is the perceived lack of implementation of indigenous and treaty rights, as indigenous peoples have had to prove the existence of their rights through often costly and drawn-out court challenges.
- Little is known about the **contents** of the Framework, with the exception that it might build new ways to resolve disputes and include tools to oblige the federal government to be more transparent and accountable.
- The announcement follows **several federal initiatives** to promote reconciliation:
    - endorsement of the *United Nations' Declaration on the Rights of Indigenous Peoples* (UNDRIP);
    - support for Bill C-262 to ensure that Canada's laws align with the Declaration; and,
    - changes to the environmental assessment process for major resource projects.

RELEVANCE

- With regards to **resource development**, the Framework is expected to entrench (or at least align with) **three key tenets** reflected in the federal government's Principles Respecting the Government of Canada's Relationship with Indigenous Peoples, UNDRIP, and court rulings on indigenous rights; namely, that:
    - the Crown has a **duty to consult** and **cooperate in good faith** with indigenous peoples prior to the approval of any project affecting their lands and other resources;
    - **engagement** aims to secure their free, prior, and informed consent when proposed actions impact indigenous peoples and their rights on their lands, territories, and resources; and
    - any **infringement** of indigenous rights must meet a high **threshold** of justification that includes indigenous perspectives and satisfies the Crown's fiduciary obligations.
- Alongside changes to the environmental assessment process, the Framework is expected to make space for a **stronger role for indigenous peoples in resource projects**.
- Participation driven by duty to consult will likely give way to **early engagement** aimed at securing consent. The Framework may offer a clearer, more accountable consultation process, elements of which are often delegated to project proponents.
- Indigenous peoples are likely to have more opportunities to exercise **influence**, for example, through mandated consideration of both traditional knowledge and impacts on indigenous culture.

MOVING FORWARD

- **Prepare a Department of Energy position** on proposed changes and a**dvocate for clearer guidance** on the accommodation of indigenous rights when free, prior, informed consent is not obtained.

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