View from the Financial Markets:
Energy and Clean Tech Stocks and Their Performance in Canada and the U.S.

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1. Executive Summary

Canada is one of the largest oil and gas producing nations in the world, and the oil and gas sector is the most important export industry in Canada. Thus, a successful and economically viable energy transition to a low carbon economy is of utmost importance for the future prosperity of Canada.

This report takes a capital markets perspective on energy transition and uses data from January 2018 to December 2022 to examine how the stock markets value traditional energy companies (herein after referred to as "energy" companies or firms) and clean tech companies and their prospects, comparing Canada and the United States. We then build on the valuation observations to study the risk and return characteristics for energy and clean tech firms in both countries and examine how these companies have been financed.

We found that the valuation multiples of clean tech firms increased substantially since 2018, peaked in 2020 (Canada) or 2021 (U.S.), and were still considerably higher than those of energy firms in both Canada and the U.S. at the end of the study period. In comparing the two countries, we found that clean tech firms were more highly valued in the U.S. On the other hand, energy (oil and gas) firms had higher valuations in Canada compared to the U.S. Based on the valuation multiples analysis, the financial markets appeared to be betting on the long-term prospects of the clean tech sector, especially in the U.S. In both countries, but particularly in Canada however, the markets were clearly less optimistic about clean tech firms than they were in 2020 because of rising interest rates and a greater focus on energy security. In both countries, according to their enterprise value to cash flow multiples, energy firms could be bought out with less than six years of their current annual cash flows. Thus, the valuations indicate that the financial markets viewed the energy sector as mature with an uncertain future.

The stock returns for Canadian clean tech firms were positive in the second half of 2020 and beat the market (the benchmark being the TSX Composite Index), but they were significantly lower than the returns performance of clean tech firms in the U.S. On the other hand, Canadian energy firm returns were exceptionally strong, especially more recently when energy prices spiked due to external forces such as inflationary pressures and the Russia-Ukraine war. The U.S. energy firms did not perform nearly as well but did also exhibit stronger performance more recently.

When we adjust the return performance for risk and examine the return-to-risk ratios, we find a similar pattern: Canadian clean tech firms did not yield stellar performance, and underperformed their U.S. counterparts, but the Canadian energy firms performed quite well overall and even compared to their U.S. counterparts.

In terms of external financing patterns, we found that equity financing was a greater source of capital for clean tech firms than debt financing. This is expected since clean tech firms are generally earlier stage, growth oriented, more uncertain and less profitable, thus making debt financing costly. The magnitude of equity financing for clean tech firms was substantially higher in the U.S. compared to Canada. This is not surprising since the U.S. has the world's deepest equity markets and institutional investors who are better informed about the clean tech industry. These two driving factors have historically made scaling up business operations easier for U.S. clean tech firms, given the relative ease of access to equity and debt financing to fund operations. This relative contrast in depth and sophistication between the U.S. and Canadian markets in turn poses a challenge for the Canadian clean tech sector. The U.S. advantage will only become more pronounced with the U.S. market reacting to the Inflation Reduction Act (IRA) that was passed into law in the U.S. in 2022, offering funding, programs, and incentives to accelerate the transition to a clean energy economy. The IRA achieves this objective by leveraging several instruments including

new tax codes, grant programs, and other incentives, to achieve a wholesome program design balancing numerous policy objectives. For example, the IRA introduces the Investment Tax Credit (ITC) and Production Tax Credit (PTC), which allow taxpayers to deduct a percentage of the cost of renewable energy systems from their federal taxes. From an environmental justice perspective, IRA Section 48(e) offers new access to clean energy tax credits with an emphasis on reaching disadvantaged populations and communities with environmental justice concerns.

In view of the advantages that the U.S. has, it is of utmost importance for Canada to have a predictable, stable, and clear regulatory environment. The IRA certainly provides numerous examples of approaches and policy instruments that could be applied to the Canadian context to enhance Canada's regulatory environment, thereby providing a competitive local market for Canadian market participants. This would provide the certainty that investors and companies need to continue to invest in Canada. The sudden moratorium on renewable energy that was announced in Alberta was not helpful in this regard. This development has been particularly impactful in a negative way since Alberta has quickly become a renewables hotbed in Canada. The opportunities in this region certainly exist, however there is no room for increased regulatory risks.

Energy firms in Canada and the U.S. didn't attract much external capital during the period of our study, partly due to climate change and energy transition concerns. In both countries, energy firms used more debt financing than equity financing, as is expected from mature firms. In 2021 and 2022 the profitability for energy firms was so high that there was very little need for external financing in both countries. A major challenge for energy firms going forward is to determine how to reduce greenhouse gas (GHG) emissions, especially if the price of emissions continues to increase and the demand for oil peaks within the next 10 to 15 years. GHG emission mitigation investments will put limitations on stock repurchases as more of the cash flows are needed to finance those investments.

2. Introduction

Canada is the fourth largest oil producing nation and the sixth largest natural gas producing nation in the world. Oil and gas are Canada's most significant exports. The transition over the next several decades to renewable energy is an issue of utmost importance to this country. The stakes couldn't be higher: If the complex process of energy transition that is ahead of us, combined with concerns over energy security, is not managed well, the economic consequences to Canada will be severe. However, if the transition is successful, Canada could emerge as a renewable energy and clean tech superpower with widespread sustainable prosperity.

Despite the tremendous growth in clean energy globally and its importance for future prosperity, Canadian clean tech companies tend to experience slower growth and raise less capital than their U.S. and European counterparts. The passing of the Inflation Reduction Act in the U.S. makes the accessibility to and price of financing even a larger concern for Canadian firms than it was before. Scaling up clean energy technologies in order to produce a globally relevant clean energy sector in Canada will require large amounts of capital investment with long horizons and unique risks. For this reason, it is essential to better understand various financing avenues for Canadian clean tech companies. One of the important avenues is through the public markets.

In this report, employing data from January 2018 to December 2022, we focus on the Canadian listed clean tech sector and compare it with its U.S. counterpart as well as with the Canadian and U.S. listed oil and gas sector. We take a financial markets perspective and investigate publicly traded energy and clean tech firms' market valuations, profitability, stock returns, risk and financing activities. The U.S. is a good

comparison for Canada. The U.S. economy is based more on high-tech and intangible assets than the Canadian economy, so in that respect the U.S. provides an aspirational benchmark for Canada. At the same time, the U.S. has a significant oil and gas sector, which faces many of the same transition challenges and issues as Canada's energy sector.

We find the valuations for clean tech companies to be higher than the valuations for energy companies in both Canada and the U.S. This indicates that the clean tech sector attracted considerable attention from investors, especially before 2021. Financial markets, however, clearly viewed the industry as a growth sector even in 2022. However, within the clean tech sector, Canadian listed clean tech firms experienced relatively modest increases in valuation compared to their U.S. counterparts, and valuations in Canada peaked in 2020. This implies that the growth prospects for U.S. clean tech firms are better than their Canadian counterparts and that investor enthusiasm for clean tech in Canada has cooled off lately.

The energy sector valuations for both countries are very modest. The increase in stock prices during the past three years has occurred because of an increase in transitory profits, not better growth prospects. The low valuations are likely due to expectations that the high level of profits will not last long, and that the assets are at risk of becoming stranded, i.e. quickly losing their ability to generate cash flows at some point in the future. High cost of capital and limited access to financing likely play a role in low valuations. It is fair to say that the sector is mature with stable current profitability, but there is a great deal of uncertainty regarding profitability and cash flows in the long term. Interestingly, the Canadian energy firms are more highly valued than their American counterparts based on multiples. This finding goes against the popular opinion among pundits that firms in the U.S. always obtain higher valuations than their Canadian counterparts. It seems that the Canadian energy sector may have a better and longer lasting future than the U.S. one.

In terms of stock returns, both the U.S. and Canadian clean tech firms experienced positive abnormal (i.e. market and risk adjusted) returns since 2018, making them good investments. The performance for U.S. firms, however, was clearly superior to those in Canada. U.S. firms' abnormal returns were excellent, even after the beginning of 2020. On the contrary, Canadian clean tech firms saw a correction in stock prices since the beginning of 2022, resulting in lower abnormal returns overall for the period of 2020-2022.

Canadian energy firms had positive abnormal returns during the full period from January 2018 to December 2022. The sector exhibited stronger momentum starting from the latter part of 2020 and further increasing abnormal returns due to the war in Ukraine, making up for the preceding leaner years. The U.S. energy firms experienced lower performance than their Canadian counterparts from January 2018 to December 2022, but similarly to Canada, experienced stronger returns since the middle of 2020, and accelerating good performance since the war in Ukraine started.

The volatilities (i.e. the variability of stock returns, measured by the standard deviation) for both the energy and clean tech firms were high in Canada. The high volatilities were also reflected in the risk-return relation. The return-to-risk ratio for Canadian energy stocks was low for the full period of 2018-2022. The monthly return-to-risk ratio was around 0.7 for the period of our study, which is considered inadequate for investing. However, after 2020 the return-to-risk ratio for Canadian energy stocks was clearly over 1, making them good investments given the portfolio risk. The Canadian clean tech stocks had surprisingly low return-to-risk ratios for the full period, due to the high volatilities and lower returns than for the energy sector. Consequently, return-to-risk ratios confirm that Canadian clean tech stocks were disappointing investments.

The volatilities for the U.S. clean tech stocks were very high, and much higher than for the corresponding sector in Canada. Despite this fact, the return-to-risk ratio was much higher for the U.S. clean tech stocks,

reflecting the strong returns for these stocks in the U.S. The volatilities for U.S. energy stocks were also surprisingly high. This resulted in low return-to-risk ratios for the energy stocks for the whole sample period. The return-to-risk ratios were even disappointing for the period since 2020.

We find Canadian listed clean tech firms were financed pre-dominantly through equity, as expected for a growth sector. The exception is the year 2022, when equity financing for clean tech firms dried up. On the other hand, when the energy firms needed external financing, they turned to debt. This was evident in 2020, which was an extremely challenging year for energy firms because of the COVID-induced lower demand for oil and gas. In that year, energy firms issued relatively more debt than in any other year in our period of study. The external equity financing for Canadian energy firms was very low – practically non-existent. This is consistent with the view that difficult market conditions and concerns about carbon emissions made it almost impossible for Canadian energy firms to attract equity capital.

The U.S. clean tech firms attracted a significant amount of equity capital, especially in 2020 and 2021, and much more in relative terms than the Canadian clean tech firms. Given the relatively vast amounts of capital, the U.S. is well known for its ability to scale up firms, and the financing patterns support this notion. As in Canada, the U.S. energy firms were predominantly debt financed when external financing was needed. This was especially true in 2020, just like in Canada.

Overall, our results indicate that clean tech firms attain higher multiples in the stock market, since they are viewed as a growth sector. This is especially true for the clean tech firms in the U.S., whose valuations were considerably higher than the clean tech valuations in Canada. The market correction towards the end of our period of study for clean tech firms resulted in lower returns for those firms compared to the energy sector in Canada. The situation in the U.S. was, however, very different from Canada, despite the correction in clean tech firm valuations. The stock performance for clean tech firms in the U.S. remained strong: The clean tech firms had very high multiples, high returns and strong ability to attract external financing.

The traditional energy sector in both countries obtained low valuations in every year in our study, despite the growing profits. This is likely due to the expectations in the financial markets that the high profits may not last long, and that they are risky, with a real chance of many of these assets becoming stranded sometime in the future. Thus, the verdict from the markets is that the traditional energy sector is a mature sector with stable cash flows in the short-term, but uncertain profits in the long-term. The interesting question is how fast the sector's profits will decline. For Canadian and U.S. provinces and states, like Alberta and Texas, that are dependent on the energy sector, the hope is that the decline in profits will be slow and that it will last several decades.

3. Methodology and Data Sources

Our analysis focuses on clean tech and traditional hydrocarbon energy firms listed on the Canadian and U.S. stock exchanges. The availability and accessibility of market and financial information allows us to assess and compare various aspects of these firms' financial and market performance.

For our analysis, Canadian clean tech firms, Canadian energy firms, U.S clean tech firms, and U.S. energy firms are grouped into four distinct portfolios. We then compare the performance of these four portfolios.

Our period of analysis begins in January 2018 and ends in December 2022. We also provide a sub-period analysis for the period 2020-2022 to examine the effects of the pandemic period and the Russia-Ukraine war.

The list of clean tech companies and energy companies on the TSX was obtained directly from the TMX group, whereas the list of U.S. renewable and clean tech and energy companies was obtained from Thomson Refinitiv Eikon (based on their TRBC business sector classification).

Monthly returns, market values and accounting information for both Canadian and U.S. firms were obtained from Thomson Refinitiv Eikon and Datastream. All stock and crude oil indices are from Thomson Refinitiv Eikon. External financing activities (equity and debt issuances) were obtained from Thomson Refinitiv Eikon and FP Advisor for U.S. and Canadian firms, respectively.

Our clean tech portfolio includes manufacturers of equipment, project developers and operating companies in the clean tech space. Our energy portfolio includes oil and gas companies (both upstream and downstream). The list of companies can be found in the Appendix.

4. Valuation Metrics for the Clean Tech and Energy Sectors

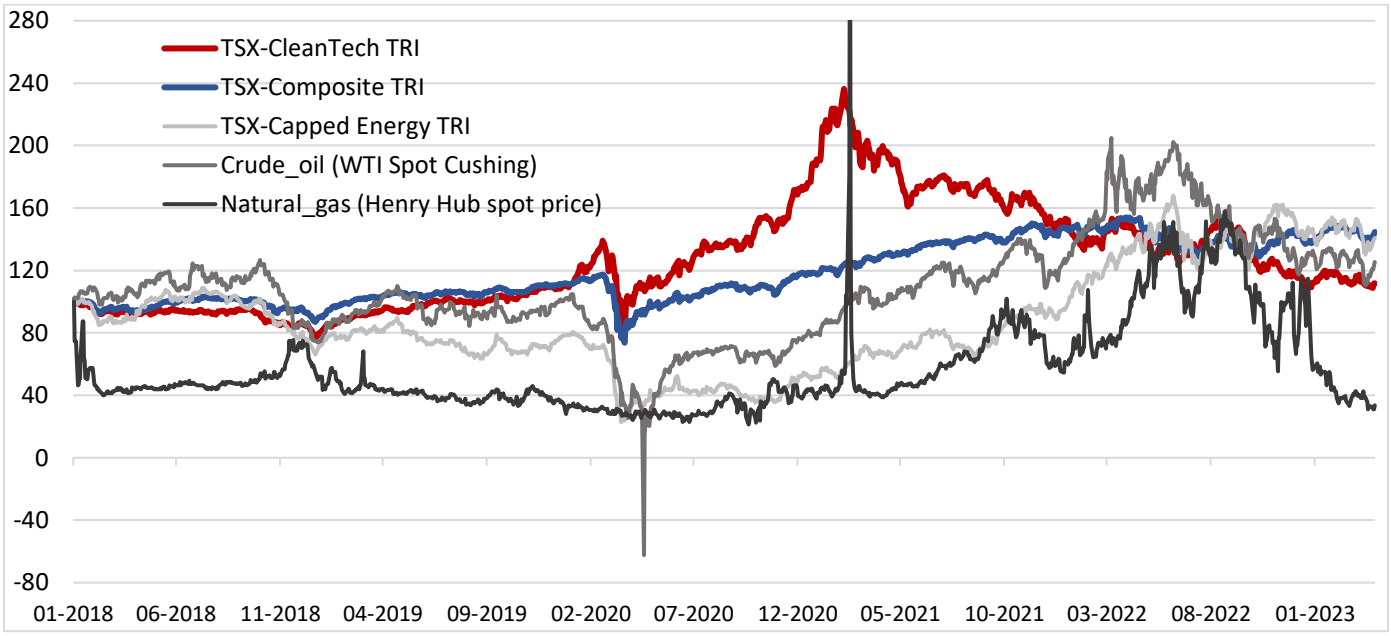
4.1. Performance of Sector and Market Indices

In Panel A of Figure 1, we investigate the performance of the TSX Clean Tech Index, the TSX Composite Index, the TSX Energy Index, as well as crude oil and natural gas prices from January 2018 to December 2022. We set the base level for all indices in January 2018 to 100. All indices are based on total returns (i.e. including dividends).

In the period 2018-2019, the TSX Composite and the TSX Clean Tech indices performed similarly and did not exhibit notably positive performance. The TSX Capped Energy Index mostly underperformed these indices. Not surprisingly, all the indices, as well as crude oil prices, plunged in the second quarter of 2020, due to the onset of the COVID-19 pandemic.

In the second half of 2020, all the indices rebounded, with the TSX Clean Tech Index exhibiting strong performance. The Clean Tech Index continued its rally through to early 2021, increasing over 100% from its bottom. Since the second half of 2021, the Clean Tech Index corrected downward, and in the latter half of 2022, underperformed the broader market. The strong clean tech returns in the latter half of 2020 are consistent with the market's focus on sustainability and climate change after the pandemic lows. On the other hand, the energy sector exhibited a more modest increase soon after the pandemic lows but exhibited strong performance in 2021 and the first half of 2022. The recent relative strength was fueled by global recovery from the pandemic and the outbreak of the Russia-Ukraine war, which has put upward pressure on energy prices due to supply-side concerns. As seen in Figure 1, crude oil and natural gas prices peaked in 2022 (noting there was also a temporary and isolated brief spike in February 2021 for natural gas prices due to the severe winter storm in Oklahoma and Texas), so that the returns performance for the energy sector surpassed the returns performance of the clean tech sector by the end of the sample period.

Figure 1, Panel A: The TSX Clean Tech, TSX Composite and TSX Energy Indices, and Crude Oil and Natural Gas Prices from Jan 2018-Jan 2023. (The base on Jan 2018 is set to 100. All indices are the total return index).

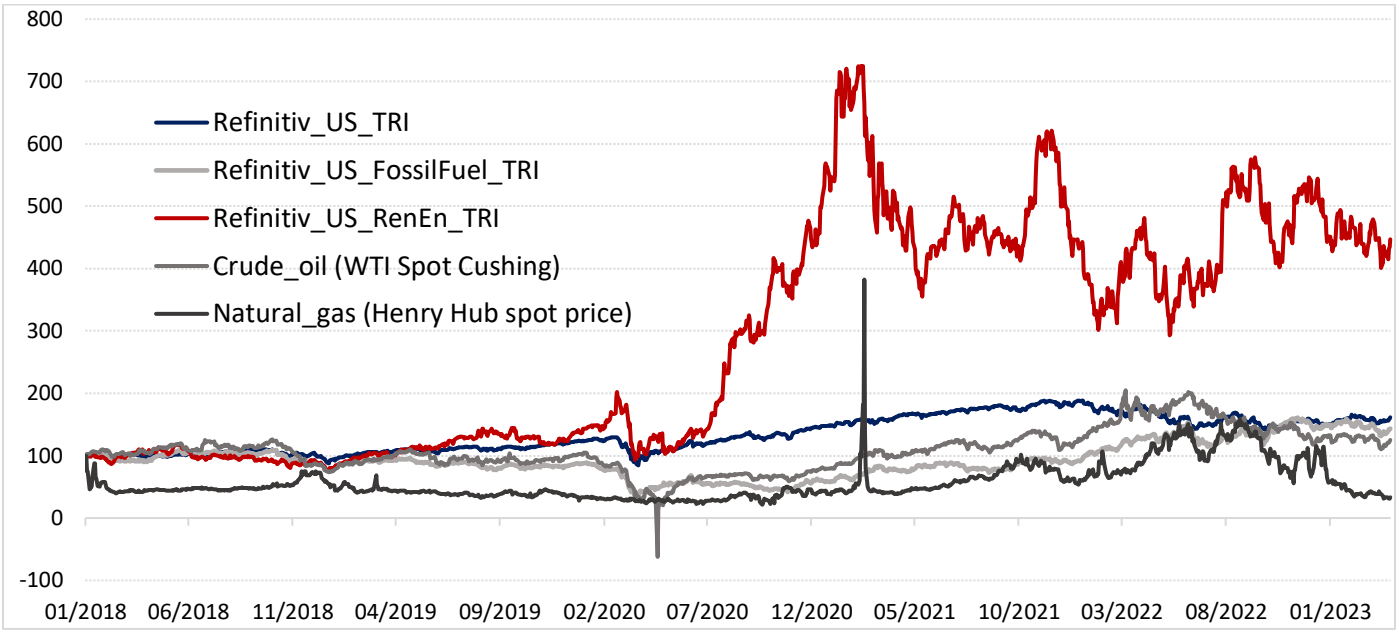


Source: Refinitiv Eikon, EIA

Panel B of Figure 1 presents the results for the U.S. We find that the Clean Tech, Energy, and Market indices had modest and similar performance in the pre-pandemic period. Not surprisingly, all the indices crashed during the onset of the pandemic in early 2020, as they did in Canada and other markets around the world. Coming out of the pandemic lows, in the latter half of 2020 and the beginning of 2021, the U.S. clean tech sector exhibited stellar performance, rising over 600% from its bottom. The index subsequently crashed from its peak in early 2021 but performed on par with the broader market after that. Interestingly, even as crude oil prices spiked in 2022, the U.S. energy sector did not perform particularly well. Total returns were near or lower than the market, and certainly lower than the clean tech sector's total returns.

Overall, the story in Canada and the U.S. are different. In Canada, the total returns for the energy, clean tech, and broader market were quite similar for the overall period from January 2018 to December 2022. In the U.S., total returns for energy firms were lower than the market, which is not surprising given the tech-heavy U.S. market index. Meanwhile, the clean tech sector in the U.S. outperformed the market significantly during the sample period.

Figure 1, Panel B: The Refinitiv U.S. Total Return Index, Refinitiv Energy-Fossil Fuel Total Return Index, Refinitiv Renewable Energy Total Return Index, and Crude Oil Price from January 2018 to January 2023. (The base on Jan 2018 is set to 100. All indices are the total return index).



Source: Refinitiv Eikon, EIA

4.2. Valuation

In this section, we investigate various valuation measures for the Canadian and U.S. clean tech and energy companies in our sample.

In Panel A of Table 1, we see that the total market value and enterprise value (EV) of the portfolio of listed Canadian clean tech companies grew significantly from 2018 to 2022. In particular, the total market value of all listed clean tech companies increased from just over CAD $30 billion in 2018 to over CAD $51 billion in 2022, or an almost 70% increase over the 5-year period. Similarly, the total enterprise value of clean tech companies increased from CAD $75 billion in 2018 to over CAD $139 billion in 2022, or roughly an 86% increase over the 5 years. While the market and enterprise values peaked at the end 2020, the increase from the 2018 levels was still substantial.

Moreover, we can attribute the growth in these valuations to an increase in company share prices rather than the number of newly listed companies, since the total number of clean tech companies on the TSX did not change much from 2018 to 2022.

In terms of operating performance, both sales and EBITDA steadily increased from 2018 to 2022, indicating that the sector was gaining operational traction as well. In terms of valuation multiples, we saw an increase in the relative valuation measures EV/sales and EV/EBITDA over the 5-year period. However, the valuation multiples came down from the 2020 highs, when investors were exuberant about the prospects of the clean tech sector. Nevertheless, the increase in the market and relative valuations over the entire sample period still implies positive investor growth expectations for the clean tech sector.

Table 1, Panel A: Market Value and EV/Sales for Canadian Listed Clean Tech Stocks

	Total Market Value (CAD mil)	Enterprise Value (EV) (CAD mil)	Sales (CAD mil)	EBITDA (CAD mil)	Book Value of Net Debt (CAD mil)	Book Value of Equity (CAD mil)	EV/Sales	EV/EBITDA
Year end 2022	51,299	139,465	29,870	12,215	88,166	39,367	4.67	11.42
Year end 2021	81,351	160,496	26,659	10,365	79,146	36,898	6.02	15.48
Year end 2020	98,358	171,759	26,593	7,180	73,401	29,864	6.46	23.92
Year end 2019	43,452	102,822	22,573	8,407	59,370	23,687	4.56	12.23

Year end 2018	30,292	75,141	20,321	7,532	44,849	22,548	3.70	9.98

Note: Total Market Value is the sum of the market value of all clean tech companies. EV/Sales is the sum of all EV divided by the sum of all sales. The sum is calculated for all companies with no missing market value and sales value.

As seen in Panel B of Table 1, there was a bumpier increase in market valuations and operating performance for the Canadian energy companies from 2018 to 2022. Unlike the clean tech sector, we saw a rather sharp decline in operating performance and market valuations in 2020, which coincided with the worst of the pandemic economic downturn, particularly for energy prices. However, since the sales and EBITDA values exhibited a more dramatic decline compared to market prices, the relative valuations (EV/Sales and EV/EBITDA) were higher in 2020 compared to other years. Overall, the relative valuations of the energy sector did not quite reach their 2018 levels by the end of 2022.

What is striking is that in Canada, clean tech companies experienced higher relative valuations compared to energy companies. Considering both EV/sales and EV/EBITDA as our relative valuation measures, in the last two years we found clean tech valuations that were about two times greater than that of energy companies. This shows that the growth expectations for the Canadian clean tech companies remain robust, even if valuations peaked in 2020, and that the markets appeared pessimistic about the long-term prospects of the energy companies.

Table 1, Panel B: Market Value and EV/Sales for Canadian Listed Energy Stocks

	Total Market Value (CAD mil)	Enterprise Value (EV) (CAD mil)	Sales (CAD mil)	EBITDA (CAD mil)	Book Value of Net Debt (CAD mil)	Book Value of Equity (CAD mil)	EV/Sales	EV/EBITDA
Year end 2022	677,738	1,007,407	386,000	169,295	329,668	421,019	2.61	5.95
Year end 2021	566,919	899,220	281,125	107,515	332,302	385,361	3.20	8.36
Year end 2020	372,690	685,998	207,163	62,192	313,308	333,091	3.31	11.03
Year end 2019	502,606	806,821	267,314	89,675	304,215	376,453	3.02	9.00
Year end 2018	429,579	732,953	265,017	86,655	303,374	372,078	2.77	8.46

Note: Total Market Value is the sum of the market value of all energy companies. EV/Sales is the sum of all EV divided by the sum of all sales. The sum is calculated for all companies with no missing market value and sales value.

Turning to the U.S. data in Panels C and D of Table 1, we see a much more dramatic picture emerge overall. The market and relative valuations of clean tech companies rose substantially from 2018 to 2022: In 2018, the market value (enterprise value) for the sample of clean tech companies was USD $11.7 billion (USD $13.5 billion), and in 2022 it rose to USD $85.2 billion (USD $94.8 billion). Meanwhile, the operating performance numbers are rather interesting. In particular, while the sales values increased from USD $14.8 billion to USD $22.8 billion from 2018 to 2022, the EBITDA values for clean tech firms actually declined into negative territory from USD $799 million in 2018 to USD $-10 million in 2022. The main reason for this significant decrease in profitability was increasing costs, especially for some minerals and metals, such as lithium and cobalt. Consequently, the EV/EBITDA multiple was undefined in 2022 (due to the negative EBITDA), even though it was increasing significantly from 2018 to 2021. More importantly, the EV/Sales multiple saw a substantial increase from 0.91 in 2018 to 4.15 in 2022 – a 351% increase.

Table 1, Panel C: Market Value and EV/Sales for U.S. Listed Clean Tech Stocks

	Total Market Value (USD mil)	Enterprise Value (EV) (USD mil)	Sales (USD mil)	EBITDA (USD mil)	Book Value of Debt (USD mil)	Book Value of Equity (USD mil)	EV/Sales	EV/EBITDA
Year end 2022	85,225	94,805	22,820	-10	9,580	24,958	4.15	neg
Year end 2021	84,819	89,069	20,680	797	4,250	25,313	4.31	111.70
Year end 2020	90,249	94,781	15,781	1,018	4,532	18,786	6.01	93.12
Year end 2019	18,957	21,011	16,091	1,138	2,054	10,838	1.31	18.46

Year end 2018	11,684	13,479	14,762	799	1,786	9,587	0.91	16.85

Note: Total Market Value is the sum of the market value of all clean tech companies. EV/Sales is the sum of all EV divided by the sum of all sales. The sum is calculated for all companies with no missing market value and sales value.

Examining the relative valuations of U.S. energy firms, we find that they declined from 2018 to 2022. In particular, the EV/Sales multiple declined slightly from 1.32 to 1.18 over this period, and the EV/EBITDA multiple declined from 7.51 to 5.45 over the sample period. Comparing the U.S. clean tech and energy sectors, we found that since 2020, the clean tech sector was valued more than three times the energy sector when using EV/sales as the relative valuation measure. The comparison using EV/EBITDA is trickier since the U.S. clean tech firms have become unprofitable overall. But certainly prior to 2022, the U.S. clean tech sector experienced more than 10 times the valuation of the U.S. energy sector. These are major differences and clearly show the market's upbeat growth expectations for the clean tech sector.

Table 1, Panel D: Market Value and EV/Sales for U.S. Listed nergy Stocks

	Total Market Value (USD mil)	Enterprise Value (EV) (USD mil)	Sales (USD mil)	EBITDA (USD mil)	Book Value of Debt (USD mil)	Book Value of Equity (USD mil)	EV/Sales	EV/EBITDA
Year end 2022	2,321,536	2,823,561	2,390,001	518,389	502,024	983,732	1.18	5.45
Year end 2021	1,563,094	2,141,157	1,609,688	290,308	578,062	857,847	1.33	7.38
Year end 2020	1,018,780	1,673,824	1,002,687	160,398	655,044	754,998	1.67	10.44
Year end 2019	1,553,584	2,166,383	1,343,225	242,421	612,799	953,912	1.61	8.94
Year end 2018	1,445,320	1,984,831	1,504,224	264,423	539,511	963,935	1.32	7.51

Note: Total Market Value is the sum of the market value of all clean tech companies. EV/Sales is the sum of all EV divided by the sum of all sales. The sum is calculated for all companies with no missing market value and sales value.

Overall, the results raise some interesting points. Clean tech is clearly a growth industry, and the valuations grew significantly in both Canada and the U.S. While the EV/sales measure was quite similar in both countries, EV/EBITDA were much higher in the U.S. This shows that financial markets in the U.S. were willing to bet on the long-term prospects of growth companies, but Canadian investors valued current profits more. In other words, financial markets were more confident that the U.S. firms would be able to scale up successfully going forward, whereas Canadian clean tech firms would be facing less lucrative futures.

It is also clear from the valuation numbers that the energy sector is mature or perhaps even a declining industry in both Canada and the U.S. The lower valuations are due to expected low cash flows going forward and/or high discount rates. Specifically, the markets were likely pricing cash flow challenges and policy and demand uncertainty in the future. In addition, the discount rate for energy firms was high, due to the risks of transition to clean and renewable energy. In other words, the markets seemed to believe that a significant amount of Canadian and U.S. oil and gas assets are in danger of becoming stranded some time in the future.

It is also worthwhile to note that the relative valuations of Canadian energy firms were generally higher than those of U.S. energy firms. In the Canadian media, we typically hear that U.S. energy firms are valued higher than Canadian firms relative to their profits. While that may have been true in the past, the data does not support this narrative for our specific sample and period of analysis.

5. Stock Returns and Risk Characteristics for Clean Tech and Energy Stocks

We examine the annualized abnormal returns for clean tech and energy firms in Table 2 below. We present the returns results for the full sample period (2018-2022), as well as for the period after the start of the pandemic (2020-2022). We computed returns based on cumulative abnormal returns (CARs) and buy-and-hold abnormal returns (BHARs), the detailed definition of which can be found in the Appendix[1]. Since these are abnormal returns, they are above and beyond the market returns. We also computed the portfolio returns on an equal-weighted and value-weighted basis.[2]

In Panel A of Table 2, we find that the Canadian clean tech firms earned strong returns by beating the market in both the full sample period as well as in the period 2020-2022. Specifically, in the full sample period the average annualized CAR was 8.2% on an equal-weighted basis, and 6.9% on a value-weighted basis. In terms of the BHARs, the average equal-weighted performance was 8.0% and the average value-weighted performance was 7.7%. Since 2020, the returns performance was also positive: The average equal-weighted (value-weighted) CAR was 9.4% (3.2%), and the average equal-weighted (value-weighted) BHAR was 7.1% (1.6%).

Table 2, Panel A: Abnormal Returns for Canadian Listed Clean Tech Stocks

	Annual Cumulative Abnormal Return (CAR)	Annual Buy-and-Hold Abnormal Return (BHAR)
Jan2018 – Dec2022		
Listed clean tech stocks (EW portfolio)	8.2%	8.0%
Listed clean tech stocks (VW portfolio)	6.9%	7.7%
Jan2020 – Dec2022		
Listed clean tech stocks (EW portfolio)	9.4%	7.1%
Listed clean tech stocks (VW portfolio)	3.2%	1.6%

Turning to the Canadian energy stocks in Table 2 Panel B, we see stronger performance compared to the clean tech stocks during the full sample period as well as in the sub-period analysis. Much of the strength comes from the rebound in energy prices after the onset of global recovery in the post-pandemic period and the Russia-Ukraine war, which created energy supply-side disruptions. Specifically, for the full sample period, the average CAR was 18.2% on an equal-weighted basis and 10.3% on a value-weighted basis. For the 2020-2022 period, the returns were even stronger, as expected: The average equal-weighted CAR was 45.5% and the average value-weighted CAR was 19.5%. The results for the BHARs were very similar. Moreover, the stronger equal-weighted results compared to value-weighted results imply that there were some small-cap companies that performed very well.

Table 2, Panel B: Abnormal Returns for Canadian Listed Energy Stocks

	Annual Cumulative Abnormal Return (CAR)	Annual Buy-and-Hold Abnormal Return (BHAR)
Jan2018 – Dec2022		
Listed energy stocks (EW portfolio)	18.2%	13.5%
Listed energy stocks (VW portfolio)	10.3%	11.3%
Jan2020 – Dec2022		
Listed energy stocks (EW portfolio)	45.5%	46.3%

[1] Cumulative abnormal return (CAR) is the cumulative return in excess of the (respective) market return. Annual buy-and-hold abnormal return (BHAR) is the annualized buy-and-hold return in excess of the (respective) market returns.
[2] In an equal-weighted portfolio, all companies are allocated equal weight in the portfolio. In a value-weighted portfolio, companies are allocated weights based on their market capitalization relative to the market capitalization of the whole portfolio.

Listed energy stocks (VW portfolio)	19.5%	21.5%

In Panels C and D of Table 2, we present the results for the U.S. clean tech and energy sectors, respectively. As can be seen, U.S. clean tech firms exhibited remarkable performance. For the full sample, the average CAR was 31.3% on an equal-weighted basis, and 55.0% on a value-weighted basis. In terms of BHARs, the equal-weighted portfolio of clean tech stocks earned 62.9%, and the value-weighted portfolio earned 81.2%. Focusing on the 2020-2022 period, investors did similarly well. These are impressive numbers when we consider that these returns results are over and above the market performance.

Table 2, Panel C: Abnormal Returns for U.S. Listed Clean Tech Stocks

	Annual Cumulative Abnormal Return (CAR)	Annual Buy-and-Hold Abnormal Return (BHAR)
Jan2018 – Dec2022		
Listed clean tech stocks (EW portfolio)	31.3%	62.9%
Listed clean tech stocks (VW portfolio)	55.0%	81.2%
Jan2020 – Dec2022		
Listed clean tech stocks (EW portfolio)	27.2%	62.8%
Listed clean tech stocks (VW portfolio)	63.6%	94.8%

Table 2, Panel D: Abnormal Returns for U.S. Listed nergy Stocks

	Annual Cumulative Abnormal Return (CAR)	Annual Buy-and-Hold Abnormal Return (BHAR)
Jan2018 – Dec2022		
Listed energy stocks (EW portfolio)	12.5%	6.9%
Listed energy stocks (VW portfolio)	10.1%	9.1%
Jan2020 – Dec2022		
Listed energy stocks (EW portfolio)	34.8%	31.3%
Listed energy stocks VW portfolio)	24.4%	24.5%

We can see that the U.S. energy stocks also did reasonably well in both the full sample period and in the sub-sample period, though not nearly as well as the clean tech stocks. In particular, in the period 2018-2022, the average annualized CAR was 12.5% on an equal-weighted basis and 10.1% on a value-weighted basis. In terms of the annualized BHAR, the equal-weighted BHAR was 6.9% and the value-weighted BHAR was 9.1%. In the 2020-2022 sub-period, U.S. energy stocks performed particularly well, earning an equal-weighted (value-weighted) CAR of 34.8% (24.4%). The BHARs yielded similar results.

We cannot consider returns without considering portfolio risk. Thus, in Table 3 we report statistics on the risk-return relationship.

Panel A of Table 3 presents the results for the Canadian clean tech stocks. At first look it seems that the mean returns were reasonably high, both for the equal-weighted and value-weighted portfolios. However, the volatilities (measured by the annualized standard deviation of returns) were also high for Canadian clean tech stocks. Consequently, the Sharpe ratios (excess returns per unit of volatility) turned out to be low. The annualized Sharpe ratios were between 0.44 and 0.66 depending on the period of analysis and the portfolio. These numbers were low in general, since typically a Sharpe ratio between one and two is considered to be good. However, the Sharpe ratios for clean tech stocks are in line and even

slightly higher than the broader Canadian market, as the annualized Sharpe ratio for the TSX Composite Index during the same period was around 0.47.

Table 3, Panel A: Mean Return, Standard Deviation, and Sharpe Ratios for Canadian Listed Clean Tech Stocks (Based on Monthly Returns)

	Annualized Mean Return	Annualized Standard Deviation	Annualized Sharpe Ratio
Jan2018 - Dec2022			
Listed clean tech stocks (EW portfolio)	17.4%	27.3%	0.60
Listed clean tech stocks (VW portfolio)	15.9%	22.3%	0.66
Jan2020 - Dec2022			
Listed clean tech stocks (EW portfolio)	19.8%	33.1%	0.57
Listed clean tech stocks (VW portfolio)	12.8%	26.9%	0.44

Note: The Sharpe ratio is calculated as the excess monthly return divided by the standard deviation of monthly returns, where the average monthly excess return equals the average monthly return minus the average monthly risk-free return (as measured by monthly yield of 1-month T-Bill).

The returns for the Canadian energy stocks were quite good for our full period of study. Given the high volatilities, however, the Sharpe ratios were low. Thus, the risk-return tradeoff for energy stocks was unsatisfactory. The situation improved considerably for the period of 2020-2022. The stock returns increased significantly. Volatilities also increased for the energy stocks, but only moderately. Consequently, the Sharpe ratios improved for the latter period. They were above one in the recent period, indicating good risk-return performance.

Table 3, Panel B: Mean Return, Standard Deviation, and Sharpe Ratios for Canadian Listed nergy Stocks (Based on Monthly Returns)

	Annualized Mean Return	Annualized Standard Deviation	Annualized Sharpe Ratio
Jan2018 - Dec2022			
Listed energy stocks (EW portfolio)	29.5%	41.8%	0.68
Listed energy stocks (VW portfolio)	19.9%	25.3%	0.74
Jan2020 - Dec2022			
Listed energy stocks (EW portfolio)	70.2%	48.5%	1.43
Listed energy stocks (VW portfolio)	32.3%	29.5%	1.07

Note: The Sharpe ratio is calculated as the excess monthly return divided by the standard deviation of monthly returns, where the average monthly excess return equals the average monthly return minus the average monthly risk-free return (as measured by monthly yield of 1-month T-Bill).

Turning to the U.S. results in Panels C and D, the findings are somewhat surprising in that both clean tech and energy stock volatilities were higher for the U.S. stocks than for their Canadian counterparts. The returns for U.S. clean tech stocks were very high for the full period, but especially for the period of 2020-2022. However, we are particularly interested in the risk-return relation, and we do find the Sharpe ratios to be between one and two for clean tech stocks depending on the period of analysis. Thus, the Sharpe ratios indicate that the U.S. clean tech stocks were lucrative investments, especially for the period of 2020-2022. The U.S. energy stocks had comparable returns to Canadian energy stocks, but the U.S. volatilities were clearly higher. Thus, the Sharpe ratios were unsatisfactory in the full period, but reasonably good in the recent period for U.S. energy stocks. It is noteworthy that the Sharpe ratios for U.S. energy stocks were lower than the reported values for Canadian energy stocks. Therefore, consistent with our earlier results on returns and valuations, clean tech stocks were an attractive investment in the U.S., while the energy stocks' performance was average overall, but showed stronger performance more recently.

Table 3, Panel C: Mean Return, Standard Deviation, and Sharpe Ratios for U.S. Listed Clean Tech Stocks (Based on Monthly Returns)

	Annualized Mean Return	Annualized Standard Deviation	Annualized Sharpe Ratio
Jan2018 - Dec2022			
Listed clean tech stocks (EW portfolio)	52.1%	57.0%	0.89
Listed clean tech stocks (VW portfolio)	90.8%	57.0%	1.57
Jan2020 - Dec2022			
Listed clean tech stocks (EW portfolio)	105.0%	69.0%	1.51
Listed clean tech stocks (VW portfolio)	143.4%	69.4%	2.06

Note: The Sharpe ratio is calculated as the excess monthly return divided by the standard deviation of monthly returns, where the average monthly excess return equals the average monthly return minus the average monthly risk-free return (as measured by monthly yield of 1-month T-Bill).

Table 3, Panel D: Mean Return, Standard Deviation, and Sharpe Ratios for U.S. Listed nergy Stocks (Based on Monthly Returns)

	Annualized Mean return	Annualized Standard deviation	Annualized Sharpe ratio
Jan2018 - Dec2022			
Listed energy stocks (EW portfolio)	29.3%	48.0%	0.59
Listed energy stocks (VW portfolio)	25.3%	37.9%	0.63
Jan2020 - Dec2022			
Listed energy stocks (EW portfolio)	60.8%	56.8%	1.06
Listed energy stocks (VW portfolio)	44.2%	44.9%	0.97

Note: The Sharpe ratio is calculated as the excess monthly return divided by the standard deviation of monthly returns, where the average monthly excess return equals the average monthly return minus the average monthly risk-free return (as measured by monthly yield of 1-month T-Bill).

Overall, investors in Canadian clean tech stocks earned good, but not great, returns and outperformed the market since 2018, making them solid investments. In the U.S. clean tech returns were extraordinarily high and superior to Canadian ones. Canadian energy firms did exceptionally well, especially since 2020, mainly due to the recent rise in commodity prices. The U.S. energy firms did not perform as well, but similarly to Canada exhibited stronger performance in the post-pandemic period.

6. Financing for Clean Tech and Energy Firms

In this section, we explore the financing activities for the sample of clean tech and energy firms in Canada and the U.S.

As we report in Panel A of Table 4 below, equity financing increasingly became an important source of financing for Canadian clean tech firms, peaking in 2021 and then dropping off significantly in 2022. Specifically, in 2019, Canadian clean tech firms raised CAD $1.4 billion in gross proceeds from equity financing, which increased to CAD $4.4 billion in 2021, but then fell to CAD $361 million in 2022. Not surprisingly, this is the same year that market valuations for clean tech firms declined significantly. The major reason for the decline in market valuations was the increase in interest rates and risk premia, because growth companies' valuations are sensitive to changes in discount rates. This resulted in the reduced appetite for equity financing. In terms of debt financing, we see a complimentary pattern emerging. Canadian clean tech firms reduced their reliance on debt financing through to 2021, when equity financing was readily available, because of high stock prices. Then the firms increased the use of

debt financing in 2022, when stock prices for clean tech firms crashed and equity financing plummeted. Specifically, in 2019, Canadian clean tech firms raised CAD $1.9 billion in gross proceeds from debt financing, which fell to CAD $370 million in 2021, and then increased to CAD $1.6 billion in 2022.

We found that Canadian energy firms were mostly debt financed. As we report in Panel A of Table 4, the gross proceeds from debt financing grew from a rather high CAD $15.6 billion in 2019 to CAD $18.4 billion in 2021, and then fell to CAD $12.2 billion in 2022. As a percentage of enterprise value, this amounts to over 2% in 2020 and 2021. Especially in 2020, which was an extremely challenging year for energy firms, we found the highest use of debt financing and lowest use of equity financing. Indeed, the external equity financing for energy companies was almost non-existent in 2020. This is consistent with the difficult market fundamentals and ESG concerns faced by Canadian energy firms, which made it nearly impossible to raise equity financing.

Table 4, Panel A: External Financing for Canadian Listed Clean Tech and nergy Companies

	Equity Financing		Debt Financing			Equity Financing		Debt Financing	
	Gross Proceeds (CAD mil)	% of EV	Gross Proceeds (CAD mil)	% of EV		Gross Proceeds (CAD mil)	% of EV	Gross Proceeds (CAD mil)	% of EV
Clean tech	**2022**				Energy	**2022**			
	361	0.26%	1,565	1.12%		2,572	0.26%	12,241	1.22%
Clean tech	**2021**				Energy	**2021**			
	4,413	2.75%	370	0.23%		2,104	0.23%	18,445	2.05%
Clean tech	**2020**				Energy	**2020**			
	1,600	0.93%	1,090	0.64%		336	0.05%	19,600	2.86%
Clean tech	**2019**				Energy	**2019**			
	1,420	1.38%	1,920	1.87%		828	0.10%	15,600	1.93%
Clean tech	**2018**				Energy	**2018**			
	983	1.31%	325	0.43%		1,759	0.24%	9,002	1.23%

Note: Gross Proceeds is the sum of all gross proceeds by type of financing and group of stocks. % of EV is the total gross proceeds as a percentage of total enterprise value (EV) for the corresponding group.

In the U.S., the numbers are even starker for clean tech firms, with gross proceeds from equity financing rising from USD $135 million in 2019 to USD $6.4 billion in 2021. Similarly to Canada, in 2022 equity financing for clean tech firms fell sharply, totaling only USD $674 million. We see a similar pattern for debt financing, although much lower dollar values than for equity financing: In 2019, U.S. clean tech firms raised USD $120 million in gross proceeds from debt financing, which increased to USD $1.5 billion in 2021, and then dropped precipitously to USD $14 million in 2022. Overall, we see that equity financing was a much greater source of capital for U.S. clean tech firms than debt financing.

As in Canada, debt financing plays a dominant role in U.S. energy firms. Particularly in 2020, which was also a difficult year for U.S. energy firms, we saw debt financing spike, and equity financing drop significantly. This was not surprising as U.S. energy firms also faced the same ESG risks as Canadian firms, so the patterns in the two countries were similar.

Table 4, Panel B: External Financing for U.S. Listed Clean Tech and nergy Companies

	Equity Financing		Debt Financing			Equity Financing		Debt Financing	
	Gross Proceeds (USD mil)	% of EV	Gross Proceeds (USD mil)	% of EV		Gross Proceeds (USD mil)	% of EV	Gross Proceeds (USD mil)	% of EV
Clean tech	**2022**				Energy	**2022**			
	674	0.71%	14	0.01%		3,308	0.12%	17,768	0.63%
Clean tech	**2021**				Energy	**2021**			

	6,364	7.15%	1,525	1.71%		7,156	0.33%	27,576	1.28%
Clean tech		**2020**			Energy		**2020**		
	4,374	4.61%	520	0.55%		1,615	0.10%	74,923	4.46%
Clean tech		**2019**			Energy		**2019**		
	135	0.64%	120	0.57%		5,711	0.26%	38,768	1.78%
Clean tech		**2018**			Energy		**2018**		
	82	0.61%	160	1.19%		8,796	0.44%	30,612	1.54%

Note: Gross Proceeds is the sum of all gross proceeds by type of financing and group of stocks. % of EV is the total gross proceeds as a percentage of total enterprise value (EV) for the corresponding group.

7. Challenges and Conclusions

According to the IEA[3], clean energy investments (including nuclear) are extending their lead over fossil fuel investments, on course to reach USD $1.7 trillion in 2023, compared to USD $1.1 trillion going into fossil fuels. To remain prosperous in the long run, it is imperative that Canada become a lucrative destination for clean tech investments, which will only continue to grow in the decades to come. In this report, we have taken a financial markets approach and compared the clean tech and energy sectors' financial performance in Canada and the U.S. over the 2018-2022 period.

In both countries, the data clearly points to a market that is valuing the growth prospects of the clean tech sector, especially compared to the traditional energy sector. However, the valuations are significantly higher in the U.S. for clean tech companies, which suggests that the market sees better long-term prospects for the sector in the U.S. The numbers in the data certainly bear this out, including U.S. stock return performance for clean tech stocks that have outpaced and outperformed their Canadian counterparts. The investor community has also stepped up, with U.S. firms accessing large amounts of equity capital, even on a relative basis, compared to Canada. This story is not new to Canadians, since the U.S. is known for its ability to scale up businesses, especially in the innovation space. The Canadian track record of scaling up is mixed at best. The gap between Canada and the U.S. is likely to grow in the coming years. After one year of its passing, the IRA has already accelerated investments in clean tech in the U.S. Canadian tax credits for clean tech are also substantial, but they don't seem to have the same positive effect on investments as the IRA has had in the U.S. One reason for this could be that the rules for Canadian tax credits and other incentives are deemed to be more complex than those in the U.S. Thus, the problem is not Canadian policy for energy transition per se, but rather the complex implementation and lack of clarity. In addition, disagreements between the federal government and some provincial governments create uncertainty that has a negative impact on investments. Political uncertainty coupled with more risk averse business attitudes compared to the U.S. is creating unnecessary hurdles for the commercialization of clean tech innovations. This should be concerning to Canada, as Canadian clean tech firms might be tempted to locate their operations south of the border. Consequently, Canadian taxpayer-funded start-ups may end up creating more wealth in the U.S. than in Canada.

While competing with the U.S. for clean tech investments is a challenge, Canada should continue to embrace the opportunities ahead. Achieving significant GHG emission reductions will require public sector financial participation and incentives. Canada is making progress on this front, with the introduction of targeted tax credits and financing opportunities including through the Canada Infrastructure Bank. But the other side of the coin requires a predictable, stable, and clear regulatory environment. This would provide the certainty that investors and companies need to continue to invest in Canada. The sudden

[3] World Energy Investment 2023, International Energy Agency.

moratorium on renewable energy that was announced in Alberta is certainly not a good sign, especially since Alberta has quickly become a renewables hotbed in Canada. The opportunities are there, but there is no room for increased regulatory risks.

On the bright side, Canadian energy companies have recently experienced strong operating performance, and their valuations and stock return performance support this. Interestingly, Canadian energy firms have outperformed their U.S. counterparts, and are valued higher, which is counter to popular opinion among Canadian energy sector pundits. One reason for the more optimistic valuations is the impending completion of the Trans Mountain pipeline and the resulting increase in the capacity to export heavy oil from the oil sands. There is no doubt that the energy sector will continue to positively contribute to the Canadian economy at least in the medium run. However, if the Canadian energy sector is serious about reducing their GHG emissions, which will be critical in continuing to attract financing and generating profits in the long run, the sector needs to reinvest more of its profits in emission reducing technologies, rather than spending record amounts in stock repurchases. The finance sector in Canada has an important role to play in this regard as a large investor and creditor to the energy sector. Financial institutions should keep on engaging with energy firms, instead of divesting from them, and emphasize the urgency of reducing GHG emissions even at the expense of short-term profits. Thus, it is crucial that the energy and financial sectors work together in order to pave the way for a successful energy transition and prosperous future for Canada.

Appendix 1: Variable Definitions

Enterprise Value (EV)

Enterprise value is the sum of the market capitalization and net debt of the company.

EV/Sales

EV/sales is the sum of EV of all the stocks in the portfolio divided by the sum of sales of all the stocks in the portfolio.

EBITDA

EBITDA is earnings before interest, taxes, depreciation and amortization.

EV/EBITDA

EV/EBITDA is the sum of EV of all the stocks in the portfolio divided by the sum of EBITDA of all the stocks in the portfolio**.**

Annual BHAR

Annual buy-and-hold abnormal return is the annualized buy-and-hold return in excess of the (respective) market returns.

Buy-and-hold abnormal return (excess over market return) during a period is calculated using the following formula:

$$\boldsymbol{BHAR_{it} = \left[\prod_{t}^{T}(1 + r_{it}) - 1\right] - \left[\prod_{t}^{T}(1 + r_{mt}) - 1\right]}$$

Annual BHAR is calculated using the following formula:

$$\boldsymbol{ann\_BHAR = (1 + BHAR_{it})^{\frac{1}{number\ of\ years}} - 1}$$

Annual CAR

Annual cumulative abnormal return is the annualized cumulative return in excess of the (respective) market return over a period.

Cumulative abnormal return (excess over market return) during a period is calculated using the following formula:

$$\boldsymbol{CAR_{it} = \sum_{t}^{T}(r_{it} - r_{mt})}$$

Annual CAR is calculated using the following formula:

$$\boldsymbol{ann\_CAR = \frac{CAR_{it}}{number\ of\ years}}$$

Mean Return

Mean return is the arithmetic mean of the monthly returns.

Standard Deviation

Standard deviation is the measure of volatility over a stated period.

Sharpe Ratio

The Sharpe ratio is the measure of risk-adjusted returns calculated as the excess monthly return divided by the standard deviation of monthly returns, where the average monthly excess return equals the average monthly return minus the average monthly risk-free return (as measured by monthly yield of 1-month T-Bill).**Gross Proceeds**

Gross proceeds are the sum of all gross proceeds by type of financing and group of stocks.

Appendix 2: Listed Canadian Clean Tech Companies

Table: List of Clean Tech Companies Listed on the TSX

	Name	Root Ticker	Clean Technology Primary Industry	Clean Technology Sub-Sector	HQ Region	Listing Type	Listing Date	TSX Venture Grad	S&P/TSX Index
1	5N Plus Inc.	VNP	Industrial Products & Services	Renewable Energy Equipment Manufacturing and Tech	Canada	IPO	20071219		
2	Algonquin Power & Utilities Corp.	AQN	Utilities & Pipelines	Renewable Energy Production and Distribution	Canada		19971223		60
3	Altius Renewable Royalties Corp.	ARR	Financial Services	Investment Company	Canada	IPO	20210303		
4	Anaergia Inc.	ANRG	Industrial Products & Services	Waste Reduction and Water Management	Canada	IPO	20210622		
5	Ballard Power Systems Inc.	BLDP	Industrial Products & Services	Energy Efficiency	Canada	IPO	19930609		Composite
6	Boralex Inc.	BLX	Utilities & Pipelines	Renewable Energy Production and Distribution	Canada		19991206		Composite
7	Brookfield Renewable Corporation	BEPC	Industrial Products & Services	Renewable Energy Equipment Manufacturing and Tech	USA	Other	20200724		
8	Brookfield Renewable Partners L.P.	BEP	Utilities & Pipelines	Renewable Energy Production and Distribution	Canada		19991118		Composite
9	Brookfield Renewable Power Preferred Equity Inc.	BRF	Utilities & Pipelines	Renewable Energy Production and Distribution	Canada	IPO	20100309		
10	Burcon NutraScience Corporation	BU	Industrial Products & Services	Low Impact Material and Products	Canada	TSXV Grad	20090618	Y	
11	Capstone Infrastructure Corporation	CSE	Utilities & Pipelines	Renewable Energy Production and Distribution	Canada	IPO	20040429		
12	Cascades Inc.	CAS	Industrial Products & Services	Low Impact Material and Products	Canada		19841016		Composite
13	DIRTT Environmental Solutions Ltd.	DRT	Industrial Products & Services	Low Impact Material and Products	Canada	IPO	20131128		
14	dynaCERT Inc.	DYA	Industrial Products & Services	Energy Efficiency	Canada	TSXV Grad	20200707	Y	
15	EcoSynthetix Inc.	ECO	Industrial Products & Services	Low Impact Material and Products	Canada	IPO	20110804		

16	Electrovaya Inc.	EFL	Industrial Products & Services	Energy Efficiency	Canada		20001110		
17	Exro Technologies Inc.	EXRO	Industrial Products & Services	Low Impact Material and Products	Canada	TSXV Grad	20210708	Y	
18	Global Water Resources, Inc.	GWR	Utilities & Pipelines	Waste Reduction and Water Management	USA	IPO	20101230		
19	Greenlane Renewables Inc.	GRN	Industrial Products & Services	Renewable Energy Production and Distribution	Canada	TSXV Grad	20210217	Y	
20	Innergex Renewable Energy Inc.	INE	Utilities & Pipelines	Renewable Energy Production and Distribution	Canada	IPO	20071205		Composite
21	Kiwetinohk Energy Corp.	KEC	Oil & Gas	Energy Efficiency	Canada	Other	20220114		
22	KP Tissue Inc.	KPT	Consumer Products & Services	Low Impact Material and Products	Canada	IPO	20121213		
23	Lion Electric Company (The)	LEV	Consumer Products & Services	Energy Efficiency	Canada	Other	20210507		Composite
24	Loop Energy Inc.	LPEN	Industrial Products & Services	Renewable Energy Equipment Manufacturing and Tech	Canada	IPO	20210225		
25	Nano One Materials Corp.	NANO	Technology	Low Impact Material and Products	Canada	TSXV Grad	20210608	Y	
26	NanoXplore Inc.	GRA	Industrial Products & Services	Low Impact Material and Products	Canada	TSXV Grad	20210715	Y	
27	NFI Group Inc.	NFI	Industrial Products & Services	Energy Efficiency	Canada	IPO	20050818		Composite
28	Northland Power Inc.	NPI	Utilities & Pipelines	Renewable Energy Production and Distribution	Canada	IPO	19970415		Composite
29	Polaris Infrastructure Inc.	PIF	Utilities & Pipelines	Renewable Energy Production and Distribution	USA	TSXV Grad	20070118	Y	
30	PyroGenesis Canada Inc.	PYR	Industrial Products & Services	Waste Reduction and Water Management	Canada	TSXV Grad	20201120	Y	
31	SunOpta Inc.	SOY	Consumer Products & Services	Low Impact Material and Products	Canada		20011106		
32	Synex International Inc.	SXI	Utilities & Pipelines	Renewable Energy Production and Distribution	Canada		19870605		
33	Taiga Motors Corporation	TAIG	Industrial Products & Services	Renewable Energy Equipment Manufacturing and Tech	Canada	QA	20210423		
34	Tantalus Systems Holding Inc.	GRID	Industrial Products & Services	Energy Efficiency	USA	TSXV Grad	20210510	Y	
35	Tidewater Renewables Ltd.	LCFS	Oil & Gas	Renewable Energy Production and Distribution	Canada	IPO	20210818		

36	TransAlta Renewables Inc.	RNW	Utilities & Pipelines	Renewable Energy Production and Distribution	Canada	IPO	20130809			Composite
37	Westport Fuel Systems Inc.	WPRT	Industrial Products & Services	Energy Efficiency	Canada	TSXV Grad	19990630	Y		
38	Xebec Adsorption Inc.	XBC	Industrial Products & Services	Energy Efficiency	Canada	TSXV Grad	20210107	Y		

Appendix 3: Listed U.S. Clean Tech Companies Eikon Business Classification)

	Name	RIC	Exchange	Country of Issuer	TRBC Sector
1	TPI Composites Inc	TPIC.O	NASDAQ Global Market Consolidated	United States	Wind Systems & Equipment
2	Broadwind Inc	BWEN.O	NASDAQ Capital Market Consolidated	United States	Wind Systems & Equipment
3	Plug Power Inc	PLUG.O	NASDAQ Capital Market Consolidated	United States	Stationary Fuel Cells
4	Fuelcell Energy Inc	FCEL.O	NASDAQ Global Market Consolidated	United States	Stationary Fuel Cells
5	Gevo Inc	GEVO.O	NASDAQ Capital Market Consolidated	United States	Renewable Fuels (NEC)
6	Ameresco Inc	AMRC.K	NYSE Consolidated	United States	Renewable Energy Services
7	First Solar Inc	FSLR.O	NASDAQ Global Select Consolidated	United States	Renewable Energy Equipment & Services (NEC)
8	Array Technologies Inc	ARRY.O	NASDAQ Global Market Consolidated	United States	Renewable Energy Equipment & Services (NEC)
9	Shoals Technologies Group Inc	SHLS.O	NASDAQ Global Market Consolidated	United States	Renewable Energy Equipment & Services (NEC)
10	CleanSpark Inc	CLSK.O	NASDAQ Capital Market Consolidated	United States	Renewable Energy Equipment & Services (NEC)
11	Advent Technologies Holdings Inc	ADN.O	NASDAQ Capital Market Consolidated	United States	Renewable Energy Equipment & Services (NEC)
12	Ocean Power Technologies Inc	OPTT.K	NYSE American Consolidated	United States	Renewable Energy Equipment & Services (NEC)
13	Ideal Power Inc	IPWR.O	NASDAQ Capital Market Consolidated	United States	Renewable Energy Equipment & Services (NEC)
14	Enphase Energy Inc	ENPH.O	NASDAQ Global Market Consolidated	United States	Photovoltaic Solar Systems & Equipment
15	Sunrun Inc	RUN.O	NASDAQ Global Select Consolidated	United States	Photovoltaic Solar Systems & Equipment
16	SunPower Corp	SPWR.O	NASDAQ Global Select Consolidated	United States	Photovoltaic Solar Systems & Equipment
17	Sunnova Energy International Inc	NOVA.K	NYSE Consolidated	United States	Photovoltaic Solar Systems & Equipment
18	Beam Global	BEEM.O	NASDAQ Capital Market Consolidated	United States	Photovoltaic Solar Systems & Equipment
19	Sunworks Inc	SUNW.O	NASDAQ Capital Market Consolidated	United States	Photovoltaic Solar Systems & Equipment
20	SPI Energy Co Ltd	SPI.O	NASDAQ Global Select Consolidated	United States	Photovoltaic Solar Systems & Equipment
21	Green Plains Inc	GPRE.O	NASDAQ Global Select Consolidated	United States	Ethanol Fuels
22	Alto Ingredients Inc	ALTO.O	NASDAQ Capital Market Consolidated	United States	Ethanol Fuels
23	Aemetis Inc	AMTX.O	NASDAQ Global Market Consolidated	United States	Ethanol Fuels
24	REX American Resources Corp	REX	NYSE Consolidated	United States	Ethanol Fuels
25	Renewable Energy Group Inc	REGI.O	NASDAQ Global Select Consolidated	United States	Biomass & Biogas Fuels
26	FutureFuel Corp	FF	NYSE Consolidated	United States	Biodiesel