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"Our Past Is the Key to Our Future": A historical perspective on opportunities and approaches for continuing reserve growth in Western Canada Sedimentary Basin

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Abstract

Uniformitarianism, where "the present is the key to the past" implies observable processes explain the origin of the material geological record. It is the fundamental principle that encapsulates geological thought since the Enlightenment. Without reference to and perhaps ignorant of uniformitarianism, the post-Modern French Philosopher Jacques Derrida introduced the concept of Hauntology in his work "Specters of Marx". This introduced extrapolations Past actions and concepts beyond the Present into the Future. Perhaps, unwittingly Gerry Reinson stumbled into the post-Modern realm by employing the phrase "our past is the key to our future" as the Diamond Jubilee CSPG convention motto in 2002. While it seems like a play on words, these changes mark a major philosophical departure that requires examination.

I ask which elements of our past can, or should, we extrapolate into the future and how, in the context of opportunities for petroleum reserve replacements and growth from:

1. new exploratory field and pool discoveries,
2. improved concepts and new technologies that make previously uneconomical resources future reserves, and
3. improved recovery factors for discovered in-place reserves,

During "the second oil price shock" in the late 1970s, fresh graduates joining the Calgary upstream petroleum industry were told light and medium crude oil production from Western Canada Basin Sedimentary was about a million barrels per day and these were "in decline and fast running out". There are those that simply follow the production decline curve to its inevitable pessimistic conclusions and remind others of when a "new" idea had been tested unsuccessfully before. The best example is Colin Campbell and Jean Laherrere's (1998) "The End of Cheap Oil"". Jean was confident that their projections were unalterably inevitable. Their paper was published following the Kyoto Climate Accord signing in December 1997 and in the same year as American Climatologist James Hansen's (Hansen, 1998) testimony to the United States Senate Committee on Energy and Natural Resources regarding anthropogenic climate change. His testimony moved that concept into the forefront of American and Global political and media thought and discourse. These events initiated a three-decade-long dialogue of conflicting perceptions and strategies that impacted global society and industry, not least the upstream petroleum industry.

So certain were even some of the highest-level petroleum industry executives of the imminent, decline of conventional production and the economic inaccessibility of unconventional resources that BP ran its "Beyond Petroleum" advertising campaign between 2000 and 2008 https://en.wikipedia.org/wiki/BP . This expensive rebranding project, which introduced the “Helios” sunburst logo, was intended to reposition BP as an “environmentally conscious energy firm”.

Yet, even in the late 1970’s the key current elements of our production mix were present. There were exciting, if smaller, new conventional Nisku Reef discoveries. Montney Formation production was part of the petroleum supply (Bird et al., 1994), bitumen mining was underway and in 1974 the Alberta Oil Sands Technology and Research Authority (AOSTRA) was established. At the same time the Canadian geographic frontier sedimentary basins also appeared to hold promising prospects following the discovery of Hibernia.

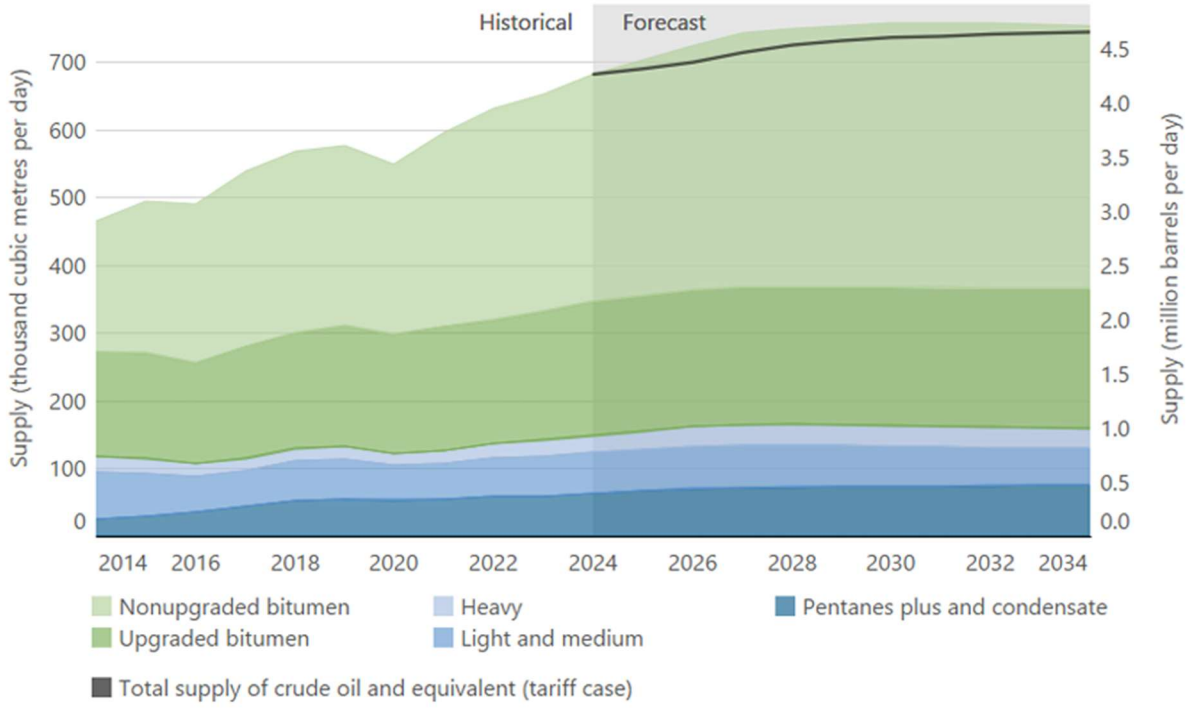


Figure 1: Historical and anticipated Alberta supply of crude oil by supply type from AER Outlook 2025 (2025, their Figure 8). Both upgraded and non-upgraded bitumen dominate the supply, showing strong growth until 2027. However crude oils continue to provide a nearly constant proportion supply for the coming decade, in part due to Montney Fm. and other contributions (Alberta Energy Regulator, 2025. Alberta Energy Outlook ST98). New EOR projects are not a significant component of the future supply.

In 2025, Western Canadian crude production, from south of 60ºN averaged >4.5 million barrels per day (bbl/day), with much of it being bitumen. There was strong overall output across the WCSB provinces. Alberta achieved a monthly production record, exceeding 21 million cubic meters (~132 million barrels) in November 2025 and accounted for more than 80% of the total

crude oil production. As a result, in 2025, Canada's upstream oil and gas industry continued to exhibit significantly higher labour productivity than the rest of the Canadian economy. Due to a lower price, revenue was slightly lower in 2025 compared to 2024, with revenues of ~$172.4 billion compared to $178.3 billion. Even so average upstream oil and gas sector workers produced ~3 times more economic output hourly than the average for Canadian workers in other goods-producing industries.

A review of how upstream petroleum industry Geoscientific and Engineering staff sought to address and "conquer" challenges enunciated in the late 1990's show how the past informs the future. Rather than believing that depletion was forcing an energy transition on society, industry employed innovation and technological change, in Canada and globally, extending the era of "cheap oil", far beyond what Campbell and Laherrere (1998) imagined:

1. Clearly, the WCSB conventional petroleum potential is not played out. To this end I have practical experience. Following the Publication of the Geological Survey of Canada assessment of undiscovered light and medium petroleum potential (Podruski et al, 1988; GSC Paper 87-26.), my good friend, Alice Payne told me bluntly that the GSC and the report's authors, were irresponsible to predict such a large undiscovered opportunity in a basin that was "all drilled up". Yet, in less than 10 years, by the mid-1990's, additional reserves exceeding the median-case prediction of our analysis were discovered. Similarly, Gunter and Longworth's (2013) analysis of enhance recovery potential in Alberta cites competition with new conventional and unconventional exploration as a significant cause for the lack of enhanced recovery programs in Alberta (Canada Energy Regulator, 2018; 2024).
2. Neither is there a "vestige of an end", as Hutton would have put it. Remembering that Bird and others (1994) characterized the Montney plays as immature, we can still identify large stratigraphic volumes characterized by active petroleum systems but few, volumetrically small discoveries, indicating additional potential opportunities in regions that remain sparsely drilled. Neither is there a reconciliation between petroleum systems (Osadetz et al., 2018) and the stratigraphic and geographic distribution of their petroleum resources. Some Geological Survey of Canada petroleum resource assessments inferred conceptual play potentials in Systems or Series (e.g. Reinson et al., 1993) by applying discovery process methods (Lee and Wang, 1983) to sets of plays. Retrospective analyses that compare various resource assessments to the new pool and new play discoveries additions, after the fact, are non-existent. How would a contemporary Montney Fm. resource potential (Canada Energy Regulator, 2024; Bird et al., 1994), impact our perspective WCSB resource potential? While an academic exercise, its results would be informative. Another opportunity looms with the increasing accessibility of generative artificial intelligence (GAI). Several methods were developed that carry the assessment of undiscovered resources into map views of resource opportunity (Gao et al., 2000; Chen and Osadetz, 2006; Amiri et al., 2016). These identify the most favourable regions of undiscovered resource potential (think of it as the GAI, data constrained,

penetration map). This will not replace the geoscientist's role as play maker and prospect developer, but it will help them to efficiently focus their attention and efforts.

3. The commercialization of new petroleum resources through technology development and processes modification, includes the process of commercializing Canada' large oil sand/bitumen resources (Hein, 2016). Most important among many innovations was the development of Steam Assisted Gravity Drainage that revolutionized bitumen production, but which also, in one of its first test applications, employed early use of a horizontal borehole drilled by Imperial Oil in the Cold Lake area. Other reservoir stimulation methods, such as induced hydraulic fracturing, which was being used in the 1940's, are not "new", except in the details of their adaptations to specific reservoir productivity challenges and their improved economic performance. Neither should we ignore additional unconventional resource opportunities like Coal Bed Gas, or minable bituminous shales.
4. Finally, we examine improved recovery from existing pools and fields. The introduction of layered rights was responsible, in part, for the surge of exploration that proved the 1988 GSC conventional light and medium gravity crude oil assessment conservative. Osadetz and Chen (2007) provide a, now dated, estimated potential of reserve growth from enhanced recovery methods that suggested EOR could double the conventional WCSB reserve lifetime. Subsequent, more detailed studies, often related to opportunities for CO_2 enhanced recovery programs (Bachu, 2016; Hares, 2020), provide even more optimistic results. Work in the Weyburn-Midale pools in Saskatchewan exemplifies this opportunity. Not only has that EOR recovery program been successful, but some wells, especially horizontal ones, intended to facilitate the CO_2-injection program, became in-fill wells that found undrained reservoir compartments, the flush production from which delayed some parts of the CO_2 flood. Gunter and Longworth (2013) identified regulatory hurdles that were a disincentive to EOR projects. Their recommendations languished for almost a decade, although some were addressed recently, while others remain unaddressed. While the water flood at the Norman Wells Kee Scarp reef was very successful, the large differentiated Middle Devonian Reef reservoirs have been among the most difficult EOR programs. To date, the most successful EOR targets are platform carbonates and shoreface sandstones, where stratiform porosity predominates and tidal processes in channels at a high angle to shoreline trends reduce reservoir compartmentalization.

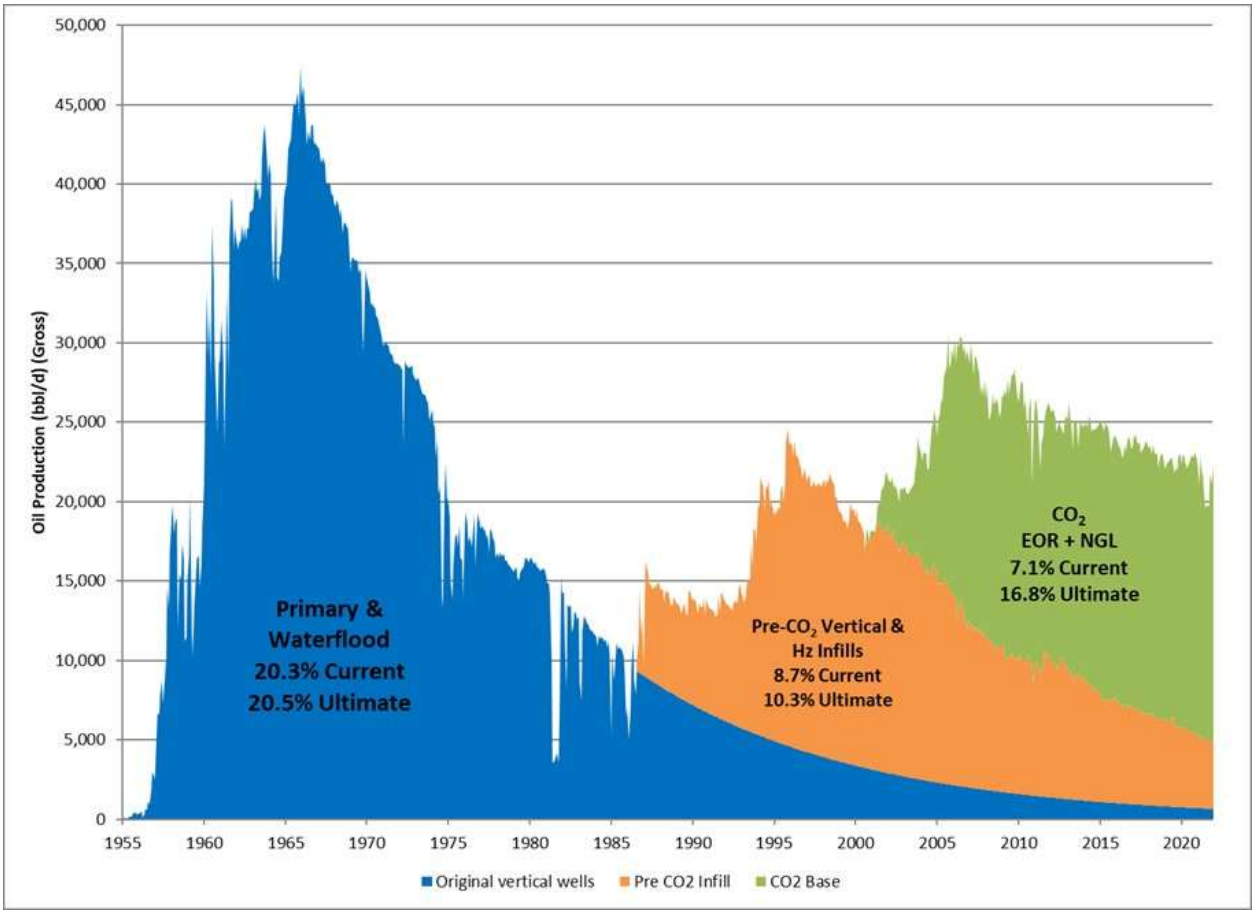


Figure 2: Weyburn Field Daily Production rate as of 2022 as attributed to recovery mechanism (Source: https://ptrc.ca/past-projects/weyburn-midale figure attributed to Whitecap Resources).

The most successful EOR program is Weyburn Field, a platform carbonate reservoir. Zhao (2024) revised the reserves growth analysis at Weyburn Field which was summarized previously (White, 2009; Wildgust et al., eds. 2013; Hitcheon, 2014). Without EOR investments that field may have approached abandonment in 2016, after producing 448.1 million bbl (71.2 million m^3), a 24.4% recovery factor. Zhao (ibid.) suggested that CO_2 EOR extends Weyburn production by 4-8.5 decades, perhaps until 2100, when annual production declines to ~ 1.5 million bbl (0.2 million m^3)/year, after cumulative production reaches 914.0 million bbl (145.3 million m^3), a 49.8% recovery factor. PTRC (https://ptrc.ca/past-projects/weyburn-midale) states that each tonne of CO_2 injected results in three incremental barrels of production, while Zhao (2024) indicates 9.2 TCF (259.9 billion m^3) of CO_2 are required to complete the EOR program, all of which will remain in storage. After production ends, the reservoir will still have a geological carbon storage capacity of 21.3 TCF CO_2 (604 billion m^3).

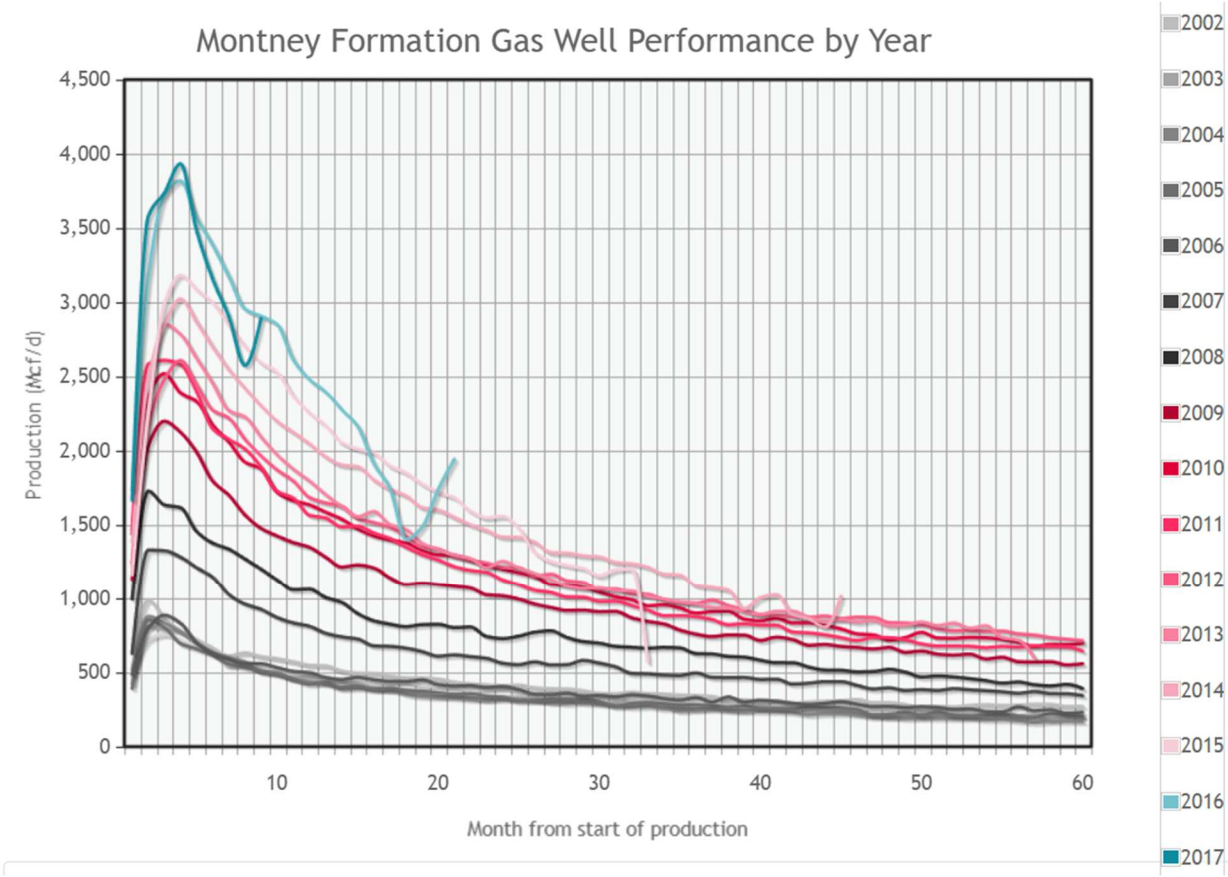


Figure 3: A history of decline curve improvement for Montney Fm. gas wells (Canada Energy Regulator, 2018).

The exploitation of "tight reservoirs" using improved drilling and completion techniques has resulted in some truly remarkable production additions from plays, like Montney Fm., an unconventional play covering 130,000 km^2 in Alberta and British Columbia (Canada Energy Regulator. 2018; 2024; Bird et al., 1994). The CER (2024) estimates Montney Formation unconventional recoverable resources at 12,719 billion m3 (449 Tcf) natural gas implying that Montney natural gas production alone could comprise 58% to 63% of Canadian natural gas supply from 2024 to 2050. Their Montney Fm. potential also includes 2,308 million m^3 (14,521 million barrels) Natural Gas Liquids (NGLs), and 179 million m^3 (1,125 million barrels) crude oil. Increasing Montney Fm. number of "frac" stages, increased production rates and EUR over time especially during the first two decades of this century.

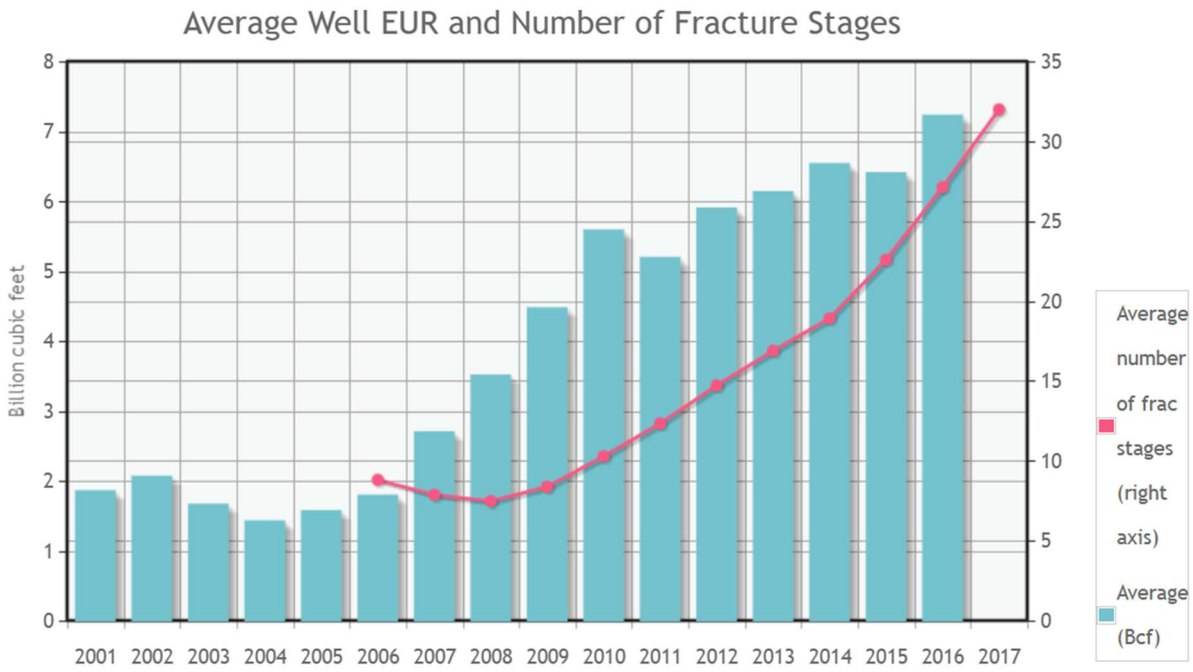


Figure 4: Montney gas well EUR improvement over time (Canada Energy Regulator (CER), 2018). Montney gas wells drilled in 2005 had EUR's of 1.8 billion cubic feet (Bcf) of gas, while wells drilled in 2016 and subsequently have EUR's that are ~4 times that of the wells drilled in 2005 and earlier (CER, 2018).

Keeping in mind that Leverson did not enunciate the "stratigraphic accumulation paradigm" until 1936, Norman Wells Field was discovered in 1919 by Dr. Ted Link, using a cable tool rig, located on a local structural feature (Osadetz, 1989). That well "blew in" from naturally fractured Canol Shales that overlay the Devonian Kee Scarp Reef, and it may have been one of the first shale wells produced in WCSB (ibid.). Many dismiss these early efforts as being irrelevant to the current brute force "multilaterals and frack" approach in low-quality reservoirs that hold enormous reserves. Yet, one should never underestimate the role of reservoir quality when looking for future value, especially in the tight plays and keeping eventual EOR in mind.

The future role of such "tight" reservoirs may already be being realized in the United States. Once dubbed, "the dumbest deal in history" Occidental Petroleum acquired Anadarko Petroleum in 2019, a century after Ted Link drilled his "shale-oil" well. Neither was it an accident that the contest for Anadarko Petroleum involved some of the most active proponents of enhanced recovery in the US onshore. Not only was the Anadarko's Delaware Basin acreage position a "good fit" for Occidental, but it also came shortly after the February 9, 2018, amendment of US Code 45Q, that provides financial incentives for the capture, storage and utilization (aka CCUS) using CO_2 in oilfield and geological carbon storage operations. On August 15th, 2023, Occidental acquired Carbon Engineering, a leading developer of Direct Air Capture (DAC) CO_2 emission mitigation started by David Keith at the University of Calgary and which operates a pilot plant in

Abbotsford, British Columbia. As this abstract was being written Occidental's 500,000 tonne/year STRATOS DAC plant near Odessa Texas is in the process of "wet commissioning". Studies at UT Austin have shown how the combination of DAC and CO_2 EOR can result in net-carbon negative oil (Nunez-Lopez et al., 2019). A glimpse of the future might be what Vicki Hollub may have been thinking in 2019.

Commonly "Energy Transition" discussions assume that Fossil Fuel sources will be phased out. Similarly, a puzzling policy feature of some emissions reduction strategies are a simultaneous encumbering of consumer preference for fossil fuel technologies, while subsidizing more costly lower emission technologies. While work must be done and costs incurred to reduce emissions, it has not been left to the "market" to find the most economically efficient method of doing this. For example, emissions mitigation using DAC for internal combustion vehicles may be a cost effective, and more rapid pathway to net zero vehicle emissions than battery EV vehicles, especially in markets that employ combustion electrical power generation.

The emissions roadmap to "net zero" is problematic considering Daniel Yergin et al.'s (2025) recent publication in "Foreign Affairs" that analyzes the structure of energy transitions. They found that new energy sources, like the rapidly expanding photo-voltaic electricity production, augments rather than replace existing energy sources. Yergin's analysis is consistent with OPEC's World Oil Outlook 2050 (OPEC, 2025). That model predicts global crude oil demand increases ~23% by 2050, with most growth coming from Asia, Africa and the Middle East, where developing economies are unconstrained by emissions reduction targets (OPEC, 2025). The emerging and developing economies saw a 1.5% (375 Mt CO_2) increase in energy-related emissions in 2024, driven by economic and population growth. This exceeds 2024 emissions reductions by developed nations. At the same time developed economies exhibited consumer resistance to increased costs associated with subsidized deployment of, or mandates for, alternative energy systems contrary to free market principles.

In the late 1990's pessimists inside and outside the Canadian upstream petroleum industry were joined by those rightfully concerned about the emissions impact of continued fossil fuel use on the natural environment and society. Their concerns are real, even if potential impacts are sometimes exaggerated, but they are commonly shown only restricted and biased subsets of technological environmental solutions. Other solutions include the continued use of fossil fuels, with mitigated environmental impacts, potentially at competitive cost. Only in late 2025 were Canadian carbon tax credits extended to EOR by the Federal Government https://decarbonfuse.com/posts/canada-unlocks-eor-for-federal-tax-credits-in-landmark-policy-shift. No one has offered Canadians the opportunity to purchase mitigation of their transportation emissions despite the large potential for geological carbon storage (Hares et al., 2022).

While it appears more desirable to employ CO_2 in EOR projects and develop CO_2 utilization revenue sources, there are opportunities for a Geological Carbon Storage (GCS) industry to employ the same skills, expertise and methods developed in the upstream petroleum industry.

This makes it important to inform society of the environmental and economic benefits of emissions mitigation. This is best illustrated by pilots projects like Quest (https://open.alberta.ca/publications/quest-carbon-capture-and-storage-project-annual-report-2024) and Aquistore (https://ptrc.ca/media/whats-new/aquistore-co2-storage-project-reached-+500000-tonnes-stored) which are not yet common knowledge. Prof. Ben Rostron recently wrote me indicating that a common response was surprise from Canadian audiences attending his Aquistore presentations during the 2024 Geological Society of America Birdsall-Dreiss lecture tour. Ben wrote of almost zero recognition or acknowledgement of Aquistore's success, with "We didn't know that had been done commercially for 10 years" being the most common comment.

The Future is "haunted" by the Past. It is also clear that innovation and technology provided solutions that allows the era of "cheap oil" to continue well into the future. The shape of these solutions was already evident in the late 1970's, when much of the groundwork for today's production mix was underway. The new and immense "tight oil resources" are well-disposed to become potentially competitive "net-zero" or even "net-negative" sources of economical energy supply (Nunez-Lopez et al., 2019) in a growing world, especially in the developing economies (OPEC, 2025; Yergin et al., 2026). In the 2011 CSPG President's Report I wrote, "As another Past-President said, "Our Past is the Key to Our Future". Truly our past is the story of legends in Canada's upstream petroleum industry. Our current success is the collective achievement of all our membership. Our future is exciting and bright as we solidify recognition that we are Canada's Energy Geoscientists, and the World notices that the CSPG/[CEGA] is a vibrant and innovative voice for Petroleum Geology and its place in society." That bit has not changed over a decade and a half.

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