

# Prospects for Alberta oil and gas in a decarbonizing world

## The Pembina Institute's submission to the Energy Diversification Advisory Committee

By Jodi McNeill and Ben Israel | June 30, 2017

### Foreword

As representatives of the Pembina Institute (Pembina), we are grateful to have been included in the recent working group held by the Energy Diversification Advisory Committee (EDAC). This submission summarizes our feedback on the working group's framing, proceedings, and next steps. As Pembina constituted the sole environmental non-governmental organization voice in the working group sessions, this perspective should be valuable to both the committee and participants in outlining an alternative viewpoint. Given the global scale of the challenges and opportunities facing Alberta's energy industry in the 21st century, embracing a diversity in perspectives will ultimately be invaluable to ensuring optimal outcomes. This submission has accordingly been designed to capture the key arguments made by Pembina throughout the engagement process.

### Introduction

It is Pembina's understanding that the mandate of the EDAC as originally conceived by the Royalty Review Committee of October 13, 2016, is "to provide advice to the government on additional steps Alberta can take to build a more diversified and resilient energy economy [including] building on the value-add related recommendations in the Royalty Review Advisory Panel Report."<sup>1</sup> Subsequently, the EDAC adopted the vision statement that "Alberta becomes a premier destination for downstream energy investment and innovation in North America." Pembina is reservedly supportive of this broad vision, and in this submission we propose potential development pathways to realize it in an economically, environmentally, and socially sustainable manner. This includes ensuring that Alberta's development trajectory is consistent

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<sup>1</sup> Department of Energy, *Energy Diversification Advisory Committee: Mandate* (2017).  
<http://www.energy.alberta.ca/Org/pdfs/EDACMandate.pdf>

with Canada's international commitments on climate change mitigation, global trends within the oil and gas industry, and external socio-economic factors that are likely to significantly influence the industry in the decades to come. These issues were recently examined at the federal level in the Pan-Canadian Framework on Clean Growth and Climate Change (PCF),<sup>2</sup> Canada's Mid-Century Long-Term Low-Greenhouse Gas Development Strategy,<sup>3</sup> and Environment and Climate Change Canada's 2016-17 Report on Plans and Priorities.<sup>4</sup> More recently and within Alberta, the Oil Sands Advisory Group (OSAG) released its set of recommendations for a responsible management of the oilsands emissions limit, aligned with its vision statement of "help[ing] Alberta's energy industry achieve the goal of being one of the most environmentally progressive and socially responsible in the world."<sup>5</sup> These provincial and national climate policies are set to have a significant impact on the future of Alberta's oil and gas industry.

This submission focuses on recommendations that we hope will elevate the above issues from the margins of the current working group discussions. We are correspondingly taking the initiative to somewhat stray from the submission guidelines so as to provide a supplementary framing for the committee to consider when it compiles its final recommendations.

## The decarbonization of global energy systems is inevitable

Decades of rigorous scientific research and abundant empirical data have robustly established that global climate change is currently underway, due to the primary driver of greenhouse gases (GHG) emitted by human activities since the mid-19<sup>th</sup> century.<sup>6</sup> Over 200 leading scientific organizations worldwide have publicly announced support of this position, and have emphasized the need for urgent policy action to avert the most potentially severe impacts on our contemporary economies and societies from local to global scales.<sup>7,8</sup> In 2015, representatives from 196 countries correspondingly negotiated the Paris Climate Agreement to

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<sup>2</sup> Environment and Climate Change Canada (ECCC), *Pan-Canadian Framework on Clean Growth and Climate Change* (2016). <https://www.canada.ca/content/dam/themes/environment/documents/weather1/20170125-en.pdf>

<sup>3</sup> Government of Canada, *Canada's Mid-Century Long-term Low-Greenhouse Gas Development Strategy* (2016). [http://publications.gc.ca/collections/collection\\_2017/eccc/En4-291-2016-eng.pdf](http://publications.gc.ca/collections/collection_2017/eccc/En4-291-2016-eng.pdf)

<sup>4</sup> ECCC, *Environment and Climate Change Canada 2016-17 Reports on Plans and Priorities* (2016).

<http://ec.gc.ca/Publications/default.asp?lang=En&xml=83801D61-4B11-4D79-AFA9-EA6AEA8DA30A>

<sup>5</sup> Oil Sands Advisory Group (OSAG), *Recommendations on Implementation of the Oil Sands Emissions Limit Established by the Alberta Climate Leadership Plan* (2017), 1. <https://open.alberta.ca/dataset/96d339c9-7c7d-46f0-a5e1-0657d76b445f/resource/96a01742-28dc-429b-ba9f-eb317baf4001/download/OSAG-Co-Chairs-Report1.pdf>

<sup>6</sup> NASA, "Scientific consensus: Earth's climate is warming," (2017). <https://climate.nasa.gov/scientific-consensus/>

<sup>7</sup> American Association for the Advancement of Science, *Climate letter to policymakers* (2009).

[https://www.aaas.org/sites/default/files/migrate/uploads/1021climate\\_letter1.pdf](https://www.aaas.org/sites/default/files/migrate/uploads/1021climate_letter1.pdf)

<sup>8</sup> State of California, "List of worldwide scientific organizations that hold the position that climate change has been caused by human action," (2011). [https://www.opr.ca.gov/s\\_listoforganizations.php](https://www.opr.ca.gov/s_listoforganizations.php)

“hold the increase in global average temperature to well below 2°C above pre-industrial levels.”<sup>9</sup>

It follows that even baseline scenarios in forecasts made by numerous organizations including the International Energy Agency<sup>10</sup> and the U.S. Energy Information Agency,<sup>11</sup> along with private companies such as Shell<sup>12</sup> and Statoil,<sup>13</sup> project the decarbonization of global energy systems in the 21st century. As the EDAC has acknowledged, this ultimately translates to progressively declining global market shares for oil and gas products. With peak demand for fossil fuels approaching well before 2050, it is imperative for Alberta energy policymakers to critically evaluate prospects for medium- to long-term competitiveness in this dramatically changing global landscape, and draw conclusions with regards to a potential diversification of the economy within and outside of the oil and gas sector.

## Alberta faces a double challenge

The imperative to decarbonize our energy systems poses a real challenge to the Alberta oil and gas industry. First, major changes in our global energy systems, such as the electrification of end uses and the associated shift toward electricity as the energy currency of the next century, will progressively decrease total demand for hydrocarbon products. As the demand falls for hydrocarbons, Alberta production will likely become economically marginalized early in an energy transitioning world as our hydrocarbons are particularly carbon-intensive and have high operational costs.<sup>14</sup>

Should the decarbonization and cost challenges not be overcome by the industry, current oil and gas assets would turn into liabilities — creating a second tangible challenge that would severely impact the economy and Alberta taxpayers. Alberta now faces a growing problem of inactive, shut-in, and orphaned oil and gas sites. There are concerning precedents in the fossil fuel and mining industries of the public being left on the hook for enormous clean-up liabilities when operators are forced into bankruptcy. For example, Canadian taxpayers are presently shouldering over \$1 billion in remediation costs for the bankrupt Giant Gold Mine in the

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<sup>9</sup> United Nations Framework on Climate Change, *Conference of the parties; Adoption of the Paris Agreement* (2015). <http://unfccc.int/resource/docs/2015/cop21/eng/109r01.pdf>

<sup>10</sup> International Energy Agency, *World Energy Outlook 2016* (2016). <http://www.iea.org/newsroom/news/2016/november/world-energy-outlook-2016.html>

<sup>11</sup> U.S. Energy Information Administration, *Analysis & Projections – Annual Projections to 2050* (2017). <https://www.eia.gov/analysis/projection-data.cfm#annualproj>

<sup>12</sup> Shell Global, “Shell energy scenarios” (2016). <http://www.shell.com/energy-and-innovation/the-energy-future/scenarios.html>

<sup>13</sup> Statoil, *Energy perspectives 2016 – Long-term macro and market outlook* (2016). <https://www.statoil.com/content/dam/statoil/documents/energy-perspectives/energy-perspectives-2016.pdf>

<sup>14</sup> This argument is developed in the next section.

Northwest Territories;<sup>15</sup> a recent ruling by the Alberta Court of Appeal on Alberta's bankrupt Redwater Energy Corp. gave creditors priority over environmental clean-up obligations;<sup>16</sup> and over US\$70 billion in unsecured liability for coal clean-up costs in the United States now radically outweigh the profit-making ability of the dying industry.<sup>17</sup>

The total outstanding — and largely unsecured — costs to remediate both inactive and currently operating sites in the province now amounts to hundreds of billions of dollars.<sup>18</sup> It is therefore imperative that Alberta's oil and gas industry remains forward-looking and healthy in the 21<sup>st</sup> century to ensure that the burden of these liabilities will not be placed on taxpayers in the near future.

The good news is that calculated development avenues are indeed available to maintain a modern and prosperous oil and gas sector in Alberta that do not contradict the commitments to climate action that we are beholden to. However, these avenues place a strong emphasis on innovation and emerging markets, and will require a paradigm shift beyond the simple objective of production growth. We will now outline key strategies and tools to meet this goal.

## Strategies for expanding hydrocarbon markets in a carbon-constrained world

Transitioning to a low-carbon economy will require mechanisms that will advantage the least carbon-intensive products. This logic is already at play in Alberta through:

- The legislated limit on oilsands emissions, which will provide an incentive to develop projects with the least carbon intensity in order to maximize production under the annual 100 Mt limit<sup>19</sup>;
- The output-based allocation system adopted as a carbon pricing mechanism for oil and gas production will similarly advantage operators with the least carbon intensity, while penalizing the worst players; and

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<sup>15</sup> Indigenous and Northern Affairs Canada, "Giant Mine Remediation Project," (2017). <https://www.aadnc-aandc.gc.ca/eng/1100100027364/1100100027365>

<sup>16</sup> CBC News, "Creditors over environment: Alberta Court of Appeals upholds Redwater Energy decision," (2017). <http://www.cbc.ca/news/canada/calgary/redwater-energy-appeal-dismissed-alberta-bankruptcy-environment-creditors-1.4083474>

<sup>17</sup> McKinsey & Company, "Downsizing the US coal industry: Can a slow-motion trainwreck be avoided?," (2015). <http://www.mckinsey.com/industries/metals-and-mining/our-insights/downsizing-the-us-coal-industry>

<sup>18</sup> Alberta Oil Magazine, "Why provincial regulations, coupled with low oil prices, are strong-arming some juniors out of business," (2016). <https://www.albertaoilmagazine.com/2016/05/provincial-regulations-coupled-low-oil-prices-strong-arming-juniors-business/>.

<sup>19</sup> Government of Alberta, *Oil Sands Emissions Limit Act*, 2016. <http://www.qp.alberta.ca/documents/Acts/O07p5.pdf>

- Other policy tools in Canada and abroad, such as low-carbon fuel standards, will contribute to advantage certain hydrocarbons over others.

As a result, reducing the carbon intensity of Alberta's hydrocarbons should be a number one priority for the province if it is to remain competitive in the long run. Alternative pathways include finding markets for Alberta's hydrocarbons beyond combustion. In both cases, these development pathways centre around technological innovation.

## Drastic reduction in greenhouse gas intensity of hydrocarbon products

Contrary to prominent industry narratives, Alberta's hydrocarbons are very carbon intensive to produce. The oilsands are still one of the most carbon intensive oil sources on earth,<sup>20</sup> and despite some strong improvements in the 1990s and early 2000s, the trend has reversed and is on the rise with a 25% increase in emission intensity for in situ and mining techniques between 2004 and 2014.<sup>21</sup> Similarly, while natural gas was long considered a relatively cleaner fuel, recent research suggest that associated fugitive emissions have been greatly underestimated in North America, especially when gas is sourced from unconventional resources.<sup>22</sup>

### 1. Shifting to less carbon-intensive techniques for oilsands extraction

Recent research shows there are near-commercially-ready technologies that have the potential to reduce operation costs by 34-40%, and emissions up to 80% on a per-barrel basis.<sup>23</sup> One limitation is that techniques associated with the best performance only apply to new site developments, so only limited improvements are available for existing sites. For this reason, additional technological innovation is required to lower the carbon intensity of Alberta's oil and gas industry.

### 2. Capturing and utilizing carbon

While carbon capture and storage has faced economic barriers preventing widespread adoption in carbon-intensive industries, carbon capture and utilisation (CCU) is a market-driven approach that focuses on creating valuable products from CO<sub>2</sub>. A recent report by the Global CO<sub>2</sub> Initiative found that at full scale, five leading products from CO<sub>2</sub> utilization and conversion

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<sup>20</sup> Carnegie Endowment for International Peace, *Know your oil: Creating a global oil-climate index* (2015). <http://carnegieendowment.org/2015/03/11/know-your-oil-creating-global-oil-climate-index>

<sup>21</sup> Pembina Institute, *Measuring oilsands carbon emission intensity* (2016). <http://www.pembina.org/pub/measuring-oilsands-carbon-emission-intensity>

<sup>22</sup> Emmaline Atherton, et al., "Mobile measurement of methane emissions from natural gas developments in Northeastern British Columbia, Canada," *Atmospheric Chemistry and Physics* (under review) (2017), 1. <http://www.atmos-chem-phys-discuss.net/acp-2017-109/acp-2017-109.pdf>

<sup>23</sup> CERI, *Economic Potentials and Efficiencies of Oil Sands Operations: Processes and Technologies* (2017). [http://resources.ceri.ca/PDF/Pubs/Studies/Study\\_164\\_Full\\_Report.pdf](http://resources.ceri.ca/PDF/Pubs/Studies/Study_164_Full_Report.pdf)

pathways could feed a market worth over US\$800 billion by 2030, with the potential of mitigating through economically-productive use approximately 15% of current annual global CO<sub>2</sub> emissions. The study explored six emerging markets: algae for biofuels and/or food additives; building materials including concrete and steel; chemical intermediates including methanol, syngas, formic acid, and malic acid, fuels for methane and alcohol; novel materials including carbon fibre; and polymers including polycarbonates, polyurethane, and PHA.

With a combination of strategic policy choices and investments in its nascent cluster of enterprise, technology, and entrepreneurship in CCU, Alberta could position itself as a global leader in this field. To achieve this, policymakers could leverage Alberta's industrial and petrochemical engineering expertise and position at the head of the current development curve in carbon utilization by courting international investment with a favourable environment for commercialization. Alberta has several unique opportunities it can take advantage of to achieve this. First, the royalty regime should be revised to use value-add credits as a lever for CCU project investment. Second, the sectoral CO<sub>2</sub> limit in the oilsands should be stringently and consistently enforced, as it creates a regulatory signal that can incent CCU. Third, private sector investment initiatives such as the NRG COSIA Carbon XPRIZE<sup>24</sup> should continue to be fostered to attract scalable demonstration technologies to the province.

### 3. Developing an “Energy Smart” Alberta

Alberta's economy is one of the most carbon intensive in Canada, and industry emissions in the province have continued to grow in the last decades.<sup>25</sup> Notably, based on the most recently published comprehensive World Bank statistics on global greenhouse gas emissions, if Alberta were an independent nation-state it would surpass Qatar to have the highest per-capita greenhouse gas emissions in the entire world.<sup>26</sup> It is therefore imperative that Alberta's industrial sector becomes more energy efficient, which can be achieved through strong policy measures to promote clustering and circular economies. On this basis we endorse the emphasis on ecoclusters that has emerged in the EDAC's discussions. Clustering entails geographic consolidation of the oil and gas industry to offer more opportunities for energy efficiency improvements in industrial operations. Clustering should maximize the potential economic return from value chains while also minimizing associated carbon emissions.

This would include attracting new activities through synergies such as reducing transportation distances, turning waste into resources, and sharing utilities including steam, heat, and

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<sup>24</sup> XPRIZE Foundation, "NRG COSIA Carbon XPRIZE," (2017). <http://carbon.xprize.org/>

<sup>25</sup> ECCC, *National inventory report 1990-2014: Greenhouse gas sources and sinks in Canada* (2016). [http://publications.gc.ca/collections/collection\\_2016/eccc/En81-4-1-2014-eng.pdf](http://publications.gc.ca/collections/collection_2016/eccc/En81-4-1-2014-eng.pdf)

<sup>26</sup> World Bank, "World Development Indicators," (2017). <http://databank.worldbank.org/data/reports.aspx?source=2&series=EN.ATM.CO2E.PC&country=#>

electricity. Such models have been proved successful in several places in Europe. For example, the Kalundborg Symbiosis is an industrial ecosystem in Denmark where the residual product of one enterprise is used as a resource by another enterprise in a closed cycle, resulting in mutual economic and environmental benefits.<sup>27</sup> Developing clustering in Alberta would make the province both energy-smart and value-chain efficient through diversification.

## Hydrocarbons beyond combustion

### 1. Solvent-based extraction of oilsands

Solvent-based extraction of oilsands could potentially reduce per-barrel production emissions by improving or replacing the extraction technique most prominently used for in situ oilsands recovery: steam-assisted gravity drainage (SAGD). While with SAGD steam is used to mobilize the bitumen, solvent-based processes inject a combination of steam and solvent or solvent only. The technique allows for reducing or eliminating the need for steam generation, which typically accounts for the majority of the GHG emissions in the case of SAGD. Solvents are usually constituted of natural gas liquids (NGL) such as propane or butane. The great share of the volume of injected solvents can typically be recovered and recycled for further use throughout the process. Many companies are presently exploring co-injection of steam and solvent, as well as pure solvent techniques that have shown strong promise in drastically reducing the carbon intensity of bitumen extraction.

However, it is important to note some caveats with these technological developments. Solvent-based bitumen extraction is currently unregulated in Alberta, and if the technology is widely adopted there will need to be regulatory diligence to ensure that other important aspects of the environment and community safety are not compromised in the interest of reducing GHG emissions. There are ongoing concerns regarding the potential for surface or subsurface contamination from solvent-assisted techniques, which leave residual subsurface solvent after the bitumen is extracted. The success of this technology will ultimately depend on the results of comprehensive impact assessments, the development of stringent and enforceable regulations, and proactive engagement with local stakeholders.

### 2. Leaving carbon in the ground, harvesting hydrogen

There is an abundant literature on the role that natural gas can play in a decarbonized hydrogen-based economy. Hydrogen has long been described as a promising, versatile fuel that could greatly contribute to solve our climate challenge.<sup>28</sup> While hydrogen as a fuel is nowadays

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<sup>27</sup> Klandborg Symbiosis, “Kalundborg Symbiosis is the world’s first working industrial symbiosis.” <http://www.symbiosis.dk/en>

<sup>28</sup> Jeremy Rifkin, *The Hydrogen Economy* (2002).

often produced from methane and therefore associated with carbon dioxide emissions, new processes have been developed to extract hydrogen from fossil fuels while leaving a residue of solid carbon powder, such as the process of methane cracking using molten tin.<sup>29</sup> This type of innovation illustrates there are opportunities to develop Alberta's vast hydrocarbon resources in such ways that would not produce carbon emissions. The province could be positioned as a welcoming home for such a disruptive technology.

## Targeting quality rather than quantity with smarter regulations

A regulatory paradigm shift from resource recovery to resource optimization is direly needed in oilsands mining, where 20<sup>th</sup> century resource recovery requirements presently compel operators to mine poorer quality ores at higher economic and environmental costs. Directive 082 provides criteria to determine which resources operators are obliged to mine, as well as the total volume of bitumen that must be recovered. Shell conducted a pilot project in fall 2016 that demonstrated triple wins for private profit, environmental outcomes, and royalty revenues by changing these requirements and promoting resource optimization instead. The pilot project demonstrated reduced tailings fines of up to 18%, an 8-12% reduction in GHGs, and a 3.5 year reduction in mine life. This demonstrates the value of shifting from a quantity-oriented regulatory paradigm to one focused on recovering only Alberta's best quality fossil fuel resources.<sup>30</sup>

## Tools for prosperity in a carbon-constrained world

### New business models

The energy sector is capital constrained, and the mobilization of private capital will be imperative to ensuring the sustainability of contemporary oil and gas business models. We therefore encourage the EDAC to recommend thoughtful implementation of economic tools for mobilizing private capital to complement and leverage concurrent public investment in value-added innovations.

For example, many large corporations including Unilever<sup>31</sup>, Starbucks<sup>32</sup> and Apple<sup>33</sup> are presently using “green bonds” to finance profitable efficiency and carbon reduction

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<sup>29</sup> The Economist, *Carbon capture and storage: On a hot-tin route – A new way to strip carbon from a fossil fuel*, December 3, 2015. <http://www.economist.com/news/science-and-technology/21679435-new-way-strip-carbon-fossil-fuel-hot-tin-route>

<sup>30</sup> Shell, *Waiver Request: Mining Criteria-Directive 082 Shell Canada Energy – Muskeg River and Jackpine Mine Approval No. 8523 & 9756* (2016). [https://dds.aer.ca/iar\\_query/FindApplications.aspx](https://dds.aer.ca/iar_query/FindApplications.aspx)

<sup>31</sup> Unilever, “Unilever issues first ever green sustainability bond,” 2014. <https://www.unilever.com/news/press-releases/2014/14-03-19-Unilever-issues-first-ever-green-sustainability-bond.html>

requirements, as well as initiatives to encourage social and environmental sustainability including conservation and biodiversity offsets. Issue rates of green bonds have tripled in the last few years. In fact, a recent report by the Organization for Economic Co-operation and Development (OECD) estimates the green bond market could be valued at US\$4.7-5.6 trillion by 2035, with annual issuances of US\$620-720 billion.<sup>34</sup>

In this vein, to underwrite energy efficiency and carbon utilization we recommend that the Minister of Energy work with the Minister of Finance, Energy Efficiency Alberta, and AIMCo to support the use of green bonds in Alberta's oil and gas industry.

## New metrics

In 2008, McKinsey estimated that economic value-add per unit of carbon emitted must be increased by a factor of ten in order to deliver an 80% reduction in global emissions while continuing to grow the economy. This economic return on carbon emitted is referred to as “carbon productivity.”<sup>35</sup> Given Alberta's economic position, and emerging life-cycle-based transportation fuel regulations such the low-carbon fuel standards recently adopted in California and British Columbia,<sup>36</sup> Pembina contends that “carbon productivity” is a natural and complementary indicator to use with emission reduction in benchmarking the province's performance over time. Moreover, carbon productivity is useful for weighing alternative investments; this tool would allow energy policymakers to proactively evaluate whether Albertans are getting the greatest economic return per additional unit of carbon emitted.

Alberta would not be alone in applying carbon productivity as a metric for deciding between value-add investment opportunities, but rather would be following emerging best practices. For example, Covestro, the Bayer Materials spinoff, notes that “[while] plastics are made from oil and other carbon sources... they make effective insulation materials for buildings, pipes and industrial installations, [that] significantly reduce fossil fuel consumption. During their lifecycle, polyurethane hard foams for example — which are seen as the best industrially produced insulation material — save up to 70 times the energy used to manufacture them. Cars

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<sup>32</sup> Green Biz, “6 benefits to companies that issue green bonds,” 2017. <https://www.greenbiz.com/article/6-benefits-companies-green-bonds>

<sup>33</sup> Environmental Finance, “Bond of the year – Apple's inaugural green bond was, and remains, the largest US corporate green issue,” 2017. <https://www.environmental-finance.com/content/awards/green-bond-awards-2017/winners/bond-of-the-year-corporate-apple.html>

<sup>34</sup> OECD, *Mobilising bond markets for a low-carbon transition* (2017). <http://www.oecd.org/environment/mobilising-bond-markets-for-a-low-carbon-transition-9789264272323-en.htm>

<sup>35</sup> McKinsey & Company, *The carbon productivity challenge: Curbing climate change and sustaining economic growth* (2008). <http://www.mckinsey.com/business-functions/sustainability-and-resource-productivity/our-insights/the-carbon-productivity-challenge>

<sup>36</sup> Smart Prosperity Institute, *Low carbon fuel standards in Canada* (2017). <http://institute.smartprosperity.ca/sites/default/files/lowcarbonfuelstandards-web.pdf>

made using lightweight plastics also help the environment because they use less fuel, and as a result less carbon dioxide is emitted.”<sup>37</sup>

## Conclusion

Alberta's oil and gas industry faces profound challenges as the world undergoes an ever-accelerating transition towards decarbonized energy systems. Implementing forward-looking policies that embrace a paradigm shift towards clean energy futures will ultimately protect the province from facing a 'carbon bubble' and falling off a steep economic cliff in the near future. Proactively addressing these realities will also protect future generations of Albertans from the risk of shouldering responsibility for immense fiscal and environmental liabilities.

Centrally, we emphatically encourage the EDAC to recommend policies that support disruptive technological innovation to foster high-grade manufacturing and value-add that can position Alberta to provide low-, zero- and negative-carbon solutions. Ultimately, doubling down on commodity businesses — including maintaining a narrow focus on increasing production for conventional transportation fuel markets — will not in our view win enduring support or advance the long-term economic interests of the province.

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<sup>37</sup> Covestro, “Lighter materials, better insulation,” 2017 <http://www.covestro.com/en/innovation/global-trends/climate-resources>