INAUGURAL PUBLICATION · 2025–2026

Queen's Interdisciplinary Investment Insights

Investigating the intersections of technical subjects and their implications in financial markets.

INSTITUTION
Queen's University

LOCATION
Kingston, Ontario

MEMBERS
15 Students from Commerce, Engineering, and Arts and Science

SECTORS
Mining, Manufacturing, Infrastructure, Energy, Transportation

Queen's UNIVERSITY

Smith SCHOOL OF BUSINESS Queen's University

SMITH ENGINEERING Queen's University

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ABOUT QIII

A New Kind of Research Publication

Queen's Interdisciplinary Investment Insights (QIII) is a student-run research publication at Queen's University dedicated to exploring the intersections of technical disciplines and financial markets.

QIII brings together students from engineering, sciences, and business to produce rigorous technoeconomic analysis across five key sectors. Our mission is to bridge the gap between technical expertise and investment insight — producing research that is both analytically rigorous and financially relevant.

ANALYZE	Rigorously assess technical developments and their market implications across multiple sectors of convergence.
EDUCATE	Lean on other students to develop an understanding of topics beyond the scope of their undergraduate education.
PUBLISH	Produce a high-quality annual research review that sets a new standard for undergraduate publication.

OUR TEAM

Meet the Analysts

QIII is organized around five sector teams, each led by a Technical Lead and a Financial Lead, with Junior Analysts supporting the research process. Overseen by Founder & Chair Sacha Giarrusso.

SECTOR LEADERSHIP

SECTOR	TECHNICAL LEAD	FINANCIAL LEAD
Energy	Matias Marjovsky	Ethan Basil
Mining	Colin Fraser	Ben Taylor
Manufacturing	Sacha Giarrusso	Peter Lawetz
Transportation	Brandon Scheidler	Sanah Currie
Infrastructure	Jacob Hansen	Graydon Macdonald

JUNIOR ANALYSTS Kylie Armstrong · Reid Vincent · Philipp Guse · Gwen Dajani · Reed Macdonald

FOUNDER'S MESSAGE

From the Desk of the Chair

QIII was founded to provide undergraduate students with the opportunity to interact with interesting topics wholistically, interacting with the technical and financial themes of key industries and learning from each other.

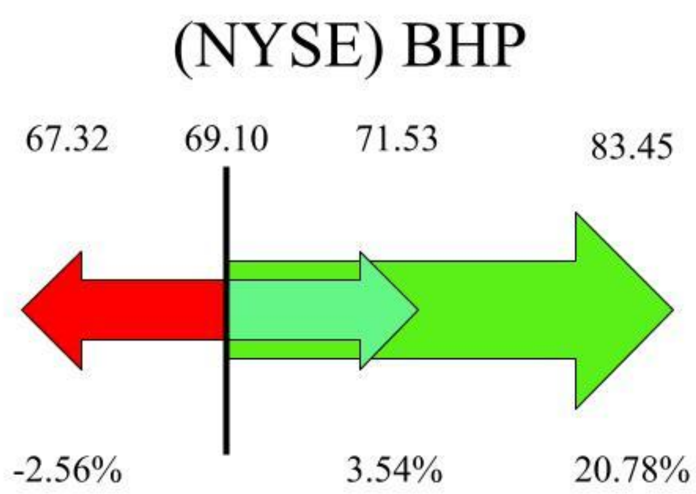
This inaugural publication is our proof of concept. It demonstrates that Queen's students, when given the right structure and mandate, are capable of producing research that rivals the quality of professional industry reports.

> *“Our goal is to be the premier undergraduate technoeconomic research publication in Canada.”*
>
> — Sacha Giarrusso, Founder & Chair, QIII

Origin

The idea for QIII came about when a began independently researching predictive maintenance techniques in mining; research which was prompted by a job opportunity whose description mentioned terms I had never heard about. As I began learning more about machine learning, sensor fusion, and pre-failure detection, the link to mine performance through minimized downtime or unnecessary predictive maintenance was blatant. Simultaneously, as I began engaging with more financial topics in my personal time, mining was a sector that particularly interested me due to the increasing prevalence in a modern high critical-mineral demand world and the close tie between solid commodities and financial markets. Rather than exploring the two topics separately, I began fusing the research together, using my engineering background to gain further insight into the benefits of certain technologies/methodologies, their impacts on production, and subsequently the financial performance of mining companies.

As I began spending more time learning, I figured it wouldn't hurt to put what I had learned into writing leading me to draft my first (very rough) article titled "*An investigation of Industry 4.0 Implementation in the Copper Industry*" (an article which is linked in the "About" section of our website). I had always enjoyed writing about topics which interested me, it was a way of motivating me to spend my free time learning. What started with a half page outline turned into more and more content as every time I felt I was done, I found a new gap and dove back in. I started with writing about the engineering, then the production improvements, then the copper market, and all of a sudden, I was on YouTube learning to build a simple DCF, then a SOTP DCF, and having AI help me build a paper trading strategy from my model. I can now say that 5 months ago, when I began investigating and modelling BHP at a share price of roughly $69 CAD, it has risen to $85 CAD (20 day-rolling average). My predictions from 5 months ago are shown below:



Perhaps this was a stroke of luck. My model is likely full of problematic assumptions and implicit bias from the benefits I presented in the article regarding the implementation of predictive maintenance practices. Though I cannot be sure of the extent of the aforementioned variables, I do know that this exercise motivated me to explore topics I would have never interacted with in my formal education, caused me to spend my free time learning and working on personal projects, and ultimately provided me the experience of walking through a process from start to finish. This is the experience we hope to offer to all our members.

Over the past 6 months, our team has spent hours of their personal time exploring, learning, and writing about topics that interest them. We allow our team to select the scope, style, and deliverable structure of their report to ensure that the generated report is a labour of love, not a burden. We are incredibly proud of all we've accomplished this year, coming from an idea to an incredible team of intelligent motivated individuals who've dedicated time and effort to the pursuit of knowledge and growth.

Mission Statement

Queen's Interdisciplinary Investment Insights is an initiative which aims to connect students from various disciplines with topics which exist as points of convergence between technical and financial fields. In joining likeminded students investigating topics of interest, the club aims to motivate members to take the exploration of real-world topics associated with their desired career trajectory into their own hands. QIII aims to motivate students to spend their free time researching within their field and developing the critical thinking skills to think laterally into other fields of study. The team-based approach to interdisciplinary investigation will also strengthen interpersonal skills necessary for success in multidisciplinary teams. QIII is an opportunity for individuals torn between passions, forced to select mono-disciplinary educational pathways to reopen the doors to interdisciplinary growth providing members the opportunity and motivation to expose themselves to topics outside of their field of study to become a more well-rounded, knowledgeable, and hopefully employable, student. Multiple interdisciplinary clubs exist which explore the intersection of engineering and business. QIII aims to stand out by incentivizing the development of a technical knowledge base through individual investigation required to produce physical media (the QIII Annual Report) which can be distributed to employers or educational institutions as a testament and proof of the personal effort QIII members have put into their own professional development. Hopefully, this exposure to real world industry topics will arm both financial and technical members with the ability to perform better when faced with technical interview questions which is one commonality in the cultures of Commerce and Engineering hiring processes. Through the pursuit of information and the creation of technical and financial reviews of various topics, members of QIII can pursue relevant knowledge with the support of other students.

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SECTOR RESEARCH

Energy

Technical Lead: Matias Marjovsky · Financial Lead: Ethan Basil

AUTHORS

Matias Marjovsky — Technical Lead

Ethan Basil — Financial Lead

Kylie Armstrong — Junior Analyst

KEY THEMES

- Oil and natural gas market volatility
- Renewables and SMR development
- Power generation infrastructure
- Energy infrastructure investment

OIL, GAS & RENEWABLES LANDSCAPE

Oil

Since the 1800s, oil has been the backbone of the Canadian economy. Currently, Canada is the fourth-largest oil producer globally, with 5 million barrels per day (bpd) of production. Most production comes from Western Canada, especially the Alberta oil sands (accounting for 65% of production), Saskatchewan, and offshore drilling in Newfoundland. Canada's reserves are a dominant resource, holding the 3rd-largest oil reserves in the world, only trailing Saudi Arabia and Venezuela.

80% of Canada's oil is exported, with 97% piped to the United States. Major companies responsible for production are Canadian Natural Resources, Imperial Oil, and Suncor Energy, while pipeline giants include Enbridge and the Trans Mountain Pipeline.

However, the industry is highly cyclical and sensitive to geopolitics, and the start of 2026 has not disappointed in the realm of geopolitical drama and its drastic impacts in the industry. From tariffs to war, this sector never fails to keep investors on their toes.

At base, this January, the United States (U.S.) carried out a large-scale military operation in Venezuela to capture its president, Nicolás Maduro. Maduro and his wife were arrested and flown to the U.S. to face charges. For the time being, Trump said the U.S. will run Venezuela until a transition government is formed. While this may be a refreshing change in politics for the Venezuelans, this poses a unique threat to the Canadian Economy.

Canada provides the U.S. with 60% of its heavy crude oil because it has much richer reserves of light crude. Major Canadian exporters include Canadian Natural Resources (TSX: CNQ) and Enbridge (TSX: ENB). However, with the U.S. controlling Venezuela, President Trump has been attempting to incentivize American oil giants like Exxon and Shell to invest in operations there, and to convince companies that already operate there, like Chevron, to expand. If American oil companies were to invest in capex in Venezuela, it would decrease the amount of heavy crude that the U.S. imports from Canada. This would put downward pressure on oil prices, severely harming the Canadian economy, and even worse, would severely harm Canadian bargaining power when North American leaders sit down at the bargaining table to negotiate the new USMCA. With all of this said, the extensive capex in an extremely unstable region makes this scenario possible, yet unlikely. The next few months will be a key indicator of whether this threat becomes reality or just a minor scare to Canadians.

Next, on Friday, March 27th, 2026, the United States and Israel led an attack on Iran. Missile and air strikes were carried out targeting Iranian nuclear facilities, missile bases, and military leadership. During these strikes, Iran's Supreme Leader, Ayatollah Ali Khamenei, was killed near Tehran. The goal was to stop Iran's nuclear program and destroy its ballistic missile capabilities. However, Iran retaliated quickly with missiles and drones at Israel, as well as U.S. military bases in the Middle East in countries like Bahrain, Iraq, the UAE, and Kuwait.

The impact of this war is already being felt. By Sunday, March 2nd, oil prices were up over 8% and are continuing to rise. “Safe-haven” commodities like gold and silver also saw a 2% boost during that time period as investors reacted to the extreme market uncertainty that war brings.

President Trump predicts the war will last 4-6 weeks. This will cause various impacts on the Canadian economy, some harmful, some helpful.

To begin, the oil price spike is good for the Canadian economy as a whole. Canada is a major oil exporter, with oil being ~14% of total exports. As an exporter, Canada will benefit from rising oil prices due to disrupted supply in the Middle East, which will strengthen the economy. With that said, given this 4-6 week timeline, costs are passed on to everyday Canadians. thereby increasing prices at the pump, which will rise due to the supply reduction, increasing inflation. Moreover, many transportation companies are now avoiding routes through the Middle East. Transport routes are being adjusted from the Red Sea and Suez Canal shortcuts to routes that loop around Africa. For inelastic products like alcohol, tobacco, and oil, these extra costs will be passed on to consumers, further increasing inflation.

Although our economy as a whole will benefit from the supply disruptions in the Middle East, in a world with such uncertainty, one thing remains crystal clear: in the coming weeks, prices will rise, and everyday consumers in Canada will feel the burden.

Natural Gas:

Canada is the world's 5th-largest natural gas producer, with ~19 billion cubic feet (bcf/d) of production. Like oil, almost all of Canada's natural gas is from the West, namely, British Columbia and Alberta. Moreover, Canada exports a massive portion of its natural gas; ~45% being exported, and 99% going to the United States. Transportation is typically through a deeply integrated pipeline network, including NGTL, Alliance Pipeline, and Westcoast Pipeline. Major Canadian players include Tourmaline Oil, ARC Resources, and Canadian Natural Resources.

In terms of performance, Natural Gas has also had a very volatile year, with a roughly flat trend compared to last year, punctuated by a few spikes. Geopolitical tensions in the Middle East have driven prices up slightly due to supply disruptions, but this effect will not be long-lasting.

With all this aid, two major themes impacting the Natural Gas industry that will be interesting to examine are the impact of AI and data centers, as well as the potential trend toward Liquefied Natural Gas (LNG) exports.

At base, to fuel the current AI boom, data centers are being built to power large language models (LLMs). North America is home to approximately 5,700 data centers operating across the continent, powered by the grid. With the growing demand for AI, this number is expected to rise dramatically increase. However, these data centers consume significant energy, increasing grid demand and reliance on natural gas, which accounts for 40% of grid generation.

A single hyperscale AI data center can use 100-500 gigawatt-hours (GWh) of electricity per day, which amounts to 2-3% of electricity consumption in North America and is equivalent to the daily electricity usage of ~55 million homes. With North America accounting for ~20% of the global hyperscale AI datacenters, and with 130-140 new datacenters being built each year globally, along with the trend of exponentially increased AI usage across the continent, it can be reasonably assumed that over the next 5 years, ~850 data centers will be built in North America. As demand for electricity in data centers increases, demand for natural gas will follow.

Next, LNG exports are a promising approach to expand natural gas exports amid uncertainty with Canada's current relationship with the United States. LNG is natural gas that has been cooled to -162 degrees Celsius. The edge here is that when gas condenses into a liquid, its volume shrinks by a factor of 600, making it possible to ship it across oceans in specialized tankers. Typically, natural gas is transported through pipelines, but as pipelines don't cross through oceans, LNG solves this problem. As of now, major LNG exporters are the U.S., Qatar, Australia, Russia, and Malaysia, with buyers including Japan, China, South Korea, India, and Germany. LNG demand is currently exploding as it replaces coal, diversifies away from unstable suppliers like Russia, and helps meet rising global electricity demand.

In the current state of politics between Canada and the U.S., there is uncertainty across the board. From tariff threats to losses of bargaining power, to negotiations that leave Canada worse off, there has never been a more promising time to expand natural gas exports to other markets.

Historically, Canada has exported gas only through pipelines to the U.S., but exporting LNG would allow Canadian gas to reach Asian markets for the first time. This would allow for premium expansion to global markets and would increase Canada's bargaining power at the table with the United States, reducing reliance on its southern neighbour.

Renewables:

Nuclear

Nuclear energy is re-emerging as a vital element in Canada's long-term energy transition, especially with the development of small modular reactors (SMRs). Canada is also leading in this field, and the Darlington New Nuclear Project in Ontario plans to deliver the G7's first grid-connected SMR, with commercial operation possible by 2030. Construction is in continuous progress, with the excavation of the Unit 1 reactor shaft 87 percent complete, and the basemat foundation is to be installed in the summer of 2026.

Other provinces outside Ontario are also considering nuclear expansion as part of their decarbonization plans. Saskatchewan is evaluating the potential for a four-unit fleet of SMRs starting in 2034, and Alberta should have its final expert report on nuclear feasibility available by the end of March 2026. Such developments indicate a wider national trend in favour of nuclear power as a predictable, low-emission baseload power source that can supplement intermittent renewables such as wind and solar.

Economically speaking, the effects of nuclear investment are high. The contribution of a SMR fleet of 4 units to GDP in Ontario, per se, is estimated at 35.1 billion, and a continuous employment of about 3700 jobs per year over a 65-year life makes it evident that it has a high economic multiplier and consistent employment stability. With governments struggling to strike a balance among energy security, emissions reduction, and economic growth, nuclear energy, particularly SMRs, presents a scalable and politically viable solution.

Nevertheless, the sector faces challenges despite its potential, including high initial capital requirements, regulatory barriers, and public perception issues. The rate at which SMR is introduced in Canada over the next decade will be one indicator of whether nuclear energy can effectively scale to meet Canada's increasing clean energy demand.

Solar

The Canadian solar industry has experienced consistent and significant growth, with installed capacity increasing by more than 3 GW between 2020 and early 2026. This trend will continue to gain momentum, with estimates suggesting that as much as 26 GW of new solar capacity will be available by 2035, making solar a valuable pillar of the Canadian energy transition.

But in the short-term market, volatility is brought to the fore. Solar module pricing worldwide in Q1 2026 has been less stable, as prices of Chinese TOPCon modules increased by 3.45% in early March. This growth was enabled by robust near-term demand for shipments and a change in export tax policies, which has heightened the sector's sensitivity to global supply chain conditions.

Meanwhile, innovation is starting to overcome one of the central structural limitations of solar land use. Other technologies noted to be taking root as scalable include those that combine solar production with agriculture, such as agrivoltaics and floating solar farms. Such advances are also strategically important because they increase the practical footprint of solar deployment without necessarily competing with agricultural or urban areas, enhancing its potential for long-term adoption.

Wind

Wind energy has become one of the fastest-growing sectors in Canada's renewable energy portfolio, with an unprecedented annual growth rate of 76 percent through 2025. The expansive nature of this growth has been driven by major projects such as the 215 million Mesgi'g Ugju'n 2 infrastructure development in Quebec, indicating that the community is committing to building clean energy infrastructure, both publicly and privately.

Another characteristic of this growth is the growing role of Indigenous ownership and involvement. By 2025, more than 70 percent of new grid-connected renewable projects had some form of Indigenous ownership, and 118 projects were operational. This is a significant change not just in the models of project financing and governance but also a substantial move to inclusive and locally oriented energy development.

Although this is an impressive domestic performance, global supply chain risks are a major limiting factor. The manufacturing of wind turbines has been heavily reliant on magnets that require rare earth elements, for which China presently controls about 91 percent of the refining capacity. This level of concentration presents geopolitical and cost risks and might reduce scalability and expose it to global trade disputes. Consequently, even though the fundamental aspects of demand regarding wind are strong, the supply-side weaknesses may define the rate and cost of future growth.

Hydrogen

Hydrogen is fast evolving as a theoretical clean energy solution to a practical part of the world's energy system. In 2026, several so-called ultra-scale hydrogen initiatives have been announced, including the North Sea Offshore Hydrogen Hub and the U.S. Pacific Solar-Hydrogen Basin, both of which leverage direct solar-to-hydrogen conversion technologies. Such projects indicate a transition toward coupling renewable generation directly with hydrogen production, making them more efficient and reducing the need for intermediaries.

Another major economic challenge facing hydrogen is cost, which is also being tackled by technological innovation. In March 2026, researchers presented a new approach to making PFAS that was not based on metals and did not use metals, not only scarce but also costly (iridium), reducing the use of metals by about 75 percent. This innovation can significantly reduce production costs, bringing green hydrogen to the threshold of price parity with fossil fuels and making it more competitive for industrial and transportation applications.

Simultaneously, improvements in electrolyzer technology have propelled efficiency to over 70 percent, driven by the development of new catalysts that increase hydrogen yield. Not only do these enhancements raise output per unit of energy input, but they also reinforce the economics of hydrogen production overall. Moreover, hydrogen technologies are helping reduce emissions in conventional processes, including steam methane reforming, thereby expanding their environmental scope.

All in all, the future of hydrogen is increasingly about scale, efficiency, and cost competitiveness. Although the mass use of hydrogen remains in the early stages of development, the convergence of technological innovations and large-scale project implementation suggests that hydrogen may soon become not just a long-term goal but also a strategic opportunity in the global energy transformation.

POWER PROJECT DEVELOPMENT & PERMITTING

1 Power Generation Development

Large-scale power generation or transmission projects in North America are multi-year, capital-intensive processes. From initial site prospecting to commercial operation, a single project may take five to fifteen years depending on technology, geography, and regulatory complexity.

1a. Early Stage Development and Site Selection

Development begins with resource assessment. Developers select candidate sites based on proximity to existing electrical infrastructure, land availability, resource quality (wind speed, solar irradiance, etc), and compatible land use. Developers may monitor these resources over a 12–24 month period to build a proper dataset. For thermal generation, proximity to gas supply is a key driver. Increasingly, proximity to large load centers like data center clusters is becoming a significant siting criterion across the continent.

Once a site is deemed viable, the developer secures land rights. In the U.S. and Canada, grid operators are increasingly requiring a demonstration of site control as a condition to enter the interconnection queue, reducing speculative filings. Developers must also conduct preliminary engineering before committing significant capital.

Across Canada and the U.S., regulators have been moving to accelerate permitting timelines for hydropower, natural gas, and generation projects.

1b. Permitting and Environmental Reviews

Permitting remains the longest and most uncertain phase. In the U.S., projects on federal land or requiring federal permits trigger the National Environmental Policy Act (NEPA), which mandates either an Environmental Assessment (EA) or a full Environmental Impact Statement (EIS). An EIS can take two to four years. State permits layer additional requirements like zoning and conditional use permits. A single project can take three to five years of permitting before construction can proceed. In Canada, regulations are similarly complex. Federal assessments are governed by the Impact Assessment Act

(IAA) while provincial regulators like the Ontario Energy Board have jurisdiction over generation and transmission approvals.

Cross-border projects face additional scrutiny. A transmission line crossing the U.S.–Canada border requires a Presidential Permit on the American side and a National Energy Board export license in Canada, adding timelines and political risk.

In the U.S., federal policy has been actively shifting. Billions in infrastructure funds have been redirected toward advanced nuclear and grid supply chain programs, while executive orders in 2025 declared a national energy emergency and directed agencies to eliminate permitting delays. In Canada, the federal government has continued deploying capital through the Canada Infrastructure Bank and the Clean Electricity Investment Tax Credit, while provinces are pursuing their own accelerated procurement processes.

1c. Offtake and Grid Interconnection

Before reaching financial close, a project must secure two critical agreements. The first is a power purchase agreement (PPA) for revenue certainty, and the second is an interconnection agreement with the regional transmission operator or utility governing physical grid connection. PPA prices are expected to continue rising alongside energy demand.

Interconnection is one of the most significant bottlenecks across North America. In the U.S., the average wait for a successful interconnection is approximately four years, with cumulative capacity in queues exceeding 2,600 GW. Interconnection is the process by which a new generation asset, or large load, is physically and contractually connected to the existing electrical grid so it can inject or withdraw power. It involves filing a request with the grid operator, completing a series of engineering studies to determine what transmission upgrades are needed, and then executing an interconnection agreement that specifies cost responsibilities, technical requirements, and timelines. The developer typically bears the cost of required network upgrades, which can range from a few million dollars to hundreds of millions depending on location and congestion.

1d. Financing and Final Investment Decision

With permits in hand, offtake contracted, and interconnection secured, the project enters the financing phase. Utility-scale projects are typically financed through non-recourse project finance structures. The capital stack may include senior secured debt (60 to 80% of project cost), tax equity, sponsor equity, and mezzanine debt. In the U.S., the Inflation Reduction Act significantly expanded federal tax credits for renewables, though certain provisions face political uncertainty heading into 2026. In Canada, the Clean Electricity Investment Tax Credit and concessionary lending through the Canada Infrastructure Bank play a similar role.

Consortium-driven investment has emerged where energy infrastructure investment is directly linked to AI compute demand. Initiatives like Stargate ($500 billion, backed by OpenAI, Oracle, SoftBank) and the AI Infrastructure Partnership (BlackRock, GIP, Microsoft) combine private equity, sovereign capital, and technology companies in hybrid financing structures.

1e. Construction, Commissioning, and Commercial Operation

Construction timelines vary by technology. A utility-scale solar farm typically takes 12–18 months, an onshore wind project 18-24 months, and a combined-cycle gas turbine plant 24–36 months. Transmission projects take considerably longer. During construction, developers manage EPC contracts, monitor budgets, and coordinate with environmental monitors and grid operators.

Commissioning involves performance testing, grid synchronization, and verification against contractual specifications. Once the project achieves commercial operation, it begins generating revenue and enters long-term operations and maintenance. Many developers sell post-COD assets to infrastructure investors or utilities seeking stabilized, cash-yielding portfolios.

ENERGY INFRASTRUCTURE CAPITAL FLOWS

2a. Private Equity Fundraising in Energy Infrastructure

Private capital has become a dominant force in North American power markets. Global energy, utilities, and resources M&A deal values rose 27% in 2025 even as deal volumes fell 2%, driven by 20 deals over $5 billion compared to just six the year prior. Power and utilities deal value specifically increased roughly 57% year-over-year.

Global infrastructure fundraising reached a record of nearly $200 billion in 2025, surpassing the prior high of $180 billion in 2022. Infrastructure assets under management reached $1.6 trillion by mid-2025. Energy and power accounted for nearly half of 2025 infrastructure deals by value. Renewables comprised roughly two-thirds of sector-focused allocations and data center strategies accounted for approximately 20%.

Nearly three-quarters of capital raised in 2025 went to the top 50 infrastructure funds, with close to half going to the top five. Digital infrastructure now accounts for almost 20% of all portfolio companies, up from 15% in 2020, with data centers representing 41% of digital deals in 2025, up from 26% the prior year.

Energy Capital Partners (ECP) exemplifies the specialist model. Founded in 2005, the firm has raised over $31 billion across five flagship equity funds and a $2.5 billion credit strategy. Its most recent flagship closed at $6.7 billion in May 2024. ECP merged with Bridgepoint Group in August 2024, creating a combined platform with approximately $87 billion of AUM. ECP has formed large-scale partnerships targeting AI-driven power demand: a $50 billion JV with KKR and a $25 billion partnership with Abu Dhabi's ADQ aimed at 25 GW of new capacity.

Brookfield led the 2020–2024 fundraising cycle with roughly $104 billion raised, followed by GIP (now under BlackRock) at approximately $86 billion and KKR at approximately $81.6 billion. Net assets in the largest evergreen PE fund structures grew sixfold between 2021 and 2025.

Recent and Closed Landmark Transactions:

Constellation / Calpine (ECP Exit) – $26.6 Billion (Closed January 7, 2026). Constellation Energy acquired Calpine from ECP, CPP Investments, and Access Industries for ~$16.4 billion equity value (50M CEG shares + $4.5B cash) with ~$12.7B of assumed net debt. The purchase price was $26.6B at 7.9x 2026E EV/EBITDA. The combined entity became the largest U.S. electricity producer. ECP originally acquired Calpine for ~$5.6 billion in 2017–18, making this the largest PE exit in the power sector in two decades, and the most profitable private-equity deal by dollar value ever.

NRG / LS Power – $12.0 Billion EV (Announced May 12, 2025; Closed January 30, 2026). NRG acquired LS Power's portfolio of 18 natural gas-fired generation assets (~13 GW), along with CPower's commercial and industrial virtual power platform, in a transaction valued at approximately $12.0B enterprise value. The purchase price reflects 7.5x 2026E EV/EBITDA, or roughly 50% of estimated replacement cost. The transaction significantly expands NRG's generation footprint across key markets including Texas and the Northeast, while also adding demand-side capabilities through CPower. Overall, the deal positions NRG to better respond to rising electricity demand and tighter grid conditions. This also suggests utilities are increasingly willing to acquire existing gas capacity at a discount to replacement cost rather than build new, given permitting timelines and capital intensity.

Talen Energy / ECP (Cornerstone) – $3.45 Billion (Announced January 15, 2026). Talen agreed to acquire approximately 2.6 GW of PJM natural gas generation assets from Energy Capital Partners, including the Waterford, Darby, and Lawrenceburg facilities. The transaction consists of roughly $2.55B in cash and $900M in Talen stock, implying a valuation of approximately 6.6x 2027E EBITDA. Strategically, the acquisition strengthens Talen's position in western PJM and adds efficient baseload generation to its portfolio. This appears to be a bet on continued load growth and improving fundamentals in the PJM market, particularly as capacity becomes more constrained.

Vistra / Cogentrix – ~$4.0 Billion Net Purchase Price (Announced January 5, 2026). Vistra agreed to acquire Cogentrix Energy from Quantum Capital Group, adding approximately 5.5 GW of natural gas generation capacity across PJM, ISO New England, and ERCOT. The net purchase price is approximately $4.0B, consisting of cash, stock, and assumed debt, offset by expected tax benefits. The valuation implies roughly 7.25x 2027E EBITDA and about $730/kW of capacity. The transaction reflects Vistra's continued focus on dispatchable generation, which remains important for grid reliability as renewable penetration increases. It also reinforces the ongoing role of natural gas in balancing supply and demand.

CDPQ / Innergex – C$10.0 Billion EV (Announced February 25, 2025; Closed July 21, 2025). CDPQ agreed to acquire Innergex Renewable Energy for C$13.75 per share in cash, implying a total enterprise value of approximately C$10.0B, including debt and other obligations. The offer represented a premium of approximately 58% to the prior closing price and around 80% to the 30-day VWAP. The transaction takes Innergex private and provides greater financial flexibility to pursue long-term renewable development projects without the constraints of public markets. This aligns with CDPQ's broader strategy of investing in long-duration infrastructure assets.

CDPQ / Brookfield / Boralex – ~$9.0 Billion EV (Announced March 25, 2026). Boralex entered into a definitive agreement to be acquired by Brookfield, alongside CDPQ, for C$37.25 per share in cash. The transaction implies a total enterprise value of approximately C$9.0B, inclusive of debt and other obligations, and represents a premium of ~32% to the prior closing price and ~36% to the 30-day VWAP. The implied valuation is roughly ~13x 2026E EBITDA. Strategically, the take-private provides Boralex with additional capital and long-term ownership to accelerate its renewable development pipeline, while also reflecting continued demand from large sponsors for scaled renewable platforms with contracted cash flows.

3a. Overview

SunZia Wind and Transmission, owned by Pattern Energy, is the largest renewable energy infrastructure project in the Western Hemisphere. Located across central New Mexico and south-central Arizona, it comprises a 3,500 MW wind farm with 916 turbines and a 550-mile HVDC transmission line. The combined investment totals approximately $11 billion, financed through a $8.8 billion construction and term loan facility plus a $2.25 billion tax equity term loan. When fully operational, the project will deliver up to 3,000 MW of wind energy to Arizona and California.

3b. Development Timeline

The project was originally conceived in 2006 as two AC transmission lines. The development and route approval alone took 17 years. Key milestones include the Arizona Corporation Commission's initial environmental compatibility certificate in 2016, the New Mexico PRC's rejection and subsequent approval of the line (2018 and December 2022), the BLM's Record of Decision in May 2023, and formal groundbreaking in September 2023. Along the way, the design evolved from AC to HVDC, the developer changed (Pattern Energy acquired the rights in July 2022), and legal challenges were raised by environmental groups and tribal nations concerned about impacts to cultural sites in the San Pedro Valley.

Legal challenges have continued at the federal level. In March 2026, tribal and nonprofit plaintiffs filed a Motion for Summary Judgment in Arizona District Court requesting that the court void the BLM's route authorization. The outcome represents a material risk to the transmission line route.

3c. Construction Status (Early 2026)

Construction is in its advanced phase. SunZia Wind South has completed access roads and foundations, with 89% of wind turbines completed, and SunZia Wind North has completed access roads, foundations, and the wind turbines are 99% completes. The HVDC converter stations use Hitachi Energy's voltage source converter technology at both terminals. Approximately 2,000 workers are in the field. Commercial operation is targeted for 2026, though the federal litigation introduces timeline risk.

3d. Technical Specifications

The wind farm uses 674 GE Vernova 3.6 MW turbines and 242 Vestas V163-4.5 MW turbines. Energy is collected via a 34.5 kV system, stepped up to 345 kV at 10 substations, and delivered via 130 miles of tie lines to the converter station. The HVDC link converts to DC for the 550-mile transmission, then back to AC for grid integration. The system will be the largest voltage source converter installation in the United States. It also incorporates AC choppers to dissipate surplus energy during temporary faults, a first for onshore wind at this scale.

Pattern Energy has signed PPAs with Shell, the University of California, and the Clean Power Alliance.

3e. Economic Impact

The project is expected to generate $20.5 billion in total economic benefits across New Mexico and Arizona. Strategically, SunZia demonstrates that large-scale HVDC transmission can unlock stranded renewable resources.

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SECTOR RESEARCH

02

Mining

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KEY THEMES

- Rare earth elements
- China's supply-chain dominance
- Critical mineral financing
- Canadian REE companies

REE ENGINEERING & PROCESSING CHALLENGES

Engineering Background

Introduction

Rare Earth Elements (REEs) have been a hot topic in the news over the past year as geopolitical tensions have been on the rise, raising questions about global supply chains. As of **2023,** China produces roughly 70 percent of global REE ore as well as **85 to 90 percent** of downstream processing (USGS, 2025); this is important because Rare Earth Elements are a key component in the creation of industrial permanent magnets. While China's production market share has declined in the past decade, rising interests in electric vehicles (EVs), renewable energy, and national defence have pushed REE supply chains into the spotlight. While China produces 90 percent of refined REEs, the country contains just **50 percent** of the global reserves (Hyyryläinen, 2024); to understand why supply chains are so difficult to secure, one must first look at the unique chemical and physical nature of the elements themselves.

What Exactly are Rare Earth Elements?

Rare Earth Elements are a group of elements that include the Lanthanides, which sit in the sixth row of the periodic table, as well as Yttrium (Y) and Scandium (Sc). Despite their name, Rare Earth Elements are not actually that rare. REEs are roughly 30,000 times rarer than common rock-forming elements like Aluminum and Iron, but are 1,000 times less rare than Platinum Group Metals (PGMs) like Gold, Palladium, and Platinum.

REEs can further be separated into different categories based on abundance and usefulness, with the most common classification being between Light vs Heavy Rare Earth Elements (LREEs and HREEs). LREEs are generally lighter and lower on the periodic table, and are more common and less useful. The two most common LREEs are Lanthanum (La) and Cerium (Ce), and the most useful are Neodymium (Nd) and Praseodymium (Pr) which are commonly used in magnets. On the contrary, HREEs are rarer and more useful. Some of the most useful HREEs are Terbium (Tb), Dysprosium (Dy), Ytterbium (Yb), as well as Yttrium (Y), which is grouped with HREEs due to similar chemical properties.

Project Economics

Classification between Heavy and Light Rare Earth Elements is useful as it helps to explain one of the largest issues around REE processing, known as the Balance Problem. In essence, the Balance Problem creates economic and engineering problems that come from the general inverse relationship between usefulness and abundance, and the fact that most REEs naturally occur together. In order for a mine to produce 1 ton of an HREE or even one of the more useful LREEs, it must also mine multiple tons of Cerium and Lanthanum. As mentioned previously, these two metals are some of the most abundant Rare Earth Elements, meaning their supply massively outweighs demand by **a ratio where Lanthanum and Cerium typically constitute 80% to 99% of the total REE content in most deposits** (Verplank et al., 2014 via Facets, 2025); this causes Ce and La to have very low prices. The market is so saturated, especially for Cerium, that it can actually be an economic burden.

During chemical extraction and processing, the presence of Cerium and Lanthanum inhibits how well other more valuable REEs can be extracted, often requiring the separation of **over 450 tons of Cerium** for every single ton of high-value heavy elements produced (Binnemans, 2014). Additionally, adding multiple tons of such a low-value commodity per ton of high-value Rare Earth Element massively increases the cost of operation because the cost of reagents and electrical demand is much higher. REE processing already has a very high capital expenditure , as the process takes up to a hundred steps of chemical extraction.

As previously mentioned, REEs typically form in deposits together, not as singular elements; this is a challenge because the elements are so chemically similar, and so extraction takes many steps of scrubbing and stripping. The high level of complexity and cost of a REE processing circuit make its practical implementation difficult. For current developments in North America, Brazil and Australia, most remote operations do not have an on-site extraction circuit planned. The most practical proposed solution is to have a centralized extraction where multiple mines could send their mixed product. This is how China is able to dominate global supply.

Chinese Infrastructure Capabilities

There are multiple factors that the Chinese government has taken advantage of to become the REE superpower of the world. Along with advantageous geology, they have created a large centralized processing facility, removing much of the cost associated with creating a new mine. This centralized framework was created in Baotou, Inner Mongolia, home to the Northern China Rare Earth Group. Rather than relying on isolated, fragmented processing facilities, China routes massive volumes of mixed ore feedstocks to this single, state-integrated hub to achieve unrivaled scale. This centralized approach was created by the country's unique geology, which presents fewer processing hurdles than Western deposits.

In the north, the world's single largest rare earth resource, the Bayan Obo deposit, is mainly an iron-REE deposit. Because the host rocks are already mined and crushed for large-scale steel operations by the Baotou Iron and Steel Group, the REE-rich material is essentially treated as a secondary byproduct or recovered directly from iron ore tailings. This absorbs a significant portion of the primary mining, crushing, and grinding capital expenditure that independent Western operations must bear entirely on their own.

Meanwhile, in southern provinces like Jiangxi, China leverages a completely different but equally advantageous geological phenomenon: ion-adsorption clay deposits. Formed by intense tropical weathering of REE-rich granitic parent rocks, 60% to 90% of the valuable heavy rare earths in these deposits are loosely bound to the surface of clay minerals by ionic bonds. Unlike hard-rock minerals that require intensive thermal cracking, acid roasting, and a hundred steps of complex chemical separation to break the mineral lattice, these ionic clays can be leached using simple, inexpensive salt solutions. By combining the low-cost, chemically accessible HREE feedstocks of the south with the massive, byproduct-driven LREE volumes handled at the centralized Baotou circuit in the north, China has established a metallurgical chokehold that keeps global market prices low and renders standalone foreign projects incredibly difficult to finance.

REE MARKET DYNAMICS & PRICING

Finance

1. Market Dynamics

The global rare earth elements (REE) market is shaped by growing demand for clean technology and by the fact that China controls most of the world's supply. In 2025, the market was valued at approximately USD $4.20 billion and is expected to grow to USD $10.51 billion by 2036, with a compound annual growth rate (CAGR) of 8.7%. This growth is being driven by rising demand for permanent magnets used in electric vehicles, offshore wind turbines, and military systems. To understand what this means for Canadian companies, it helps to first look at what is driving demand and why China holds so much market power.

1.1 Demand Drivers

The most important REEs from a financial standpoint are neodymium (Nd), praseodymium (Pr), dysprosium (Dy), and terbium (Tb). These are used to make neodymium-iron-boron (NdFeB) permanent magnets, which are found in EV motors, wind turbines, and defence equipment. A single electric vehicle can use 1 to 2 kg of NdPr magnet material. Offshore wind turbines require even more rare earth content per unit of power generated than onshore turbines, and this segment is expected to grow at over 20% per year through 2030. Military applications such as fighter jet motors, radar systems, missile guidance, and naval propulsion also rely heavily on dysprosium and terbium, and there are currently no good substitutes for these elements in high-performance military hardware.

By volume, magnets make up the largest application for REEs, representing **41.0% of global REE revenue** as of 2025. Cerium accounts for 38% of total REE volume but earns very little revenue because there is far more of it than the market needs. This issue is explained in more detail in the Engineering section under the Balance Problem. The global market is expected to process **197 kilotons** of REEs in 2025, rising to 273 kilotons by 2031.

1.2 China's Control Over the Supply Chain

China's control over the REE supply chain goes beyond just mining. As of 2025, China produces roughly **60-70% of global raw REE material** and processes **about 90% of the world's REE output**. Its position in magnet manufacturing is even stronger: **China now produces 94% of the world's sintered permanent magnets**, up from around 50% two decades ago. This means that even countries that mine some REEs still often rely on China to process and manufacture the final product.

China's cost advantage comes largely from its centralized processing model. The Baotou processing hub in Inner Mongolia handles REE ore from many different mines at once, which spreads the high fixed costs of processing across a much larger volume of material. This 'one hub, many mines' approach means China can afford to process low-value elements like cerium and lanthanum while still making money on the high-value ones. Western countries have not been able to replicate this model, and closing that gap is the central challenge for Canadian REE development.

1.3 How China's Export Controls Split the Market

In April 2025, China introduced a system requiring companies to get government approval before exporting seven key REEs and all permanent magnet products. By November 2025, this was expanded to cover five more elements and even applied to products made outside China if they contained Chinese-origin REE material above a very small threshold. This was a major shift in how the global REE market works.

The result has been a **split market**: Chinese domestic prices stayed relatively stable, but prices outside China became much more volatile. NdPr oxide prices rose over 40% through 2025, and one industry executive noted that dysprosium was selling for about three times the Chinese quoted price in European markets by late 2025. Chinese magnet exports to the US fell 93% year-on-year in May 2025. This price gap creates a **supply premium** for REEs sourced from outside China, which is exactly the opportunity that Canadian producers are trying to access.

2. Pricing

REE pricing is more complicated than most commodities. There is no central exchange where REE prices are publicly listed like there is for gold or copper. Instead, prices are set through private deals between buyers and sellers, or tracked by specialized price-reporting services like Fastmarkets and Shanghai Metals Market (SMM). Prices are usually quoted per kilogram for refined oxides of each element. This lack of price transparency, combined with China's market control, means REE prices can shift sharply based on political events with little warning.

2.1 Current Pricing Overview

The table below shows approximate prices for key REEs as of mid-2025. The large difference in price between the high-value heavy REEs and the very cheap light REEs (La, Ce) is a good visual summary of the Balance Problem described in the Engineering section.

Element	Symbol	~Price (USD/kg)	YTD Change	Primary Use
Neodymium-Praseodymium Oxide (NdPr)	Nd/Pr	~$245/kg	+64% (2025)	Permanent magnets (EVs, wind turbines)
Dysprosium Oxide	Dy	~$400-450/kg	Down ~30% then recovering	High-heat magnets, defence
Terbium Oxide	Tb	~$930/kg	+105% (2025)	Magnet strength, green phosphors
Cerium Oxide	Ce	<$5/kg	Near zero; oversupply	Catalysts, polishing (low value)
Lanthanum Oxide	La	<$3/kg	Minimal	Batteries, optics (low value)

2.2 What Drives Price Changes

REE prices are affected by a number of factors that are important for understanding the investment risk of any Canadian project:

- Chinese Export Policy: China's April 2025 licensing system and its later expansions have created uncertainty in global supply. Around half of European companies that applied for export licenses received approval, which means buyers outside China cannot always count on getting what they need. This pushes prices up when supply tightens.

- Demand in China Itself: About two-thirds of global magnet demand comes from industrial applications inside China. When China's own economy is slow, such as during the weakness in its housing and construction sector since 2022, overall REE prices can fall even if Western demand for EVs and defence systems is strong.
- Myanmar Supply Disruptions: Myanmar supplies a meaningful share of the heavy REE ore that Chinese processors use. Ongoing conflict in Myanmar has reduced shipments, which tightens the global supply of elements like dysprosium and terbium and pushes their prices higher.
- The Balance Problem: The oversupply of cheap cerium and lanthanum effectively raises the cost of producing the more valuable elements, since a mine must process all of them together. Producers who cannot sell their Ce and La end up with a cost that eats into their margins on the valuable elements.

2.3 Price Floors and Sales Strategy

Because prices are so unpredictable, having a guaranteed minimum price (a price floor) or a committed buyer (an offtake agreement) is increasingly important for project financing. Governments have started to act on this: the US has effectively set floor prices for defence-grade REEs that are roughly 70% above Chinese market rates, making it worthwhile to source from non-Chinese suppliers even at higher cost. Canada has also started signing offtake agreements with select critical mineral producers and is looking at stockpiling certain elements.

For smaller Canadian developers, the most realistic near-term sales strategy is to produce and sell a mixed rare earth carbonate (MREC). This is an intermediate product that can be shipped to a separation facility rather than requiring the developer to build their own costly separation plant from day one. Selling MREC first reduces upfront costs and gets cash coming in, while giving the company time to eventually finance a more advanced processing facility.

3. Capital Requirements and Investment Landscape

Building a rare earth mine and processing facility requires a very large amount of upfront money, a complex multi-step process, and many years to develop. These high barriers to entry are a big part of why China has been able to take over the market while Western projects have struggled to get off the ground. Understanding where the money goes at each stage is key to evaluating whether a Canadian REE project makes financial sense.

3.1 The Cost Structure of REE Projects

The capital costs for a rare earth project can be broken down into three broad phases, each of which builds on the last:

- Exploration and Feasibility ($10M to $50M): This covers drilling programs, resource estimates, test work on how the ore can be processed, and a preliminary economic assessment (PEA) or pre-feasibility study. For remote Canadian deposits, these costs are higher because of the need for helicopter access, permitting studies, and engagement with local Indigenous communities.
- Mining and Primary Processing ($300M to $800M): This covers building the open-pit mine, the ore processing plant, and the gravity and flotation circuits that produce a mixed carbonate product. Road and port infrastructure for remote projects can add $150M to $300M on top of this. For example, the Ashram project's 2015 PEA put the total required capital at about $763M, which included the cost of a 185-kilometre all-weather access road.
- Separation and Refining ($200M to $500M or more): This is the step where the mixed rare earth input is separated into individual oxides. It involves a complex series of chemical extraction stages (often over 100 steps), large amounts of chemical reagents, and significant power usage. This is also the step where China has the biggest advantage because of its shared infrastructure and large scale.

When you add these phases together, building a complete mine-to-oxide project in Canada often costs over $1 billion. This is why the preferred model in Canada is to have multiple mines ship their MREC to one shared separation facility, which reduces the cost burden on each individual project. This approach mirrors the Baotou hub model that has given China its long-standing cost advantage.

3.2 Government Funding and Support Programs

Given how much capital is needed and how important REE supply chains are to national security, both the Canadian and US governments have significantly increased their financial support for the sector. Key Canadian programs include:

- Critical Minerals Sovereign Fund (C$2 billion, Budget 2025): This fund allows the federal government to take direct ownership stakes in strategically important critical mineral projects, through equity investments, loans, and offtake contracts. This is a relatively new approach for the Canadian government and reflects how seriously the sector is now taken.
- First and Last Mile Fund (C$1.5 billion, 2026 to 2030): This fund targets the infrastructure gaps that prevent remote mining projects from reaching market, such as road, rail, and port access.
- Critical Minerals Infrastructure Fund (CMIF): An existing program that provides grants for infrastructure studies at the project level. The Ashram project has received C$2.6M in conditional funding from this program for road access studies.
- Critical Mineral Exploration Tax Credit (30%): This tax credit reduces the after-tax cost of exploration for investors using flow-through share agreements, helping support junior mining companies that need to raise capital.
- C$6.4 Billion Production Alliance (October 2025): Under Canada's G7 Presidency, Canada announced over 20 new investments and partnerships aimed at accelerating 26 critical mineral projects.

On the US side, the Department of Defense has become a direct funder of North American processing technology. The most notable example is the US$22.4M commitment to Ucore Rare Metals' RapidSX project, discussed in Section 5. The US also reportedly invested around US$400M in Mountain Pass operator MP Materials. This defence-sector funding is an important tailwind for Canadian processors that can supply defence-grade REE oxides into North American supply chains.

3.3 Key Investment Risks

Despite strong government support, investing in Canadian REE projects still carries significant risk compared to most other mining sectors:

- Price Volatility: REE prices are unpredictable and are heavily influenced by Chinese government decisions. A project that looks profitable at today's prices could struggle if China eases its export restrictions and prices fall back toward Chinese domestic levels.
- Processing Risk: Every REE deposit has different mineralogy, meaning the processing plant design has to be tailored specifically to that ore. If the process does not work as planned at the pilot stage, it can set a project back by years.
- Radioactive Waste: Most economically viable REE deposits contain monazite, which occurs alongside naturally radioactive material including thorium. Handling and disposing of radioactive tailings adds regulatory complexity, cost, and community concern that is not present in most other mining projects.
- Finding Buyers: Without a committed customer for separated oxide products, a project cannot secure financing. The lack of a functioning separation industry outside China creates a circular problem: mines need a processor to sell to, and processors need a mine to supply them.

4. Role of Government

Governments in Canada and allied countries have moved beyond offering small subsidies for REE projects. They are now acting as direct investors and strategic partners. This shift reflects a growing view that critical mineral supply chains are a matter of national security, similar to how governments have historically managed things like oil, steel, or microchips.

4.1 Canada's Strategic Approach

Canada's Critical Minerals Strategy, backed by nearly $4 billion in Budget 2022 and expanded significantly through 2025, lists REEs as one of six priority minerals alongside lithium, graphite, nickel, cobalt, and copper. Canada's goal is not just to dig up ore and export it, but to process and refine it domestically and eventually manufacture magnets and other finished products in Canada. This would create more skilled jobs and give Canada and its allies a reliable, transparent supply of REEs that does not depend on China.

The government has introduced several tools to support this goal, including designating certain critical minerals as national security priorities under the Defence Production Act (which allows the government to direct domestic production if needed), proposing new export permit rules to respond quickly to foreign supply chain pressure, and negotiating cooperation agreements with Japan, the EU, Australia, and the United States.

4.2 The Case for a Saskatchewan Processing Hub

One of the most discussed ideas in Canadian REE policy is building a centralized REE separation facility in Saskatchewan. The province has existing expertise in handling nuclear and radioactive materials through Canadian Nuclear Laboratories and the University of Saskatchewan, which is important because most REE deposits contain some radioactive thorium. A Saskatchewan hub could accept mixed cake material from multiple Canadian mines and separate it in one place, rather than requiring each mine to build and pay for its own separation plant.

Saskatchewan's advantages for this kind of facility include its nuclear-grade chemical expertise, existing mining and energy infrastructure, a supportive provincial government, and access to the power supply needed to run an energy-intensive separation circuit. While no hub has been formally approved yet, the concept has gained support from Natural Resources Canada and several junior mining companies. If built, it would be the Canadian equivalent of China's Baotou hub.

4.3 Permitting Timelines and Indigenous Consultation

One of the most consistent challenges for Canadian REE development is how long it takes to get permits. Remote projects in northern Quebec, the Northwest Territories, and Labrador require reviews under the federal Impact Assessment Act, provincial environmental assessments, and meaningful consultation with Indigenous communities under the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP). These processes are legally required and important, but they can add five to ten years to a project timeline, during which costs and market conditions can change significantly.

Prime Minister Carney's government has committed to speeding up the permitting process for projects that are considered nationally important, which could shorten timelines for projects like Ashram. Ontario has committed nearly C$3.1 billion in loans, grants, and scholarships to support Indigenous ownership and participation in its critical minerals sector, recognizing that working with Indigenous communities as partners rather than just stakeholders is both a legal requirement and often a condition for projects getting approved at all.

CANADIAN REE COMPANIES OF INTEREST

5. Canadian Companies of Interest

The three companies below represent different stages of the Canadian REE value chain and give a useful picture of the financial and strategic landscape. Together they cover a producing processor, a technology developer, and an early-stage exploration company.

Company	Ticker	Stage	Key Metric	Strategic Relevance
Neo Performance Materials	NEO (TSX)	Producing	~$482M trailing revenue; EBITDA guidance raised to $67-71M	Only integrated mid/downstream REE processor outside China; operates in Canada, Europe, Asia
Ucore Rare Metals	UCU (TSXV)	Pre-revenue / Development	US$22.4M DoD funding; CA$36.3M conditional Canadian gov't approval	RapidSX technology could become a key part of North American REE separation; targeting early production 2026
Mont Royal Resources (Ashram)	MRZ (TSXV/ASX)	Exploration / PEA	73.2Mt @ 1.89% TREO indicated resource; 2015 PEA NPV est. $2.32B pretax	One of North America's largest REE deposits; NdPr-rich; government infrastructure funding secured

5.1 Neo Performance Materials (TSX: NEO) -- The Integrated Processor

Business Overview

Neo Performance Materials is the most financially established Canadian-linked REE company. Based in Toronto and listed on the TSX, Neo processes rare earth materials and manufactures magnet products, making it one of the only companies in the world doing this outside of China. It operates three business segments: Magnequench (bonded NdFeB magnetic powder used in EV motors, sensors, and small actuators), Chemicals and Oxides (rare earth chemicals and industrial materials), and Rare Metals (specialty metals like tantalum, niobium, hafnium, gallium, and indium).

Financial Performance

Neo's 2024 revenue was approximately **USD $475.8 million**, down 16.75% from $571.6 million in 2023. This decline reflected weaker REE prices through much of 2024. The company posted a net loss of $12.95 million that year. However, 2025 has shown a clear recovery: Q3 2025 revenue was $122.2 million compared to $111.3 million in Q3 2024, a 9.8% increase year over year. Revenue through the first three quarters of 2025 was $358.5 million versus $340.9 million in the same period of 2024. Management raised its full-year 2025 Adjusted EBITDA (earnings before interest, taxes, depreciation, and amortization) guidance to **$67 to $71 million**, up from its earlier estimate of $64 to $68 million, driven by strong volume growth in its Magnequench segment. As of mid-2025, Neo held trailing twelve-month revenue of about $482 million and had over $110 million in available liquidity.

Relevance to the China Supply Chain Issue

Neo is arguably the most relevant Canadian-linked company when it comes to China's export controls. Its Magnequench division is one of the only facilities outside China that can produce NdFeB bonded magnetic powder at commercial scale. This is exactly the kind of product that has been directly affected by Chinese export restrictions. Neo operates manufacturing plants in Thailand, China, and Estonia, and has positioned itself as the go-to non-Chinese supplier for automotive and industrial magnet customers. In March 2026, Neo signed a major agreement with Cyclic Materials to recycle magnet scrap and feed it back into its magnet manufacturing process, helping to reduce dependence on new raw material sourcing. Neo's ability to operate across the value chain from refined oxides all the way through to finished magnet products is a major advantage that most smaller Canadian mining companies cannot match in the near term.

From a valuation standpoint, Neo has traded at a discount to its peers due to recent earnings pressure, which could make it an interesting entry point for investors looking for exposure to non-Chinese REE processing with an existing revenue base and a dividend track record.

5.2 Ucore Rare Metals (TSXV: UCU) -- The Technology Developer

Business Overview

Ucore Rare Metals is a Halifax-based development-stage company. Its main asset is a proprietary separation technology called RapidSX. Traditional rare earth separation uses large, fixed chemical columns and requires a lot of infrastructure. RapidSX is designed to be more compact, modular, and more energy-efficient. Ucore's strategy is that RapidSX can lower the upfront cost and ongoing operating cost of building a separation facility outside of China, which has historically been the biggest obstacle for Western REE processing.

Financial Position and Government Backing

Ucore is not yet generating revenue and is currently losing money, reporting a net loss of approximately CA$33.3 million in its most recent annual period. Its investment case rests entirely on whether its future projects succeed. What is notable for a company at this stage is the level of government funding it has secured: **US$22.4 million in non-repayable funding** from the US Army Contracting Command for construction of a commercial RapidSX machine at its planned Louisiana processing facility, plus **CA$36.3 million in conditional Canadian government approval** for its Canadian processing work (announced October 2025). State-level incentives in Louisiana worth an estimated US$15 million have also been committed. In total, government support at various stages of commitment amounts to over CA$90 million.

The Louisiana facility is designed to separate six of the seven REEs that are on China's export control list: Pr, Nd, Sm, Gd, Tb, and Dy. Early production is targeted for the second half of 2026.

Valuation and Risk

Ucore trades at a price-to-book ratio of about **15.8 to 19.9 times**, which is much higher than the Canadian Metals and Mining sector average of 3.4 times. This high valuation reflects investor expectations about future success rather than current results. Analyst models based on discounted cash flow have estimated a fair value of **CA$22 to $25 per share**, compared to a recent market price around CA$6.46 to $8.53, which suggests the market is pricing in a lot of risk around whether Ucore can successfully execute its plans. Analysts forecast revenue growing at 61.3% per year once production starts, with the company reaching profitability within three years. Ucore is a high-risk bet on whether Western REE processing infrastructure can be built successfully, with the unusual feature that the US Department of Defense is the company's main financial backer.

5.3 Mont Royal Resources / Ashram Deposit (TSXV/ASX: MRZ) -- The Strategic Resource

Business Overview and Asset

The Ashram Rare Earth and Fluorspar Deposit in northern Quebec is one of the largest undeveloped REE deposits in North America. It is now held by Mont Royal Resources, a company formed through a merger between Commerce Resources Corp.

and an Australian-listed entity in October 2025. The project is located about 130 km south of Kuujjuaq in the Nunavik region of Quebec and is being planned as an open-pit mine.

Ashram's NI 43-101 compliant resource estimate (updated in 2024) is large: **73.2 million tonnes at 1.89% TREO indicated, and 131.1 million tonnes at 1.91% TREO inferred**. About 21% of the rare earth oxide content is NdPr, which is the most commercially valuable part of the basket. A 2015 preliminary economic assessment (which is now being updated) estimated a pretax NPV of **$2.32 billion** at a 10% discount rate, a pretax internal rate of return (IRR) of 44%, and total capital costs of $763 million. The project also contains a large fluorspar deposit, which adds additional revenue potential.

Infrastructure and Development Timeline

The main challenge at Ashram is not the quality of the ore but the lack of infrastructure to get there. The project has no road access from its current location, and building one is estimated to have cost around $300 million at 2015 prices. Mont Royal has received CA$2.6M in conditional funding from Natural Resources Canada for a road access study, and the company is now evaluating a route that would connect Ashram to the town of Schefferville by road, then use an existing rail line to reach the port of Sept-Iles. A PEA update is being worked on with a target completion in the first half of 2026.

On the processing side, the company has done pilot-scale metallurgical testing at two labs in Australia, confirming that Ashram ore can produce a clean, high-grade monazite concentrate that could be sold as an intermediate product. The plan is to start by selling this concentrate, then eventually finance a separation facility once the mine is running and generating cash.

Financial Profile and Strategic Value

Mont Royal is a very small company with a current market capitalization of about CA$21 million, which is a very small fraction of the deposit's estimated NPV. This large gap between market value and estimated resource value reflects the high risk: Ashram still needs hundreds of millions in future capital, multiple years of permitting, a solution to the road access problem, and ongoing consultation with Indigenous communities in Nunavik. The company has also applied for US Department of Defense funding, pointing to Ashram's dysprosium and terbium content as relevant to US military supply chain security.

For investors, Ashram is a long-term bet on the REE sector rather than a near-term investment. It is not suitable for investors looking for quick returns, but it could be very valuable if the Canadian government follows through on its infrastructure commitments and if REE prices stay high outside of China. The NdPr-rich monazite mineralogy is one of the most commercially attractive deposit types in the world, and the fluorspar co-product gives the project some additional income diversification.

6. Conclusion

China's control over rare earth element production, processing, and magnet manufacturing is one of the biggest supply chain risks facing Western countries today. The export controls introduced between April and November 2025 turned this from a long-term concern into a real and immediate problem, halting parts of the automotive industry, splitting global markets into separate pricing zones, and forcing governments to rethink their industrial policies.

Canada is well placed to respond. It has significant REE reserves in Quebec, Labrador, the Northwest Territories, and Ontario. The Toronto and Vancouver exchanges are among the top global centres for mining finance. And the federal government has put real money behind its critical minerals goals through the sovereign fund, the First and Last Mile Fund, and the broader C$6.4 billion Production Alliance.

The three companies covered in this section show the range of investment options available. Neo Performance Materials offers current revenue and an established processing business with near-term upside from recovering REE prices. Ucore Rare Metals offers high potential upside from its separation technology, backed by significant government funding, but carries meaningful risk as a pre-revenue company. Mont Royal Resources / Ashram offers long-term exposure to a world-class deposit that is still years away from production.

What all three have in common is that their success depends on two things: REE prices outside China staying high enough to justify the extra cost of non-Chinese supply, and governments continuing to provide funding and streamline permitting. If both hold, Canada has a realistic path to becoming a meaningful REE supplier for allied nations within this decade. If either one changes, most Canadian projects become economically marginal.

For the finance analyst looking at this sector, the key things to evaluate are the mix of elements in each deposit and what price can realistically be earned for each one, the specific processing approach and whether it has been proven at scale, the infrastructure requirements and who is paying for them, the regulatory and radioactive materials obligations, and how firm the government funding actually is. REE project analysis is one of the more complex areas in mining finance, and the geopolitical dimension makes it even more important to get the details right.

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SECTOR RESEARCH

03 Manufacturing

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KEY THEMES

· Industry 4.0 technologies are revolutionizing manufacturing
· Machine vision represents a disproportionate advantage in QA/QC in specific industries
· Companies in the Aerospace, Automotive, and Semiconductor space including the Musk line of corporations stand to benefit

AI METROLOGY IN HIGH-PRECISION MANUFACTURING

A new wave of technologies is on the cusp of revolutionizing industrials through the employment of automation, AI, and machine learning. These technologies are incapsulated within the "Industry 4.0" umbrella term, one representing the innovations and advancements associated with the fourth industrial revolution. Previously, I examined the employment of certain Industry 4.0 technologies in mining and addressed their implications in relation to the increasing supply deficit in the Copper industry. This article aims to evaluate the employment of specific technologies and their impacts in high-precision, low-tolerance manufacturing. Specifically, the paired use of AI, machine vision, and permeating sensing methods to detect both surface and sub-surface defects in manufactured products. Through evaluations of the methods, results, and production impacts of implementing strong defect detection technologies, predictions regarding financial performance of manufacturers, automation implementation and AI firms, and industrial indices will be made.

Metrology is the science of measurements and represents a key component of manufacturing. Measuring manufacturing components represents a critical step in the quality control process, representing the detection of defects, irregularities, and any other errors through the comparison of measured values against tolerances and allowances. Measurements are recorded using various methods each tailored to the specific application. In manufacturing metrology, measurement tools can primarily be sectioned off into two branches; contact and non-contact. Contact measurement tools such as calipers, micrometers, and CMMs (Coordinate Measuring Machines), are simple, upfront cost-effective, and both accurate and precise. They do propose certain drawbacks including faster rates of wear, slower measuring speeds, and the risk causing damage to or contaminating material surfaces. Machine vision introduces an opportunity to conduct surface measurements more rapidly and while eliminating the risk of damaging the measured object. Machine vision utilizes sensors, including broadband cameras in conjunction with software, to rapidly convert digital images into measurements. Additionally, using AI trained with a large database of images, machine vision can detect surface defects rapidly without being in contact with the manufactured part. Utilizing machine learning and vision introduces an opportunity to close the loop between automated manufacturing quality control and assurance. In layman's terms, using live measurements of the manufactured product can help rapidly diagnose the quality of the part allowing adjustments to be made within the manufacturing process to reach the correct tolerances and allowances. Furthermore, collecting large quantities of data regarding production quality introduces opportunities to improve manufacturing processes to ensure future products meet quality standards. Rapid diagnosis times allow for improved throughput times from raw materials to completed products while ensuring quality control meets standards.

AEROSPACE MANUFACTURING: SPACEX

Engineering standards vary immensely by industry and application. Certain subsectors of manufacturing including medical/biotechnology, aerospace and defense, automotive, tech and more are particularly susceptible to costly failures caused by defective manufactured products. Inherently, this necessitates high-precision manufacturing and razor-thin margins for error. These industries have long stood at the cutting edge of revolutionary advancements in manufacturing accuracy and are leading the charge with implementation of industry 4.0 technologies. A particularly relevant example involves the current ecosystem of the private space exploration sector; an environment which is shaping up to be the second great space race. In recent history, governments, including the US, China, Japan, UK, and Canada to name a few, have begun supporting the development of private space exploration sectors through contracting private firms. This has allowed certain countries to maintain a competitive advantage and interest in global space exploration without the financial load of solely government funded initiatives. The United States offers the most bustling market of private space exploration firms including SpaceX, Blue Origin, United Launch Alliance (ULA), Axiom Space, Sierra Space, Virgin Galactic, and more. Currently, SpaceX stands as one of very few private firms which have found strong non-contract global revenue streams through their operations because of their StarLink program which has installed over 11,000 orbital satellites with the intention of delivering high speed internet and cellular service globally [1]. Additionally, SpaceX has received enormous government contracts including a sizeable 5.9-billion-dollar portion of a 13.5-billion-dollar joint department Pentagon contract to support Space Force launches through to 2029 [2]. Additionally, they received a recent 57-million-dollar U.S. military satellite contract. SpaceX is also particularly interesting due to their reusable approach to rocketry. Typically, rocket launches including ULA's Atlas V or NASA's SLS utilize solid rocket booster stages for initial high power and lift to overcome the immense atmospheric drag during the first portion of the launch. These solid rocket boosters (SRBs) operate analogously to igniting a firecracker. Once lit, the firecracker will combust vigorously at a specific rate which can only be controlled by changing the chemical composition or geometry of the firecracker, not during the use of the combustible, and will continue exploding until the fuel is depleted. This means SRBs offer advantages in power, but disadvantages in controlling the rocket in-flight. Additionally, SRBs are terrible for the environment due to their production of ozone-depleting substances including hydrogen chloride (HCl) and Aluminum Oxide (Al2O3). All SpaceX rockets, including the Falcon 9, Falcon Heavy, and Starship, utilize entirely liquid propellent boosters. Furthermore, these boosters contain their own control systems allowing SpaceX to de-orbit, land, and reuse boosters for multiple missions offering advantages in cost, time, and latent defect probability.

If a manufacturing process has a probability of creating a latent defect, for the sake of an arbitrary example we'll define that 1 in 100 products are manufactured with a critical hard-to-detect defect, then reusing parts which have performed as expected in use reduces the likelihood of replacing the object with a newly manufactured product which may contain a latent undetectable defects. However, it is important to consider that reused parts are susceptible to fatigue and may develop additional defects because of repeated loading. Typically, Engineers use large factors of safety in terms of a material or objects ability to sustain cyclical loads without failing. This is a variable within the control of engineers as opposed to latent manufacturing defects which are more challenging to control or predict. Recovering rocket boosters and reusing them has the additional advantage of providing insight into the impact of flight on the boosters and in understanding the stress and strain the boosters experience to more accurately understand and model the fatigue of the rockets.

Beyond secondary quality considerations such as latent failures and fatigue, SpaceX utilizes AI across all operations including manufacturing. SpaceX has not publicly expressed the use of machine learning or vision in specific components of their manufacturing but has expressed the use of advanced automated manufacturing systems. These include utilizing cutting-edge manufacturing techniques including metal additive manufacturing, specifically Laser Beam Powder Bed Fusion (PBF-LB) metal AM to produce the Raptor 3 engines used on the Starship launch vehicle.

AUTOMOTIVE MANUFACTURING: TESLA

Tesla has substantially more transparency in their manufacturing processes and discloses the use of machine vision AI systems which constantly observe and monitor the manufacturing processes. Using machine vision, Tesla extracts high-quality images of components and assemblies in conjunction with machine learning which allows for real time defect detection. Tesla relies immensely on machine vision as smart factories now deploy AI and sensor networks to inspect parts in real time. Predictive analytics flag anomalies before they become defects, reducing scrap rates and unplanned downtime. In gigacasting specifically, X-ray inspection systems verify the internal integrity of large castings where surface inspection alone is insufficient. Tesla's investment in cutting edge manufacturing is broad. Tesla has employed the use of gigacasting and other automated practices. Gigacasting is a form of high-pressure casting in which very large machines produce massive structural parts as a single piece. Where traditional manufacturing relies on many stamped metal components welded together, gigacasting consolidates them into one solid casting, simplifying assembly and reducing potential failure points. From an engineering standpoint, this proposes advantages by eliminating numerous joints and welds allowing for greater structural integrity, fewer seams, reduced probability of assembly defects, and simplified part design. In manufacturing, cycle times can be reduced resulting in lower labor requirements per unit and reduced tooling and equipment overhead. Tesla pioneered large-scale gigacasting in automotive production, consolidating more than 70 individual parts into a single rear underbody casting on certain models. The results of faster build times and lower per-unit costs prompted rapid interest from competitors. Ford Motor Company, Toyota Motor Corporation, and BYD Company are among the established players now investing in similar capabilities, recognizing that the technology represents a structural shift rather than a temporary trend. Tesla has also employed numerous other Industry 4.0 manufacturing methods including industrial robotics which handle the most demanding physical tasks in gigacasting plants for operation, part extraction, and trimming without fatigue or variation. Beyond gigacasting, robotic arms perform welding, material handling, and precision assembly across all types of manufacturing, delivering speed, safety, and process consistency. Additionally, Computer Numerical Control (CNC) machining brings micron-level precision to cutting and shaping operations. After a gigacasted product is produced, CNC tools are typically used for creating tight tolerances that the casting process alone cannot guarantee. High repeatability, minimal material waste, and reduced manual intervention are the hallmarks of CNC-integrated lines.

SEMICONDUCTOR METROLOGY: TERAFAB JV

The importance of denoting Tesla's investment in Industry 4.0 manufacturing methodologies is due to the close ties of Tesla and SpaceX including sharing high level management such as Elon Musk (CEO and CTO of SpaceX, CEO and Member of the Board of Tesla) and their materials engineering teams lead by Charles Kuehmann (VP of Materials Engineering for both firms). Additionally, when considering their work on a joint venture to produce the Terafab semiconductor fabrication facility, it is more than likely machine vision and AI metrology technologies have already been implemented at SpaceX. To dive deeper into the Terafab venture, it will aim to produce two nanometer AI semiconductor chips in an initially 0.5TW/year facility which can scale upwards as the facility itself produces 1 TW/year through solar power. Additionally, on top of the joint efforts of all three of Elon Musk's largest companies, the Terafab project has recently (April 23rd, 2026) announced a partnership with Intel, specifically outlining the use of Intel's 14A advanced manufacturing process to produce artificial intelligence chips. This is the industry's first high numerical aperture extreme ultraviolet (High NA EUV) process which allows eight nanometer (1x10-9 m) resolution printing allowing for 1.7 times smaller printing than existing EUV methods. This allows for immense benefits in chip density while reducing the need for multiple patterning steps which is more cost-effective. This nano-scale manufacturing process relies heavily on machine vision and metrology to inspect the silicon wafers throughout the manufacturing process, detecting micrometer-sized defects such as grinding marks, scratches, or cracks, during thinning and assembly. This allows Intel to catch defects earlier which avoids downstream damage to the wafers as well as potentially recovering materials before they are ultimately too damaged to reuse. Intel has determined that up to 50% of wafer-thinning issues can be detected earlier with inline machine vision inspection compared to offline inspection. This allows the wafer to be reworked earlier in the process, avoiding whole-wafer delamination in later processes. Additionally, machine vision allows defects to be detected as they occur, shuts down manufacturing tools at the onset of a defect as to not cause further damage, and in doing so, increases product quality while saving Intel 2 million USD annually in scrap avoidance.

SPACEX IPO & MARKET IMPLICATIONS

Through the analysis of modern manufacturing practices in industries with high precision requirements, there exists multiple investment opportunities. The SpaceX IPO sets the new bar for the largest IPO in history, aiming for a $1.75 - 2 trillion USD valuation. Following an IPO at a share price of $135 USD for 556 million issued shares, SpaceX raised 75 billion USD, exceeding Saudi Aramco's previous record of $29 Billion USD [3]. When trading commenced, the stock price rallied 20% in a day and continued rising above the $200 USD mark, raising SpaceX's total market capitalization above $2.5 trillion USD. The underwriting syndicate of the offering includes major financial institutions including Morgan Stanley, Goldman Sachs, JPMorgan Chase, Bank of America, and Citigroup as active bookrunners alongside 16 other financial institutions in smaller roles.

As standard in public offerings, the makeup of the investors was 80% institutional and 20% retail. It is important to note that not everything relating to this IPO was "business as usual". In the retail space, purchasing shares was possible through multiple platforms including Robin Hood and Fidelity. Most of the platforms had no minimum investment requirement, barring Fidelity, which lowered its minimum investment requirement from $500,000 USD to $2,000 USD. Additionally, Fidelity shortened the "no flip" period from 30 days to 15 days. This introduced accessibility to smaller retail investors and a more rapid introduction of additional liquidity from those looking to flip the stock.

SPACEX VALUATION MODEL

Due to the diversified infrastructure model of SpaceX, creating accurate comparisons between existing public companies is challenging. It necessitates creating multiple peer sets and combining the derived multiples and ratios to arrive at a valuation. SpaceX's revenue structure is additionally complex. A combination of lump sum contracts, subscriptions, one time product purchases across space launch, AI model and infrastructure, and telecom operations.

Company Comparison Table

All values in billions of USD, information drawn from Yahoo Finance [16]

Technology/Aerospace	Ticker	Mkt Cap	EV	Revenue LTM	EBITDA LTM	EV/Revenue	EV/EBITDA	Revenue Growth
GE Aerospace	GE	357.09	366.39	48.31	11.04	7.58	33.19	24.70%
RTX Corporation	RTX	251.52	283.64	90.37	15.26	3.14	18.59	8.70%
Lockheed Martin	LMT	122.28	141.08	75.11	7.99	1.88	17.66	0.30%
Northrop Grumman	NOC	77.37	91.6	42.37	7.31	2.16	12.53	4.40%
Boeing	BA	180.48	206.79	92.18	-3.26	2.24	-63.43	14%
Sector Averages						3.4	3.708	10.42%

Commercial Space	Ticker	Mkt Cap	EV	Revenue LTM	EBITDA LTM	EV/Revenue	EV/EBITDA	Revenue Growth
Rocket Lab	RKLB	68.26	67.02	0.67958	-0.16483	98.62	-406.6	63.50%
AST SPaceMobile	ASTS	26.16	26.12	0.8494	-0.31639	30.75	-82.56	1952.20%
Intuitive Machines	LUNR	4.13	4.33	0.33426	-0.9064	12.95	-4.78	198.70%
Planet Labs	PL	10.9	10.66	0.33561	-0.5172	31.76	-20.61	
Sector Averages						43.52	-128.6375	738.13%

Telecommunication	Ticker	Mkt Cap	EV	Revenue LTM	EBITDA LTM	EV/Revenue	EV/EBITDA	Revenue Growth
T-Mobile	TMUS	204.39	322.08	90.53	33.88	3.56	9.51	10.60%
Verizon	VZ	196.54	384.05	139.15	51.1	2.76	7.52	2.90%
AT&T	T	161.83	298.64	126.53	44.41	2.36	6.72	2.90%
Charter	CHTR	17.67	113.98	54.64	21.97	2.09	5.19	-1%
Sector Averages						2.6925	7.235	3.85%

AI Infrastructure	Ticker	Mkt Cap	EV	Revenue LTM	EBITDA LTM	EV/Revenue	EV/EBITDA	Revenue Growth
CoreWeave	CRWV	58.22	91.1	6.23	3.02	14.62	30.17	111.60%
Applied Digital	APLD	13.28	14.38	0.31926	0.0139	45.04	1034.53	139.30%
Core Scietific	CORZ	8.97	10.02	0.35474	-0.09674	28.25	-103.58	44.90%
Nebius	NBIS	66.03	66.23	0.8779	-0.0386	75.44	-1715.8	683.90%
Sector Averages						40.8375	-188.67	244.93%

Target	Ticker	Mkt Cap	EV	Revenue LTM	EBITDA LTM	EV/Revenue	EV/EBITDA	Revenue Growth
SpaceX	SPCX	2520	2530	19.3	3.95	131.09	640.51	15.40%

As depicted in the model above, the EV/Revenue and EV/EBITDA multiples of 131x and 660x respectively that SpaceX currently trades at are unparalleled in all industries the company operates in. The closest comparisons are certain commercial space and AI infrastructure companies with EV/Rev multiples of between 30x and 100x with both sector averages in the 40x range. Even with a generous multiple of 60x ,70x, even up to 100x, the current SpaceX price is highly overvalued against peers. This is where the fundamental challenge is; SpaceX truly has no peers. Until the IPOs of Anthropic and OpenAI, there are no peers in the model development space to compare against. Even then, no company has combined end to end connectivity infrastructure from launch, to delivery, to computation. As such, comparative analysis should be taken with a grain of salt.

It is my opinion that with all the considerations discussed in this article, the current valuation of SpaceX is overvalued. Due to the telecom dependency of the business, a business which cannot grow revenues at the rate AI investments consume funds, paired with the uncertainties of proposed initiatives which have not begun, including Terafab and the orbital data centers, an EV/Revenue multiple of 131x is far too high. The current share price reflects extreme market optimism and dependence on the success of proposed initiatives, competitiveness in the AI model development space, and few interruptions in the development of existing Starlink and Starship programs. My prediction is that the share price will fluctuate dramatically once the quiet period ends and retail investors are free to flip the stock. Additionally, if any quarterly earnings reflect lower-than-expected performance, particularly slower revenue growth and increased CapEx without successful launches, AI product development, or other tangible advancements, there will be significant downward motion in the stock price. Lastly, in the longer term, if SpaceX cannot grow away from the Starlink business being its primary revenue source to becoming simply a means of AI computation communication infrastructure, they will not be able to capitalize on the opportunities propping up the TAM cited in the SpaceX S1.

DOWNSIDE PERSPECTIVE

The SpaceX S1 included the largest total addressable market in human history, $28.5 trillion USD, a value larger than every nation's GDP barring the US. Of this TAM, $26 trillion USD was attributed to AI related initiatives. Furthermore, $2.4 trillion USD comes from AI infrastructure, which is the bulk of SpaceX's existing and proposed AI initiatives as they pivot towards a neoscaler model. Another $22.7 trillion USD is tied to "enterprise applications" which includes AI automated workflows and the employment of the Grok AI in enterprise. The significance of the Grok AI's performance in the projected opportunity of SpaceX cannot be understated. Model development is a financially fruitful business model that requires incredible capital investment to rise above the saturated market competition. As it stands, xAI and its products are not a competitor of Anthropic and OpenAI. To get to that level will require additional CapEx, continuing a cycle of investment and operating at a net loss. This cannot happen when the current price in propped up upon revenue projections of consistent quarter over quarter growth extending as far as the next decade. Alternatively, SpaceX is pursuing a $60 billion USD all-stock acquisition of Cursor, a model development firm, expected to close in the third quarter. This acquisition was announced near when SpaceX stock price peaked and is subject to change depending on the long-term performance of the stock. Although this acquisition would significantly strengthen SpaceX's AI development capabilities, there is significant uncertainty regarding the final terms of the acquisition.

Following SpaceX's acquisition of xAI in February 2026, the combined entity was valued at $1.25 trillion USD [4]. Personally, the $500 billion USD valuation gap that appears to have risen between February and now feels dramatic. The Terafab - Intel partnership, though promising, will only tangibly aid the balance sheet in coming years with an unclear timeline in place. The Terafab project aims to internalize chip manufacturing to eliminate the angst of global supply challenges. This does provide the positive impact of reducing expenditures in purchasing chips from other manufacturers such as Nvidia, TSMC, Samsung, and Intel while eliminating supply chain disruptions. It does not, however, provide very many opportunities for revenue growth. In a firm with a $1.75 trillion USD valuation and only $18.5 billion USD in revenue in FY2025 (12.3 billion USD from Starlink which already runs at an operating margin of above 60%), opportunities for additional revenue streams are essential. It is also important to note the capital structure of the firm as in 2025 SpaceX operated at a $5 billion USD net loss largely driven by immense capital expenditure on AI infrastructure and the acquisition of xAI. The firm also refinanced its debt with a $20 billion USD 18-month bridge loan which is designed to consolidate earlier, more fragmented debt, including term loans from xAI and the X platform. Additionally, recent news indicates further Starship development will add roughly 15 billion USD to existing CapEx.

Musk has articulated a strong vision for the firm's future, including the further development of the Starlink business, development of AI and robotics similar to the Tesla Optimus, and construction of data centers in space. Additionally, SpaceX have ambitious plans to continue to advance human spaceflight and ultimately achieve interplanetary colonization of our solar system. The very ambitions of the firm present a challenging dichotomy between financially fruitful opportunities and those which Elon Musk himself desires. Musk, who following the IPO will retain his seat as CEO and CTO with a strong equity hold on the company, has historically demonstrated a habit of following projects he is passionate about despite the financial impact. To name a couple examples, Musk's acquisition of X, formerly Twitter, was a personal decision motivated by Musk's displeasure with the state of modern social media "censorship" and a desire for more unrestricted expression. This decision has resulted in a 75-80% decline in the valuation of the company due to immense losses of advertising revenue and driving away corporate partners who disagreed with political views of Musk. Another example, Tesla's Cybertruck which Musk conceptualized following Musk's opinion that the classic "3 box design" of modern trucks was "boring" and him wanting to design something futuristic that looked like it came from "Blade Runner and Mad Max". In the end, the final Cybertruck design exhibited numerous issues and resulted in a devastating sales flop which missed Musk's projections by 84%. Additionally, Tesla sales have declined dramatically in protest of the political opinions and reach of Musk, especially following his involvement in the Department of Government Efficiency (DOGE) and with President Trump. Following President Trump's inauguration in January 2025, Tesla stock tanked from $429.36 USD at open on January 20th to a low of $241.45 USD on April 17th. After a public feud between the President and Musk leading to Musk's resignation from the Trump administration in May 2025, Tesla prices have begun rallying upwards (currently at roughly $380 USD) but still have not returned to their original high. Musk has the challenging decision with SpaceX of prioritizing opportunities which directly benefit the financial performance of the firm or those that advance his personal passion of interplanetary colonization. Skepticism from investors reflects that historically, he has continuously chosen to follow his own ambition which may come at the cost of stock performance. Additionally, Musk has repeatedly faced SEC investigations for market manipulation because of a history of questionable tweets that introduced movements in Tesla share price.

The structure of the SpaceX IPO has left Elon Musk as an owner of all Class B shares, worth 10 votes rather than the singular vote of Class A shares. This means he retains 80% majority voting right and over 50% ownership over the company. Though this unilateral control could be viewed as positive to fans of Musk as a streamlined corporate governance structure which allows the visionary to execute his vision for SpaceX, it does introduce skepticism towards the value that owning equity in the company truly gives shareholders. In the hands of a historically volatile but successful leader whose personal vision for the company is vastly different from the initiatives necessary to grow the revenues of the company, there's a lack of comfort in the minimal say shareholders have.

Price Opinion: Bear

I believe at an EV/Rev multiple of a 75x, resulting in a share price of roughly $80 USD and an EV if $1.45 trillion USD, SpaceX would safely valued still at an immense premium to its telecom peers but at nearly identical and slightly reduced multiples to its commercial space and AI infrastructure peers. This would account for the significant dependency on telecom revenues and currently underdeveloped AI infrastructure.

UPSIDE PERSPECTIVE

With the previous section in mind, it is also essential to be unbiased on the upside potential of SpaceX. The Starlink business has grown revenues twice over the last year and continues to show immense potential for internet, and now, cellular connection globally without the need for terrestrial cell towers. Additionally, Terafab semiconductor chip manufacturing presents an opportunity in increasing the operating margins of SpaceX and xAI operations and put SpaceX one step closer to their orbital data center goal. SpaceX launches have also reached a new high this year and have been the recipient of numerous government and commercial contracts. If Musk is capable of avoiding his previous pitfall of making decisions driven by personal ambition, directing SpaceX to continue investing in the opportunities that have genuine financial potential, the upside potential of SpaceX is enormous. These opportunities include continuing to expand Starlink to achieve the objective of 100% global coverage, advancing payload launch capabilities to maintain their position as the preferred private contractor for orbital satellite injection, and expanding the Terafab facility independently support the AI chip requirements of existing systems as well as the orbital data center initiative. This last slightly more ambitious initiative to produce data centers in orbit could provide environmental, resource, and energy preferable alternatives to the water and electrically demanding terrestrial technology. This would provide yet another revenue stream for the firm which could create serious upside. Additionally, rumours of further mergers with Tesla have circulated post IPO. This would introduce stronger balance sheet revenue stability and additional synergies in the co-operative initiatives of the two companies. With an additional revenue stream complimenting the already diverse income structure of SpaceX, many of the criticisms of the overly optimistic forward-looking valuation become less poignant. Additionally, the successful acquisition of Cursor could propel SpaceX into the Mount Rushmore of AI model development companies alongside OpenAI and Anthropic. This would open up significant opportunities within the AI sector and make the claims of the S1's TAM potentially (partially) attainable.

Terrestrial data centers offer a useful financial benchmark for understanding the orbital opportunity. Construction of a standard data center averages $10–$12 million per megawatt (MW) of commissioned IT load, with AI-optimized facilities reaching $20 million per MW or more [5]. JLL's 2026 Global Data Center Outlook places the current global average at $11.3 million per MW, a 6% year-over-year increase [6]. On the revenue side, a mid-scale 30 MW colocation facility must generate approximately $100 million per year in revenue to achieve a 10% internal rate of return after accounting for electricity costs and maintenance [7]. Colocation pricing across U.S. primary markets exceeded $200 per kilowatt per month on average in 2025, with power-constrained hubs pushing rates significantly higher [8]. IBISWorld estimates the total U.S. hyperscale data center services market at $111.2 billion in 2025, with the broader U.S. data processing and hosting industry approaching $383.8 billion [9].

These impressive revenue figures are, however, offset by substantial and growing operating costs overwhelmingly tied to power and water. Electricity represents 15–25% of total data center operating expenses, and a 30 MW facility can carry $100 million in annual operating costs [7]. A 100 MW hyperscale facility, considered a standard deployment unit for major cloud operators, may consume roughly 530,000 gallons of water per day for cooling alone, according to International Energy Agency estimates [10]. In aggregate, U.S. data centers directly consumed approximately 17 billion gallons of water for cooling in 2023, a figure projected to double or quadruple by 2028 as AI expansion continues [11]. Community opposition to these environmental footprints is already material: $98 billion in U.S. data center projects were blocked or delayed in Q2 2025 alone due to local resistance [12]. U.S. customers and regulators are increasingly scrutinizing the strain large-scale facilities place on local electricity grids and water supplies, creating both permitting friction and reputational risk for operators in established markets. These terrestrial constraints — power scarcity, water consumption, community opposition, and grid congestion — form the core of Musk's stated rationale for the orbital data center initiative [13].

Translating these economics into an orbital context requires understanding Starship's payload capacity and launch economics. In its baseline reusable design, Starship is specified to deliver over 100 metric tons (100,000 kg) to low Earth orbit per launch, with SpaceX targeting a customer price of $10–$180 million per launch depending on maturity of operations [14]. As reuse cycles accumulate, the internal cost per kilogram is projected to fall from ~$94/kg at six flights to as low as $13–$32/kg at high cadence [15]. For a preliminary orbital data center capacity estimate, one can apply the terrestrial metric of $10–$12 million per MW of IT capacity and consider that a modern server rack weighs approximately 100–200 kg fully equipped. A conservative single Starship cargo manifest of 100 metric tons could therefore deliver on the order of 500–1,000 fully equipped server racks to orbit, representing somewhere in the range of 5–20 MW of compute capacity depending on rack density — the equivalent terrestrial build cost of which would be $50–$240 million [5][6]. At a colocation revenue rate of $200/kW/month, a 10 MW orbital facility would carry an annual revenue potential of approximately $24 million per MW, or $240 million annually for a 10 MW deployment — suggesting a payback horizon broadly comparable to terrestrial builds, before accounting for the elimination of land, cooling water, grid interconnection, and permitting costs that increasingly constrain earthbound projects [8][9]. While the engineering challenges of orbital thermal management, power generation, and latency are non-trivial, the fundamental unit economics suggest that at sufficient Starship launch cadence, space-based computing could become cost-competitive with, and regulatorily preferable to, terrestrial alternatives in the medium term.

Price Opinion: Bull

I believe at an EV/Rev multiple of a maximum of 100x, resulting in a share price of roughly $140 USD and an EV if $1.93 trillion USD, SpaceX would be over-valued but somewhat reasonable and at an immense premium to its telecom peers but similar multiples to its commercial space and AI infrastructure peers. This would incorporate significant forward-looking optimism regarding certain fruitful opportunities in AI infrastructure without being naïve to the immense challenges and costs of not only developing products and advancing projects but making them commercially viable to break free of the cash burn cycle into positive earnings.

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04

SECTOR RESEARCH

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KEY THEMES

· Autonomous vehicles
· Canada-China EV trade agreement
· Transportation infrastructure
· BYD investment memo

AUTONOMY, SAFETY & CYBERSECURITY

Abstract

Canada's transportation sector finds itself at a genuine crossroads. Battery costs have collapsed by over ninety percent in a decade, autonomous driving is pushing its way onto public roads, and the politics of global trade are deciding which countries get to build the next generation of vehicles. Despite all of that, Canada still falls short. It has the minerals, the clean power, and the engineers, but not the manufacturing scale, the battery capacity, or the integrated supply chains that China and Germany have built up over decades. However, a recent move Canada has made was the January 2026 Canada & China electric vehicle trade agreement, which reduced tariffs on Chinese-built EVs from 100 percent to 6.1 percent on an annual quota of 49,000 units. While this deal won't close the gap alone, what it does is open a door that has been shut for years. This report examines the deal in the full context of autonomous vehicle development and the broader forces reshaping transportation, then presents a complete investment memo on BYD Co., Ltd. (HKEX: 1211), the world's largest EV manufacturer and the most direct beneficiary of the new arrangement. We recommend a long position based on three independent factors: The Canada & China Ev agreement gives BYD policy-secured access to the Canadian market for the first time; the company's international expansion is accelerating across multiple continents, providing a structural margin tailwind that the market is consistently underpricing; and BYD is a vertically integrated manufacturer, meaning it designs and produces in-house most of the components that other automakers buy from external suppliers, and that integration produces a per-vehicle cost advantage that competitors with outsourced supply chains cannot replicate.

Index Terms

Autonomous Vehicles, BYD Co., Battery Technology, Canada & China EV deal, Electric

Vehicles (EV), EV Tariff Policy, Lithium Iron Phosphate (LFP) Chemistry, Transportation Infrastructure, Vertical Integration.

Introduction

The global transportation sector is in the middle of its most significant reshaping in over a century. Battery costs have fallen by more than ninety percent over the past decade. Autonomous driving is moving from research labs onto public roads. And supply chain politics is rewriting which countries get to build the next generation of vehicles. For Canada, this moment carries real weight.

Canada has everything that should make it a major player. It holds all five of the critical minerals needed for next generation of EV batteries, it has abundant clean hydroelectric and nuclear power designed suited for large scale manufacturing. And its automotive industry, concentrated in Ontario, has a long and serious history of building vehicles for global markets. What it does not have is the manufacturing scale, the battery cell capacity, or the fully integrated supply chains that China and Germany have spent the last fifteen years building from the ground up.

That gap is real and continues to grow more each day. China produced more than nine million electric vehicles in 2025, which accounts for roughly two thirds of global EV output. Germany continues to anchor premium manufacturing in Europe through deep technical specialization and supplier networks built over more than a century. By comparison, Canada produced fewer than 200,000 EVs in 2025, almost all of them coming out of joint venture plants where the design, technology, and battery sourcing decisions are made somewhere else. No single policy announcement closes a gap of that size, but the country can begin closing it through deliberate and well sequenced steps.

The January 2026 Canada & China EV trade agreement is the most consequential step Canada has taken in that direction in years. Rather than trying to outspend the United States on domestic manufacturing subsidies, the Canadian government chose a different path: open the door to partnership with the world's most capable EV producers in exchange for tariff relief on Canadian canola exports to China. By cutting the tariff on Chinese-built EVs from 100 percent down to 6.1 percent on a quota of 49,000 vehicles annually, rising to 70,000 by 2030 [1, 3], the agreement does not solve the manufacturing problem on its own. It is, however, a meaningful first step, and it sets a template for how Canada can use targeted trade policy to close the distance to the global leaders.

This report examines that deal in detail, places it in the context of broader transportation trends, and uses it as the lens for a structured investment memo on BYD Co., Ltd. Section II examines the autonomous vehicle landscape, covering regulation, liability, and cybersecurity. Sections III through V cover adjacent forces shaping the sector: diversifying transportation funding models, the scaling of artificial intelligence in transportation, and future-proofing transportation infrastructure. Section VI analyzes the Canada-China EV trade deal in full. Section VII presents the investment memo on BYD. Section VIII concludes.

The Promise of Autonomy

You have probably heard it before that autonomous vehicles offer substantial potential benefits. This includes reductions in accidents, more efficient traffic flow, expanded mobility for elderly and disabled populations who cannot drive, and less carbon footprint through optimized routing. Yet, if we look at The Society of Automotive Engineers (SAE) International framework which classifies vehicles from Level 0 (no automation) through Level 5 (full automation requiring no human oversight). Commercial deployment today is only at Levels 2 and 3, where the human operator retains legal responsibility, supplemented by a small number of Level 4 robotaxi fleets operating in geofenced service areas under remote human supervision. This section examines the three areas that explain why deployment has stalled at these levels: safety requirements, liability & responsibility, and data privacy.

Safety Requirements

Laws & policy are beginning to catch up with technology. The United Kingdom's Automated Vehicles (AV) Act 2024 is among the most comprehensive frameworks enacted to date, requiring self driving vehicles to pass a verity of performance evaluations and to reach what the act terms a “minimal risk condition” in the event of automated system failure, meaning the vehicle must safely pull over and transfer control back to the human operator [5]. While countries like France and Germany are also requiring advanced automated vehicles to record driving data, like how airplanes have black boxes, effective 2025 [5]. Canada is behind these countries on these requirements, because it only has small testing programs in Ontario and British Columbia, but no comprehensive national act has been proposed. Currently, Canada does not yet have one clear national rulebook for self driving vehicles.

The United States has a different problem. Instead of having one clear national system, self-driving vehicle rules are split between the federal government and individual states. The National Highway Traffic Safety Administration (NHTSA) gives general guidance, but individual states establish their own operating rules [6]. For manufacturers seeking to scale their autonomous vehicle service internationally, they may have to follow different rules in every state, which increase legal costs, adds paperwork, and slows down the rollout of the technology.

Liability & Responsibility

Self-driving cars also create a major legal question: who is responsible if something goes wrong? Traditional traffic law assumes that a human driver is in control of the vehicle. But if a car is driving itself, that assumption no longer works When a self driving vehicle crashes, three liability approaches typically apply: product liability against the manufacturer or software developer for design or production issues; a human safety supervisor who failed to step in and prevent the risk; and/or the company operating the vehicle fleet [5]. Sorting all of this out requires countries to formally redefine who counts as a “driver”, a step Germany and the United Kingdom have already taken but Canada has not.

Insurance is undergoing a similar issue. Premium models that price an individual driver's risk profile do not work when there is no individual driver. If there is no real driver, insurance may need to shift toward the manufacturer or fleet operator instead.

Data Privacy and Cybersecurity

Self-driving vehicles collect massive amounts of data. A single robotaxi can produce more than four terabytes of sensor data per hour, drawing from lidar, radar, cameras, GPS, and vehicle-to-infrastructure communication. That data is essential because it trains the machine learning models, evaluates incidents, and allows for wireless software updates. However, it also creates serious privacy and cybersecurity risks. These vehicles may collect sensitive information about where people travel, how roads are used, and what is happening around the vehicle.

Because of this, cybersecurity is becoming a major issue in transportation. New standards such as the ISO/TS 5083:2025 standard are being developed to make sure connected vehicles handle data securely, use encryption, and receive safe software updates [5]. Deloitte's 2025-2026 Transportation Trends report flags cybersecurity as one of the five critical issues reshaping the sector [6], noting that transportation agencies have hardened their IT systems but lack operational technology, which is the actual hardware and software controlling the vehicle. For Canada, the import of Chinese manufactured vehicles under the new trade deal raises legitimate questions about who has access to the country's data at a national scale, and what Canada can do if foreign access or cybersecurity risks are discovered.

Country	Safety Requirements	Data Recorded Mandate	Liability Approach
United Kingdom	AV Act 2024	Required 2025	Manufacturer primary liability
Germany	StVG Amendment 2021	Required 2025	Type-approval liability pool
France	Decree Act 2021	Required 2025	Pending national legislation
United States	NHTSA guidance only	Voluntary	Product liability (state law)
Canada	Small testing in Ontario & BC only	Not yet mandated	Under development
China	National testing standards	Partial mandate	Manufacturer liability

TABLE I Autonomous vehicle requirements, mandates, and approaches by Country. Source: compiled from [5], [6].

TRANSPORTATION FUNDING & AI DEPLOYMENT

Diversifying Transportation Funding Models

Canada and the United States share a growing transportation funding crisis rooted in the same structural problem: both countries remain heavily dependent on fuel taxes that were designed for a world of gasoline-powered vehicles and are becoming less effective with every passing year. As vehicles grow more fuel efficient and electric vehicle adoption accelerates, governments collect less revenue per kilometer driven while facing the same — or greater — infrastructure costs [21]. The result is a widening gap between what transportation systems need and what existing funding mechanisms can deliver.

The scale of the shortfall is substantial on both sides of the border. In Canada, the federal government collects approximately $5 billion annually in fuel taxes, of which roughly $2 billion is transferred to municipalities through the Gas Tax Fund, while provincial governments collectively generate an additional $8 billion for road repair and construction [22]. In the United States, the fiscal challenge is even more acute. The gap between Highway Trust Fund expenditures and revenues reached $13.5 billion in 2024 and is projected to climb to nearly $37 billion annually by 2034.

The federal gas tax has not been adjusted since 1993 and now produces less than half of projected fund outlays, making the current model structurally unsustainable over any meaningful planning horizon [23]. In both countries, the expansion of electric vehicle use compounds the problem: EV drivers contribute little or nothing through fuel taxes while relying on the same road networks, and transportation agencies absorb the resulting shortfall without any compensating revenue mechanism.

Road User Charges

One of the most substantive long-term policy responses being explored on both sides of the border is a transition toward road user charges — fees based on actual distance travelled rather than fuel consumed. This approach aligns funding more directly with real road usage and represents a practical mechanism for ensuring sustainable transportation revenue as vehicle technology continues to evolve [24]. Several jurisdictions have already moved in this direction, with pilot programs and permanent schemes demonstrating that distance-based charging is administratively feasible at scale [25]. The model does not penalize EV ownership, but it does reduce one of the principal financial advantages currently associated with electric vehicles: the effective exemption from fuel-tax contributions to road maintenance. As EV adoption grows, that exemption becomes increasingly difficult to justify on equity grounds, and the political window for transitioning to user-charge frameworks will likely narrow as the EV-owning population expands.

Public-Private Partnerships and Innovative Financing

Beyond user charges, transportation agencies are also expanding their use of long-term public-private partnerships as a mechanism for mobilizing capital that public budgets alone cannot provide. Under these arrangements, dynamic tolling systems can generate substantial upfront revenue for governments while private concessionaires recover their investment through user fees over the life of a concession agreement [26]. The American Society of Civil Engineers has formally endorsed the expansion of innovative financing mechanisms of this kind, including both public-private partnerships and mileage-based user fees, as necessary complements to traditional public funding [27]. In Canada, the Canada Infrastructure Bank was established specifically to facilitate large-scale infrastructure financing of this type and is well positioned to support projects that combine public objectives with private capital [28].

The January 2026 Canada-China EV trade agreement adds urgency to both of these reform tracks. As the domestic vehicle fleet electrifies more rapidly under the new tariff structure, the revenue gap within fuel-tax-dependent highway and transit funding systems will continue to widen [29]. Governments that respond to this shift through proactive structural reform — whether through road user charges, expanded public-private financing, or both — will be better positioned to maintain and modernize their transportation networks than those that continue relying on temporary fiscal transfers to bridge a structural shortfall that is only going to grow.

Scaling Artificial Intelligence in Transportation

Artificial intelligence is no longer a future-facing concept in transportation—it is an active and accelerating force, reshaping how goods move, how roads are managed, and how public transit systems serve their riders. The global AI in transportation market reached $5.53 billion in 2025, and research from Precedence Research projects that figure will grow to $34.83 billion by 2034, representing a compound annual growth rate of roughly 22.9 percent [10]. That trajectory reflects the breadth of AI's applications across the sector: from the machine learning models embedded in autonomous vehicles to the optimization algorithms quietly rescheduling bus routes in real time. Understanding where AI is being deployed today—and where the remaining barriers sit—is essential context for evaluating the broader forces shaping transportation investment.

Traffic Management and Real-Time Optimization

One of the most visible deployments of AI in transportation is in traffic signal management. Traditional traffic lights operate on fixed timing schedules that were calibrated years or decades ago and cannot adapt to real conditions. AI-based systems, by contrast, pull in live data from cameras, road sensors, and GPS feeds to dynamically adjust signal timing in response to current traffic volumes, pedestrian crossings, and incidents [11]. The practical effects are meaningful: studies of AI-managed signal networks have found reductions in average wait times and improvements in intersection throughput, reducing the fuel waste and emissions that come with extended idling. Deloitte's 2025– 2026 Transportation Trends report highlights AI-driven traffic management as one of the most promising near-term tools for transportation agencies seeking to extract more capacity from existing road networks without costly physical expansion [6].

Public transit is another domain where AI optimization is delivering measurable results. By analyzing ridership demand in real time, machine learning models can predict peak travel periods and trigger service adjustments— rerouting buses, adding express runs, or redistributing fleet vehicles—before congestion develops. Research on AI managed public transit systems suggests these applications can reduce urban congestion by as much as 25 percent in optimized corridors [12]. For cities managing aging fleets with limited capital budgets, that kind of efficiency gain matters enormously. The technology also improves equity outcomes: when AI systems optimize schedules based on actual ridership patterns rather than fixed timetables, underserved routes tend to receive more responsive service.

Predictive Maintenance

Perhaps the most economically significant application of AI in transportation is predictive maintenance, which is the practice of using sensor data, historical service records, and machine learning models to anticipate when a vehicle or piece of infrastructure is likely to fail—before it actually does. The traditional approach to maintenance is largely reactive: something breaks, and then it gets fixed. That model is expensive in terms of both direct repair costs and in the operational disruption that comes from unexpected failures. AI-driven predictive systems change that equation by identifying degradation patterns early enough for planned, lower-cost interventions [9, 11].

New York City's Metropolitan Transportation Authority (MTA) has been a well-documented example of predictive maintenance in action, applying AI to its bus fleet to flag vehicles requiring service before breakdowns occur on route [13]. In the infrastructure domain, researchers have developed edge AI frameworks that embed prediction models directly into road-side hardware, enabling systems to forecast signal failures, sensor degradation, and pavement stress events within a 24-hour window [8]. The appeal is intuitive: a planned maintenance visit costs a fraction of an emergency repair, and avoiding a bridge closure or a transit breakdown eliminates the economic and safety costs that ripple outward from those disruptions. A scoping review of 58 peer reviewed studies published between 2015 and 2025 found that predictive maintenance, intelligent monitoring, and optimization are the three areas where AI has the most consistent, well-documented impact on transportation infrastructure resilience [9].

AI in Freight and Logistics

Beyond passenger transport, AI is proving its value in commercial freight. Route optimization tools draw on realtime traffic feeds, weather data, and delivery constraints to continuously recalculate the most efficient paths for trucks, reducing both fuel consumption and delivery times. Fleet telematics systems apply the same predictive maintenance logic used in transit to commercial fleets, monitoring engine diagnostics, tire pressure, and driver behavior to flag issues before they become costly failures [15]. A survey of 300 transportation decision-makers conducted by Breakthrough during the 2025 peak shipping season found that nearly half—49 percent—reported AI had a significant impact on their ability to navigate end-of-year shipping challenges, and that AI was the most effective single tool for managing volatility in that period [2]. The operational implications are significant: carriers that deploy AI-driven logistics tools are reporting meaningful reductions in fuel costs, empty miles, and vehicle downtime relative to competitors still relying on static routing schedules.

Barriers to Broader Deployment

Despite the clear operational case for AI in transportation, deployment remains uneven. A 2025 nationwide survey of U.S. State Departments of Transportation conducted by the American Association of State Highway and Transportation Officials (AASHTO) found that while several agencies are piloting or actively applying AI in operations, a significant number are still in exploratory or planning stages [7]. The survey identified three consistent barriers: data quality problems that undermine model performance, regulatory uncertainty about how AI-assisted decisions interact with existing safety and procurement requirements, and resource constraints that make it difficult for smaller agencies to build or retain the specialized technical staff needed to implement and maintain these systems. Data quality is a particularly foundational issue. AI models are only as good as the data they are trained on, and many transportation agencies operate fragmented legacy systems where sensor networks are incomplete, records are inconsistently formatted, and there is no unified data architecture across operational domains. Until those underlying data problems are resolved, the benefits of AI will remain accessible primarily to larger, better-resourced agencies.

For the transportation sector broadly, and for the Canadian context specifically, the scaling of AI represents both an opportunity and a coordination challenge. The tools exist, the market is growing rapidly, and the operational case is documented. What is missing in many jurisdictions is the institutional infrastructure, the data standards, procurement frameworks, and workforce capacity—that would allow agencies to move from pilots to system-wide deployment.

Closing that gap is as much a governance problem as a technology problem, and it will require deliberate policy attention alongside continued investment in the underlying digital infrastructure that AI depends on.

Future-Proofing Transportation Infrastructure

Transportation infrastructure is the physical backbone of any economy, and it is under pressure from two directions at once. From behind, decades of underinvestment have left a significant share of existing roads, bridges, and transit systems operating well past their intended design lives. From ahead, a set of accelerating changes—climate volatility, electrification, autonomous vehicles, and rapid urbanizations placing demands on infrastructure that was never designed to accommodate them. Meeting those demands requires more than increased spending. It requires a rethinking of how infrastructure is planned, built, maintained, and eventually replaced.

The State of Existing Infrastructure

The American Society of Civil Engineers (ASCE) releases a comprehensive assessment of U.S. infrastructure every four years. Its 2025 Report Card found that recent federal investment has begun to make a difference, representing the most positive assessment since the report was first issued in 1998 and an incremental improvement over the previous cycle in 2021 [16]. The improvement reflects the early impact of the 2021 Infrastructure Investment and Jobs Act (IIJA), which injected

$580 billion in new funding for cross transportation, water, energy, and broadband. However, the progress is modest relative to the underlying need. Among transportation-specific categories, bridges, roads, aviation, and transit all remain in varying states of deficiency, with nine of the eighteen assessed categories still falling short of acceptable condition [16]. ASCE estimates that $9.1 trillion in investment is needed to bring all categories to a state of good repair, against only $5.5 trillion currently planned between 2024 and 2030 — a gap of $3.7 trillion [17]. As one ASCE official put it, the nation's infrastructure is not in a midlife crisis but an old-age crisis, with everything coming due at the same time [16].

The funding gap matters not just for the condition of today's roads and bridges, but for the cost borne by ordinary people and businesses. The average U.S. driver loses approximately $1,400 per year in vehicle operating costs and time due to roads in poor condition [17]. Every dollar of deferred maintenance compounds into a larger future liability: a bridge that can be rehabilitated today for a modest sum becomes a far more expensive replacement project if it is allowed to deteriorate further. ASCE estimates that if infrastructure investment levels are sustained, each American household could save $700 per year [16]. That arithmetic — invest now or pay more later — is the essential case for treating infrastructure not as a discretionary budget line but as a long-term capital commitment.

Climate Resilience as an Infrastructure Design Standard

Future-proofing transportation infrastructure requires confronting climate change as a design input rather than an external risk. A 30-year global analysis of transportation infrastructure resilience research, published in 2026 in the journal Multimodal Transportation, found that climate variability, aging assets, and cyber threats are converging to create compound vulnerabilities in transportation networks that single-domain engineering approaches cannot adequately address [18]. The study identifies four critical gaps: insufficient integration of climate projections into longterm asset planning, limited cross-sector coordination between transportation and adjacent systems like energy and water, inadequate governance frameworks for managing interdependent infrastructure risks, and a shortage of equity focused analysis that accounts for how infrastructure failures affect different communities disproportionately [18].

ASCE’s 2025 Report Card reinforces this point directly, recommending that all future infrastructure investments be evaluated across their full life cycle including the projected impact of more frequent extreme weather events [16]. A bridge designed for the flood conditions of the 1980s may be technically sound by conventional engineering standards while remaining inadequate for the conditions it will actually face over its remaining service life. Designing for resilience, rather than just for baseline performance, adds upfront cost but dramatically reduces the probability of catastrophic failure and the far larger economic and human costs that follow from it.

Digital Twins and Smart Infrastructure

One of the most consequential technological developments in infrastructure management is the emergence of digital twins—real-time virtual models of physical assets that are continuously updated with sensor data, historical records, and environmental inputs. Think of it like this: instead of engineers scheduling a bridge inspection every few years and hoping nothing has changed, a digital twin gives them a living, continuously updated model of that bridge that shows strain in the beams, changes in vibration patterns, and moisture accumulation in real time. The global digital twin market was valued at approximately $35.8 billion in 2025 and is projected to reach $328.5 billion by 2033, growing at a compound annual rate of roughly 31 percent [19]. That growth is being driven in significant part by transportation and infrastructure applications, where the value of continuous, data-driven asset monitoring is clearest.

Deloitte’s 2025–2026 Transportation Trends report documents a notable real-world example in Broward County, Florida, where the metropolitan planning organization is building a digital twin called SMART METRO that integrates housing, zoning, population, and climate data to support infrastructure planning decisions [6]. The system is designed to forecast both congestion and flood risks, simulate the transportation and land-use effects of proposed developments, and allow planners to interrogate the model in plain language and receive geospatially visualized results.

That kind of tool represents a meaningful shift in how infrastructure investment decisions are made—from backward-looking condition assessments to forward-looking scenario modeling that accounts for the full range of stresses a network will face over its life. Parallel applications are emerging in port management, rail corridor planning, and urban transit network design, all following the same logic: better data, processed in real time through intelligent models, produces better decisions.

Preparing for Electrification and Autonomous Vehicles

The electrification of the vehicle fleet and the gradual introduction of autonomous vehicles both place specific demands on infrastructure that was designed for a different era. Charging infrastructure is the most immediate bottleneck for EV adoption: the Canada-China trade deal opens the door to Chinese-manufactured EVs at accessible price points, but those vehicles are only as useful as the charging network available to their owners.

Building out charging infrastructure at the scale that mass-market EV adoption requires means rethinking not just where chargers go, but how the power grid is designed and managed in relation to transportation networks. The ASCE's 2025 energy sector grade of D+ reflects the scale of that challenge: electric vehicle adoption and data center expansion are together projected to add 35 gigawatts of new electricity demand by 2030—double the 2022 level—against a grid that is already strained [17].

CANADA–CHINA EV TRADE AGREEMENT

The Canada & China Ev Trade Agreement

Canada's 2026 EV deal emerged from an escalating agricultural tariff dispute. When Ottawa imposed a 100 percent tariff on Chinese built EVs in 2024, citing concerns regarding competition with domestic manufacturers, Beijing retaliated in October 2025 by raising the tariff on Canadian canola from 84 percent to 90 percent [3]. Canola is one of Canada's largest agricultural exports, and the retaliation imposed substantial economic pressure on farmers. Because both sides were being hurt by the trade dispute, Canada and China had a reason to negotiate a compromise.

Terms of the Agreement

Prime Minister Carney announced the agreement in January 2026. It sets an annual import quota of 49,000 Chinese built EVs into Canada at a 6.1 percent tariff, replacing the previous 100 percent [1, 7]. The permits are given out in two rounds during the year, with 24,500 vehicles allowed in the first half (March 1,2026) and another 24,500 in the second half. In exchange, China lowered its tariff on Canadian canola and other agricultural goods, making it easier for Canadian farmers to sell into China.

Year	Annual EV Quota	Tariff Rate	Permit Issuance
2024 (pre-deal)	None	100%	N/A
2026 H1	24,500 (first half)	6.1%	March 1, 2026
2026 H2	24,500 (second half)	6.1%	Approx. Sep 2026
2027-2029	49,000 annually	6.1%	Annual renewal
2030 onwards	Approx. 70,000 annually	6.1%	Annual renewal

TABLE II Canada-China EV Trade Agreement: Quota and Tariff Schedule. Source: [1], [7].

Implications for the Canadian Market

The tariff change matters because it completely changes the price of Chinese EVs in Canada. A Chinese manufactured EV with a sticker price of $35,000 previously faced an effective $35,000 tariff at the 100 percent rate. At 6.1 percent, the same vehicle incurs approximately $2,135 in import duty, a figure manufacturers targeting the sub $40,000 range can now realistically reach. Battery technology is the foundation of this cost advantage. Battery packs account for 30 to 40 percent of the bill of materials on an electric vehicle [4]. Chinese manufacturers have largely standardized on Lithium Iron Phosphate (LFP) batteries, which sacrifices a measure of energy density in exchange for lower production cost, improved thermal safety, and a longer cycle life relative to the Nickel Manganese Cobalt (NMC) batteries that remains common in Western vehicles. Global battery supply is now expanding faster than demand. McKinsey projects realistic supply of 4,750 to 5,270 GWh against demand of approximately 3,910 GWh by 2030, placing continued downward pressure on cell prices toward $75 to $80 per kWh [4]. Manufacturers that own their cell production capture these cost reductions directly, while manufacturers that purchase cells from suppliers realize only a fraction of the savings.

Tesla and Volvo are among the first commercial winners under the deal because both already build significant volumes in China that now qualify for the quota [1]. The second wave is the Chinese brands themselves, including BYD, Chery, and SAIC, for whom the quota is a structured way into a market that was effectively closed to them at the consumer level.

Risks and Strategic Tensions

The deal has not been universally welcomed. Ontario Premier Doug Ford warned publicly that it risks a flood of cheap Chinese vehicles without any guarantee of equivalent investment in Canadian production [3]. Chinese EVs benefit from decades of large manufacturing/funding from the government, while Canadian producers do not have the same cost structure. Another concern is that Canada may not be using its natural advantages strongly enough. Canada has critical minerals, clean electricity, and engineering talent, all of which are valuable for the EV battery supply chain. The Transition Accelerator's roadmap for Canada's battery value chain makes the same argument from a different angle, recommending that Canada use its critical mineral leverage to negotiate manufacturing investment as a condition of market access, rather than opening the market unilaterally and hoping the investment follows [8].

There is also a risk involving the United States. The United States has maintained its 100 percent tariff on Chinese EVs and has signaled that vehicles entering North America via Canada may face secondary tariff treatment under the United States-Mexico-Canada Agreement (USMCA) [2]. This makes the situation uncertain. Any company considering Canada as a North American distribution hub has to account for possible U.S. pushback.

BYD INVESTMENT MEMO

Investment Memo: Byd Co., Ltd.

This section presents a structured investment memo on BYD Co., Ltd. (HKEX: 1211; SZSE: 002594), the world's largest electric vehicle manufacturer by volume. The memo covers a company overview, an industry overview and investor sentiment review, three independent investment theses, a discounted cash flow valuation with sensitivity analysis, and a structured assessment of risks and mitigants. We recommend a long position in BYD with a price target of $52.00 (USD), representing approximately 28 percent upside from the current price of $40.50 (USD). The recommendation rests on three independent reasons: the Canada & China Ev agreement gives BYD policy-secured access to the Canadian market for the first time; the company's international expansion is accelerating across multiple continents, providing a structural margin tailwind that the market is consistently underpricing; and BYD is a vertically integrated manufacturer, meaning it designs and produces in -house most of the components that other automakers buy from external suppliers, and that integration produces a per-vehicle cost advantage that competitors with outsourced supply chains cannot replicate.

HKEX: 1211 / SZSE: 002594	BYD Co., Ltd.	Recommendation: BUY
USD $40.50 (Current Price)	Investment Memo | Transportation Sector | May 2026	Target: USD $52.00 Upside: +28.4%
Company Overview	**Revenue Mix (FY2025)**	**Key Financials**
• Founded 1995 in Shenzhen; world's largest EV producer by volume in 2024 and 2025 • Sold over 4.5 million new energy vehicles in 2025; over 2.25 million pure BEVs • Exported more than 1 million vehicles in 2025; targets 1.5 million in 2026 • Vertically integrated: cells, motors, power semiconductors, vehicle software, and assembly all in-house • Plans approximately 20 Canadian dealerships in 2026 following the trade deal • Three primary business segments: Automobiles (BEV + PHEV); Batteries & Energy Storage (Blade LFP); Mobile Handsets & Electronics	Automobiles (BEV + PHEV): 60% Batteries & Energy Storage: 20% Mobile Handsets: 12% Other / Services: 8% BYD trades at a discount to peers despite leading global EV volumes and an industry-best battery cost position	FY2025 Revenue: RMB 804B FY2025 Net Profit: RMB 32.6B YoY Revenue Growth: +3.5% YoY Net Profit: -19.0% EV/EBITDA (TTM): 18.5x P/E (TTM): 24.1x International revenue rising from approximately 8 percent of total in 2024 to 25 percent by 2027E. Canada is the next leg

TABLE (BYD SNAPSHOT) BYD Co., Ltd. Company Overview, Revenue Mix, and Key Financial Metrics. Source: [9]; market data as of May 2026.

Industry Overview

The global EV market has moved past its early-adopter phase and is now operating under mass-market dynamics. Battery costs have come down far enough that LFP-equipped vehicles can now compete on price with internal-combustion equivalents in most major markets. Deloitte projects that battery-electric vehicles will account for 81 percent of all new EV sales globally by 2030, with the EV segment as a whole capturing roughly 32 percent of total new car sales [5]. China is expected to make up 49 percent of global EV demand, Europe 27 percent, and the United States 14 percent. Canada sits in the long tail of remaining markets, but the new trade agreement positions it to gain ground faster than comparable peers.

Battery economics represent a structural tailwind for vertically integrated manufacturers. McKinsey's analysis of regional battery supply and demand projects global oversupply through 2030, particularly in China [4]. For BYD, this is a direct advantage: as cell costs come down, the company captures those savings internally rather than passing the margin to a third-party supplier. Canada is entering this market at a useful moment. Structured access at a 6.1 percent tariff arrives just as global EV competition intensifies, battery costs decline further, and Chinese manufacturers have already refined their playbook for establishing local distribution around tariff barriers in markets like Brazil and Hungary.

Investment Rationale and Sentiment

The market is currently pricing BYD as a China-constrained business saddled with margin pressure and geopolitical overhang. Three concerns drive this consensus view. First, domestic price competition in China cut net profit by 19 percent in 2025 and a further 55.4 percent in the first quarter of 2026, overshadowing what is happening internationally. Second, a geopolitical risk premium applied to all Hong Kong-listed Chinese equities suppresses the trading multiple regardless of operating fundamentals. Third, limited brand recognition in North America leads investors to underestimate BYD's commercial potential at the consumer level.

We believe this view misses three offsetting factors that are systematically underpriced. The Canada deal is the latest step in a multi-year, multi-continent expansion playbook that has already proven successful in Brazil, Norway, Thailand, and the United Kingdom. BYD's vertical integration across cells, motors, chips, and final assembly maintains positive margins even when the company prices aggressively for market share, an advantage that rivals with outsourced supply chains cannot replicate. And the Blade LFP Battery is precisely the technology fit for the affordability segment driving the next wave of mass-market EV adoption, both in Canada and globally.

Investment Theses

Thesis 1: Canadian market entry opens a structurally undervalued international growth vector.

The 49,000-unit annual quota represents approximately 29 percent of Canada's total 2024 EV sales of roughly 170,000 units, which is a meaningful market position to capture from a standing start. BYD's Atto 3 SUV and Seal sedan, priced in the $25,000 to $31,000 range, sit squarely in the highest volume Canadian purchase segment. At full quota with an average vehicle price of approximately $27,000, the Canadian opportunity represents roughly $1.3 billion in annual revenue. Approximately 20 dealerships are planned across Canada in 2026, leveraging operational templates already proven in the United Kingdom, Norway, and Germany. The quota expansion to 70,000 units by 2030 provides a policy-secured, visible revenue ramp.

Thesis 2: International expansion is systematically undervalued by the market.

BYD exported more than one million vehicles in 2025 and has guided to 1.5 million in 2026, representing over 40 percent year-on-year export growth. International revenue grew from roughly 3 percent of total in 2021 to 14 percent in 2024, and the company is on track for approximately 24 percent by 2026. Vehicles sold internationally typically command higher average selling prices than equivalent models in China, which means international growth functions as a direct structural margin expansion vector. This mix shift offsets the domestic price war pressure that currently dominates investor attention. The market is pricing BYD as a domestic Chinese manufacturer; in reality, it is executing the most successful international EV expansion in automotive history.

Thesis 3: Vertical integration creates a cost moat that widens as battery prices fall.

BYD is what is known as a vertically integrated manufacturer. Most automakers operate by designing a vehicle and then purchasing the major components from a network of external suppliers: batteries from companies like LG Chem or Panasonic, motors from Bosch or Continental, and semiconductors from specialized chip manufacturers. BYD does almost none of this. It designs and makes its own battery cells, its own power semiconductors, its own electric motors, and its own vehicle software, all under one roof. The practical result is that every dollar saved as battery costs fall goes directly to BYD's bottom line rather than to a supplier's margin. No other major automaker operates at this level of integration.

The numbers behind that advantage are substantial. BYD's battery cell cost is estimated at roughly $60 to $65 per kWh, against an industry average of approximately $110 per kWh. That gap, multiplied across a typical 60 to 80 kWh battery pack, produces roughly $3,000 to $4,000 per vehicle in cell-level cost advantage alone. Including additional savings from in-house motors, semiconductors, and integration overhead, the full per-vehicle advantage reaches approximately $6,000 to $8,000. As global oversupply continues to push cathode material prices down through the 2026 to 2027 window, BYD captures these savings directly.

R&D spending of 63.4 billion (RMB) in 2025, approximately twice the company's net profit for the year, sustains the technology pipeline, including the second-generation Blade Battery and the Flash Charging network that has grown to 4,990 stations across China as of March 2026.

Risk	Mitigant
R1: Canada-US trade friction. Pressure from Washington could push Ottawa to reverse the EV concession, eliminating quota access.	M1: The deal is structured as a reciprocal agricultural trade arrangement; reversing it carries real domestic political cost given the Prairie farming constituency.
R2: Brand awareness gap. BYD is largely unknown to Canadian consumers compared to Tesla and the legacy automakers.	M2: BYD has built brand recognition from zero in the UK, Norway, and Thailand using exactly the formal-dealer playbook now planned for Canada.
R3: Data security review. Regulators may impose national security reviews on Chinese-manufactured connected vehicles, restricting market access.	M3: BYD already segments vehicle data systems by region. The same approach used to meet European regulatory requirements is portable to Canada.
R4: Domestic price war continuation. Continued competition in China could push automotive gross margins below the 20 percent floor.	M4: International revenue is rising fast (8 percent to 24 percent of total by 2026E), and overseas ASPs are higher, providing a structural margin offset.

TABLE III Investment Risks and Mitigants for BYD Co., Ltd.

Valuation Framework

Our valuation uses a discounted cash flow framework to capture BYD's multi-segment growth profile across automobiles, batteries and energy storage, and electronics. Revenue is forecast at the segment level, with automobile revenue growing fastest through 2028 as international expansion accelerates before moderating as EV adoption matures. Gross margins are held near 20%, reflecting BYD's vertical integration and battery cost advantage, while EBITDA margins remain around 5.5% to 6.0% as international growth offsets domestic price competition in China.

We then calculate unlevered free cash flow by adjusting after-tax operating profit for depreciation, capital expenditures, and working capital needs. The model applies a 9.0% WACC to reflect BYD's higher-growth EV profile, Hong Kong-listed China risk, and above-market volatility. Terminal value is estimated using a 14.0x EV/EBITDA exit multiple based on comparable EV and automotive peers.

Under these assumptions, the model produces a target price of USD $52.00 per share, implying approximately 28.4% upside from the current price of USD $40.50.

Exit Multiple Method	WACC Build
EBITDA Exit Multiple 14.0x	10-Year US Treasury 4.20%
Terminal Value $298B	Equity Risk Premium 5.80%
PV of Terminal Value $164B	Country Risk Premium 1.60%
Sum of PV of FCF $108B	Beta (Levered) 1.55
Enterprise Value $272B	Cost of Equity 17.6%
Less: Net Debt ($5.8B)	Cost of Debt (pre-tax) 4.20%
Equity Value $278B	Tax Rate 15.0%
Shares Outstanding 2.90 billion	After-Tax Cost of Debt 3.30%
Price Per Share (USD) $52.00	Debt / Capitalization 35.0%
Current Price (USD) $40.50	WACC 9.00%
Implied Return +28.4%	

TABLE (VALUATION OUTPUTS) BYD DCF Valuation Outputs by Method, with WACC Build.

Line Item	2023A	2024A	2025A	2026E	2027E	2028E	2029E	2030E	2031E	2032E
Total Revenue (USD $B)	83.1	107.0	110.5	122.1	135.1	149.9	161.6	173.4	183.0	190.5
YoY Growth %	42%	29%	+3.5%	10.4%	10.6%	10.9%	7.9%	7.3%	5.5%	4.1%
(-) COGS	66.4	85.4	88.2	97.5	107.8	119.7	129.0	138.5	146.2	152.0
Gross Profit	16.7	21.5	22.3	24.7	27.3	30.1	32.6	35.0	36.8	38.4
Gross Margin	20.2%	20.1%	20.2%	20.2%	20.2%	20.1%	20.2%	20.1%	20.1%	20.2%
(-) R&D	6.6	7.8	8.7	9.6	10.7	11.8	12.8	13.8	14.4	15.0
(-) SG&A	5.5	7.2	7.4	8.1	8.9	9.9	10.7	11.6	12.2	12.7
EBITDA	4.5	6.5	6.3	6.8	7.6	8.4	9.1	9.8	10.1	10.7
EBITDA Margin	5.5%	6.0%	5.7%	5.6%	5.6%	5.6%	5.6%	5.6%	5.5%	5.6%
(-) D&A	1.4	1.8	1.9	2.1	2.3	2.6	2.8	3.0	3.2	3.3
EBIT	3.2	4.7	4.4	4.8	5.2	5.8	6.3	6.7	7.0	7.4
(-) Tax (15%)	0.4	0.7	0.7	0.7	0.8	0.9	1.0	1.0	1.1	1.1
NOPAT	2.7	4.0	3.7	4.1	4.4	4.9	5.4	5.7	6.0	6.3
(+) D&A	1.4	1.8	1.9	2.1	2.3	2.6	2.8	3.0	3.2	3.3
(-) CapEx	4.0	5.4	5.8	6.5	7.2	7.8	8.5	9.1	9.6	10.0
(-) Change in NWC	2.5	3.2	3.3	3.7	4.1	4.5	4.8	5.2	5.5	5.8
Unlevered FCF	(2.3)	(2.8)	(3.4)	(4.0)	(4.5)	(4.8)	(5.2)	(5.5)	(6.1)	(6.2)

TABLE IV BYD Discounted Cash Flow Model: Income Statement and Free Cash Flow Build (USD Billions).

Price Per Share (USD)

EBITDA × ↓ / WACC →	8.0%	8.5%	9.0%	9.5%	10.0%	10.5%
10.0x	$45.2	$43.6	$42.3	$40.9	$39.8	$38.7
12.0x	$50.3	$48.5	$47.0	$45.5	$44.3	$43.1
14.0x	$55.5	$53.7	$52.0	$50.6	$49.2	$47.8
16.0x	$60.6	$58.7	$56.9	$55.3	$53.8	$52.4
18.0x	$65.8	$63.7	$61.8	$60.0	$58.4	$56.9

Implied Return

EBITDA × ↓ / WACC →	8.0%	8.5%	9.0%	9.5%	10.0%	10.5%
10.0x	+11.6%	+7.7%	+4.4%	+1.0%	-1.7%	-4.4%
12.0x	+24.2%	+19.8%	+16.0%	+12.3%	+9.4%	+6.4%
14.0x	+37.0%	+32.6%	+28.4%	+24.9%	+21.5%	+18.0%
16.0x	+49.6%	+44.9%	+40.5%	+36.5%	+32.8%	+29.4%
18.0x	+62.5%	+57.3%	+52.6%	+48.1%	+44.2%	+40.5%

TABLE V BYD DCF Sensitivity Analysis: Exit EV/EBITDA Multiple vs. WACC. Price per share and implied return. Base case (14.0x, 9.5%) highlighted in yellow.

Summary

BYD is the world's most vertically integrated EV manufacturer, combining scale, battery cost leadership, and a proven international expansion strategy. The January 2026 Canada-China EV trade agreement gives BYD policy-backed access to a G7 market that was previously difficult to enter under the 100 percent tariff regime. While the market continues to price BYD primarily as a China-exposed automaker facing domestic margin pressure, we believe the company's international growth story is underappreciated.

The March 2026 issuance of Canadian import permits provides a near-term catalyst, while the quota expansion to approximately 70,000 vehicles annually by 2030 creates a visible multi-year revenue opportunity. At the same time, BYD's vertically integrated cost structure should allow the company to capture battery cost declines more directly than competitors that rely on external suppliers. Together, these factors create an asymmetric risk-reward profile that we believe is not fully reflected in the current share price. Our USD $52.00 price target implies approximately 28 percent upside under a 14.0x exit multiple and 9.0 percent WACC. In the bull case, a 16.0x exit multiple and 8.5 percent WACC implies upside of approximately 45 percent, while a more conservative 12.0x exit multiple and 10.5 percent WACC still implies approximately 6 percent upside.

TRANSPORTATION OUTLOOK

The transformation of the transportation sector is significant but uneven. Autonomous vehicle technology continues to advance, but commercial deployment remains limited by regulatory complexity, liability uncertainty, cybersecurity concerns, and the need to build public trust through years of safe real-world operation. By contrast, electrification is advancing more quickly, supported by falling battery costs, expanding EV supply chains, and policy decisions that are reshaping global vehicle markets.

The Canada-China EV trade agreement accelerates this electrification story by giving Canadian consumers access to more affordable EV options. However, it also introduces meaningful strategic trade-offs. Lower-cost Chinese EVs could increase competitive pressure on domestic manufacturers, while the agreement may also create friction with the United States, which continues to maintain a more restrictive position toward Chinese-built vehicles.

For BYD, entry into Canada sits at the intersection of three durable trends: the global shift from internal-combustion vehicles to electric vehicles, the rise of LFP batteries as a mass-market standard, and the emergence of Chinese automakers as serious global competitors rather than low-cost regional players. BYD's vertical integration, R&D commitment, and proven multi-scale expansion strategy position the company well as the EV industry enters a more competitive landscape. [9]

For Canadian policymakers, the central question is whether the trade deal's short-term consumer benefits can be converted into long-term strategic advantage. Canada has valuable critical minerals, clean power, engineering talent, and an established automotive base. These assets give the country real leverage in negotiations over where future EV and battery manufacturing capacity will be built. Whether Canada uses that leverage effectively will determine whether it becomes a meaningful participant in the EV supply chain or remains primarily an importer of the next generation of vehicles.

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05

SECTOR RESEARCH

Infrastructure

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KEY THEMES

- Alternative housing construction
- Prefabricated and modular housing
- Material and construction costs
- Canadian prefab market outlook

PREFAB HOUSING BACKGROUND

Background Information

With the first temporary shelters built around 400,000 years ago, housing has experienced many shifts and issues. The most prominent modern issue with housing is shortage. The elevated strain on the housing market is causing the industry to again to look at ways to reduce building time and costs. Hence a growing market segment is prefab housing. We will attempt to cover past developments of prefab housing, setting up the reader with background knowledge, providing a brief overview of the current market, discussing engineering and financial implications, and providing outlook to equip the reader with a rigorous understanding of the modular housing market.

The idea of prefabricated modular housing is not new. During the first half of the 20th century a companies attempted to capitalize on an increase in housing demands. These companies, including Sears, Roebuck and Co, and the Canadian Aladdin Corporation, provided partially assembled homes at a comparative premium to traditionally assembled houses. These 'kits' came assembled according to the future homeowners' budget, with cheaper options providing all necessary parts and more expensive kits coming with cutout shapes ready to be assembled.

Overall, these catalogue homes had the advantage of providing industry standard quality at a cheaper price point. For once, assembly and companies where vertically integrated. This reduced dependence on outside contractors in the assembly process. Further, less skilled labour was necessary once shipped to the destination with some kits being directly assembled by the homeowner, rather than carpenters.

Eventually, the market for catalogue homes declined. The Second World War brought on an increase in demand for building supplies and resources, which were reallocated from housing to the war effort. Furthermore, newer technologies and a shift in consumer taste towards suburbs meant that the players ceased production during the mid 1940s.

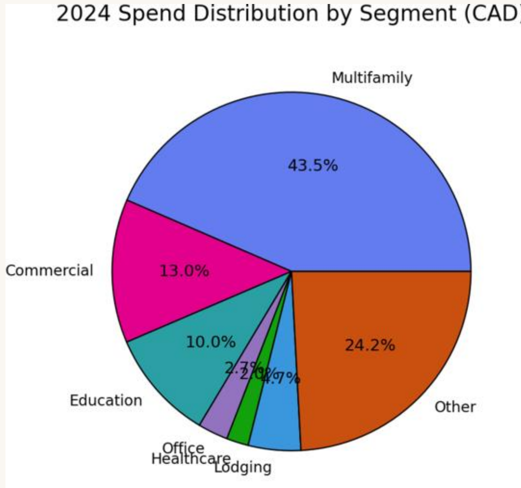
The idea of prefabricated housing was not unique to North America. As a result of the high housing demand after the Second World War, quick deployable and scalable housing was necessary. Especially Eastern Bloc countries embraced prefab housing in the second half of the 20th century, although Western European countries equally utilized prefab housing methods for social developments. Large panel-system buildings provide a solution to construct buildings quickly and cheaply. For large panel system buildings precast concrete walls were shipped from the factory to the construction site and then assembled into multistory apartment blocks.

While precast components reduced built times through efficient casting and construction process, precast components meant a high degree of standardization was necessary and as a result these houses are often considered architecturally subprime. However, the effect on eastern European countries cannot be understated, with almost any larger metropolitan area having at least several large panel tower blocks.

Current Prefab Market

The strained housing market has again increased interest in looking for a cheaper, quicker alternative to traditional housing methods. Currently the Canadian prefab market is estimated at 5.1 billion dollars. The growth is set at 5% CAGR. Nearly half of the current valuation can be accounted for by single family housing. These developments are driving growth in the metropolitan areas and surrounding suburbs. These trends exceed global development. At a world stage prefab housing is set to grow at 2.6% CAGR and is valued at 15.6 billion USD. As prefab housing has existed for almost a century, the prefab industry has experienced many changes and innovations, both in a technical and engineering perspective.

Figure 1 Distribution of current housing market



Technical implications

Material Considerations

The materials used in residential construction vary with where the structure is being built, what the building will be used for, and available capital to do so. For simplicity, this report will focus on the use of timber, structural steel, and concrete and their effect on the different construction methods.

Timber is the most widely used material in residential construction in North America, being used in approximately 90% of homes [1]. Its use cases include framing, flooring, roofing, interiors, and with the increase in engineered timbers, be used for mass timber construction. It has many advantages which include a high strength to weight ratio, being low cost and highly available, highly sustainable, and can be modified to meet required needs [2]. There are also disadvantages to the material. Timber is vulnerable to its environment, being moisture, pests, and fire, which can impact its strength capacity. Additionally, the anisotropic characteristics of lumber mean it can warp, shrink, or creep over time [3].

Structural steel, while historically being used for more commercial construction purposes, has recently seen an increase of use in residential construction [4]. Its uses include structural beams and columns, rebars, and full steel-frame in seismically active areas. Its advantages include a high strength-to-weight ratio, dimension stability (homogeneous structure), resistance to environmental factors, and having a predictable structural performance [5]. The disadvantages of structural steel are its higher cost, being a poor thermal insulator, is more difficult to modify, and the high carbon cost associated with manufacturing [6].

Concrete is used in virtually all residential builds, regardless of how timber and steel are utilized. Its use cases include footings, foundation walls, and slabs. Some of its advantages include high compressive strength, resistance to environmental factors, and a high thermal mass. Concrete also has several disadvantages, namely its high carbon cost, which account for 8% of global emissions [7], its long working time due to formwork and curing requirements, and its poor tensile strength [8].

Below is a figure comparing the strengths of each of the respective materials in both tension (positive) and compression (negative).

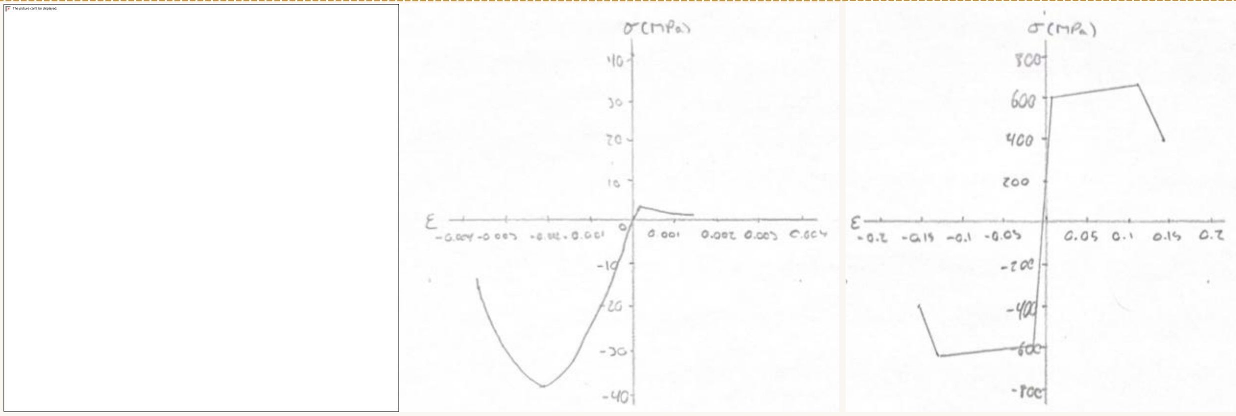


Figure 2: Stress-strain diagram for timber (parallel), steel (S500), and concrete (C25/30) [9], [10]

MATERIAL COSTS & PREFAB MARKET ECONOMICS

Material Cost Considerations

Traditional Material Costs

The cost of construction materials has risen substantially over the past four decades. The three materials discussed in this report — lumber, structural steel, and concrete — have each followed different cost trends since 1980. When adjusted for inflation, the real cost increases are more moderate than the nominal figures suggest, though the period after 2015 has seen significant real cost growth across all three materials.

Lumber prices have been the most volatile of the three inputs. In real 2025 dollars, lumber peaked at approximately $681 per thousand board feet (MBF) in 1980 before declining steadily to a low of $341/MBF in 2010. A significant supply disruption during the COVID-19 pandemic caused prices to spike well above $2,000/MBF in real terms in 2021, the largest single-year increase in the dataset. Prices have since returned to approximately $620/MBF. British Columbia's allowable annual harvest has declined by an estimated 20–30% due to pine beetle damage and wildfires, which is expected to apply modest upward pressure on prices going forward [29].

Structural steel prices have been influenced by two opposing forces: global oversupply from Chinese producers placing downward pressure on prices, and US Section 232 tariffs of 25% on Canadian steel exports increasing costs domestically. In real 2025 dollars, steel reached a high of approximately $1,130 per tonne in 1980 and declined through the 1990s before recovering during the commodity boom of the mid-2000s. Prices peaked again in 2022 at approximately $1,850 per tonne in real terms before falling back to the current level of approximately $980 per tonne [30].

Concrete is the most stable of the three inputs. Real prices declined from approximately $202/m³ in 1980 to a low near $155/m³ in the mid-1990s, before gradually recovering to $260/m³ today. The most notable recent development is the introduction of federal carbon pricing, which is expected to add an estimated $8–$15/m³ to concrete costs by 2030–2035 as producers pass through compliance costs [31].

The combined effect of material and labour cost increases has raised the national average hard construction cost per single-family home from approximately $27,000 in 1980 to $469,000 in 2025, measured in nominal dollars. In real 2025 dollars, this represents an increase from approximately $99,000 to $469,000, with the majority of the real cost increase occurring after 2006. Hard construction costs exclude land, soft costs, permits, and developer margin.

Figure 5: Historical material costs, Canada, nominal and real 2025 CAD (1980–2025)

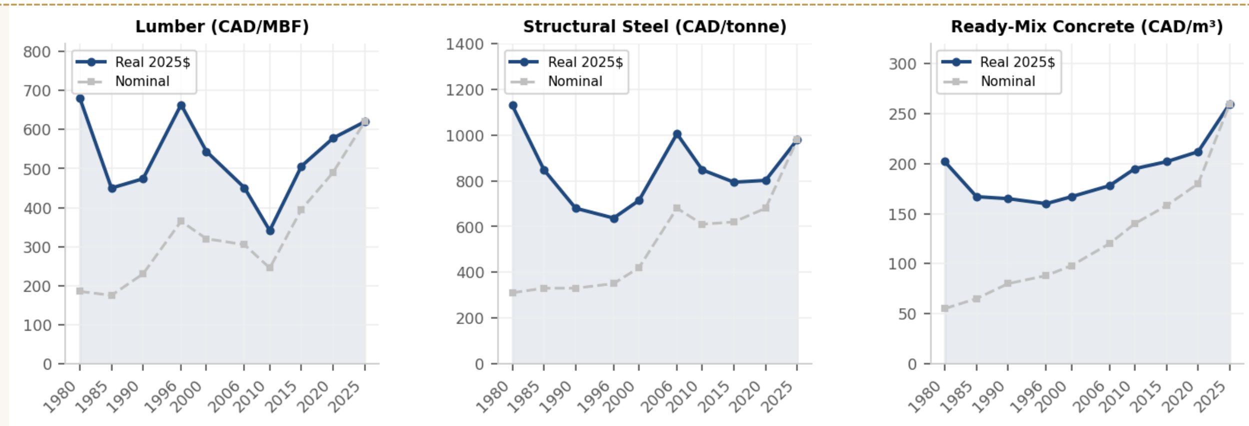


Figure 6: Traditional construction cost per single-family home, national average, nominal and real 2025 CAD (1980–2025)

Year	Nominal CAD	Real 2025 CAD	CPI Multiplier	Key Driver
1980	$27,000	$99,000	3.68x	Stagflation; high material and labour inflation
1985	$37,000	$95,000	2.57x	Stabilization; lumber prices flat
1990	$52,000	$107,000	2.06x	Recession onset: costs plateau
1996	$66,000	$120,000	1.82x	Slow real cost growth; weak CAD
2000	$77,000	$131,000	1.70x	Commodity cycle warming: floor area expands
2006	$141,000	$209,000	1.48x	Commodity supercycle peak; labour shortage
2010	$188,000	$261,000	1.39x	Larger homes post-GFC; costs stabilize
2015	$226,000	$289,000	1.28x	CAD weakens; import costs rise
2020	$346,000	$408,000	1.18x	COVID onset; costs surge in H2
2025	$469,000	$469,000	1.00x	Labour inflation dominant; tariff uncertainty

Projections of Future Material Costs

Material cost projections are presented across three scenarios — Low, Mid, and High — through 2035. The scenarios reflect different assumptions about inflation, trade policy, and regulatory outcomes. A CPI inflation rate of 1.5% per year is used in the Low scenario, 2.0% in the Mid scenario, and 2.8% in the High scenario.

Lumber costs in the Mid scenario are projected to rise at approximately 2.0% per year in real terms, driven by ongoing BC harvest constraints and the continuation of current US tariff levels of approximately 14.5%. The High scenario assumes tariff escalation to 25%, which would push nominal prices to approximately $1,198/MBF by 2035. The Low scenario assumes tariff resolution and a stable harvest, resulting in modest real price growth of 0.5% per year.

Steel costs are projected to remain relatively flat in real terms in the Mid scenario, at approximately 0.5% annual real growth. The High scenario reflects continued tariff escalation and slow adoption of lower-cost electric arc furnace production, while the Low scenario assumes tariff relief and faster adoption of green steel production methods.

Concrete costs are projected to grow at 1.5% per year in real terms in the Mid scenario. The primary driver is federal carbon pricing, which is scheduled to reach $170 per tonne by 2030 and is expected to add approximately $10/m³ to concrete costs by that date. This cost is treated as near-certain under current policy and is included in the Mid scenario baseline [31].

Figure 7: Material cost projections, Canada, nominal CAD (2025–2035)

Year	Lumber Low (CAD/MBF)	Lumber Mid	Lumber High	Steel Low (CAD/t)	Steel Mid	Steel High
2025	$620	$620	$620	$980	$980	$980
2026	$618	$643	$676	$951	$1,010	$1,109
2028	$631	$688	$760	$941	$1,052	$1,257
2030	$648	$742	$872	$936	$1,097	$1,430
2032	$666	$803	$997	$931	$1,143	$1,625
2035	$697	$906	$1,198	$922	$1,221	$1,954

Figure 7: Material cost projections, Canada, nominal CAD (2025–2035) — Lumber and Steel scenarios

Year	Concrete Low (CAD/m³)	Concrete Mid	Concrete High	CPI Mult.
2025	$260	$260	$260	1.00x
2026	$264	$269	$278	1.015x
2028	$275	$292	$319	1.057x
2030	$285	$318	$374	1.116x
2032	$296	$347	$438	1.177x
2035	$313	$392	$541	1.281x

Figure 7: Material cost projections, Canada, nominal CAD (2025–2035) — Concrete and CPI scenarios

Prefabricated Material Costs

Prefabricated construction uses the same materials as traditional construction. The cost difference comes from how those materials are used. Because prefabricated components are built in a factory setting, material cutting is more precise, and purchasing can be done in bulk. This reduces material waste from approximately 30% of total input weight in traditional construction to between 5% and 17% in prefabricated construction [22].

CMHC's Housing Supply Challenge found that prefabricated construction reduces hard construction costs by 15–25% compared to traditional methods and reduces construction time by approximately 25% [24]. The shorter construction timeline reduces interim financing costs by an estimated $8,000 per unit at current interest rates, based on the average four-month reduction in build time for a standard single-family home.

Applying the CMHC cost savings range to the 2025 national average hard construction cost of $469,000, a prefabricated home would cost approximately $352,000–$398,000 to build. Including interim financing savings, the total cost advantage is estimated at $80,000–$150,000 per unit on an all-in basis, excluding land. CMHC notes that per-square-foot costs are not always lower with prefabricated methods, and that the cost advantage is greatest when building at scale with standardized designs [24].

Figure 8: Prefabricated vs. traditional construction cost comparison, national average (2025)

Cost Component	Traditional	Prefab	Saving
Hard construction cost	$469,000	$352,000–$398,000	15–25%
Build timeline	~15 months	~11 months	~27%
Interim financing cost (est.)	~$28,000	~$20,000	~$8,000
Material waste (by weight)	~30% of inputs	~5–17% of inputs	Up to 83%
All-in turnkey cost (excl. land)	$580,000–$700,000	$430,000–$560,000	$80,000–$150,000

CONSTRUCTION METHODS & TIMELINES

Construction Considerations

Traditional Construction

The traditional construction process is currently the most widely used construction process for residential homes in Canada. It reflects a linear, site-based method where homes are built on-site, and sequentially, from the foundation through to the interior, with inspections after each major stage [11].

There are several advantages to the traditional construction process. It is a highly versatile process, and can meet the exact needs of the clients, the structure can adapt to site conditions and changes which can be made mid-build, and it is an established practice with many workers familiar with the process. Its disadvantages include a heavy reliance on skilled manual labour, which results in a costly and time-consuming process. The sequential build process means that if one aspect of the building is delayed, it compounds into the next, furthermore, it is subject to adverse weather conditions which can affect project timelines. Environmentally, traditional construction methods produce more on-siter waste which increases the carbon cost of the building [12], [13].

Below is a timeline of the traditional construction process including which processes take place at which point. The estimate is that from start to finish, one single, detached home takes approximately 15 months to build [14].

Pre-construction 5 months	**Foundation** 2 months	**Framing** 1.5 months	**Exterior** 1.5 months	**Interior** 2 months	**Final Touches** 3 months
Permits	Site prep	Skeleton	Ext. Walls	Electrical	Painting
Plans	Footings	Sheathing	Siding	Plumbing	Finishing
Site Tests	Pouring	Inspection	Roof	Drywall	Final Inspection

Figure 3: Traditional Construction Timeline

Prefabricated Construction

Prefabricated construction takes the bulk of the building process off-site. All the structural components, including floors, walls, and roofs, are built in modular sections which can then be transported on-site where they will be assembled. This building process allows multiple aspects of the building to be done simultaneously. For example, while the site is being prepared and the foundation poured, construction on the main structure has already begun, thereby reducing the time needed [15].

Advantages to prefabricated construction include a significantly decreased timeline, a concurrent building process where work can be done both on the site, and the structure simultaneously as well as more predictable costs as materials can be bought in bulk. Additionally, the environmental impact both to the construction site and carbon cost from material waste is lower than traditional methods and the entire construction process is less susceptible to weather delays since most of the construction is done in a factory, or inside the house after assembly. There are several disadvantages that must be accounted for. These include less design flexibility, as changes to the design are more difficult once construction begins, transportation costs for moving the house from the factory to the site, and less familiarity with the process could hinder approval processes [16] [17].

By comparison to traditional methods, prefabricated construction is estimated to take around half as much time to complete when compared to traditional construction methods [18]. Below is a timeline of the prefabricated construction process including which processes take place at which point. The estimate is that from start to finish, one single, detached home takes approximately 11 months to build [19], [20].

Pre-construction 5 months	Foundation	Factory Build 2 months	Delivery 2 weeks	Interior 1.5 months	Final Touches 2 months
Permits	Site Prep	Modules Built	Assembly	Electrical	Painting
Plans	Footings	Runs Parallel to	Sealing	Plumbing	Finishing
Site Tests	Pouring	Foundation	Inspection	Drywall	Final Inspection

Figure 4: Prefabricated Construction Timeline

R&D Considerations and Net Revenue Projections

The Canadian prefabricated home manufacturing industry generated approximately $3.8 billion CAD in revenue in 2024, growing at a rate of 5.2% per year between 2019 and 2024 [25]. The broader modular construction market in Canada is projected to grow at 5.7% per year through 2030, reaching approximately USD $3.0 billion [26]. This rate of growth exceeds the expected growth in overall Canadian housing starts, suggesting that prefabricated construction is gaining market share relative to traditional methods.

Industry operators currently achieve estimated EBITDA margins of 12–16%. As production volumes increase and fixed costs are spread across more units, margins are expected to improve to 15–20% [25]. A key development in Canadian prefab production is the opening of a 60,000 square-foot automated manufacturing facility by Promise Robotics in Calgary in March 2025, which represents the first large-scale robotics-assisted prefab production operation in Canada.

Federal policy has provided support for the sector. In May 2026, CMHC launched the Prefab Plus program, which extends mortgage loan insurance to prefabricated and modular homes with a minimum 5% down payment [27]. The federal government has also committed $25 billion CAD toward modular factory financing, and CMHC's Rapid Housing Initiative has funded over 10,000 units built using modular methods. The main risk to the sector is the high upfront capital requirement, as prefab operators must typically purchase materials before securing a client. Provincial building code fragmentation is also estimated to reduce industry growth by approximately 1.6% per year [28].

Figure 9: Canadian prefab industry revenue outlook, Low / Mid / High scenarios (CAD $B, 2024A–2030E)

PREFAB BENEFITS, EMISSIONS & OUTLOOK

Construction Benefits

Factory Style Construction (parts can be built simultaneously vs traditional sequencing)

What are the benefits/downsides of building off site (potential for auto/fewer delays etc)

Quantitative comparisons of construction speeds (solves demand outpacing supply)

Environmental Benefits

It is estimated that when using traditional construction methods, about 30% of the total weight of the building materials is left as waste on the construction site [21]. The table below compares the CO_2 emissions between on-site, traditional construction and modular prefabricated construction, where the prefabricated method emits 43% less emissions [22].

Table 1: Comparison of the CO2 emissions between traditional and prefabricated construction [22]

Metric	Traditional	Prefabricated	Difference	% Difference
CO2 Emissions (Tons)	98.9	56.3	42.5	43%

It is difficult to compare the environmental impact of transportation between traditional and prefabricated construction. It would be reasonable to estimate that the emissions caused by transportation throughout the entire construction process would be about equal for both methods for the following reason. With traditional construction methods, workers, machinery, and materials must move back and forth from the construction site, whereas with prefabricated construction, all the work is done in the factory. However, the prefabricated modules must then be transported to the site for assembly. Each of these cases have varying environmental costs depending on the location of the site and how accessible it is for people, which could change the costs although not significantly [21].

Constraints

There are several constraints associated with prefabricated construction that can be resolved with time, and knowledge of the process. These include difficulties with inspections and building codes that would need to be modified to include prefabricated construction. A high capital requirement needed to initialize the construction process and typically materials need to be purchased before a client is found, and quality assurance with potential clients, both on the primary and secondary markets, may not trust the prefabricated construction process and would need to be educated on its benefits to see them and reverse popular opinion [23].

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Sources: StatCan BCPI Table 18-10-0289-01; CMHC Housing Market Information Portal absorbed unit prices; Altus Group Canadian Cost Guide 2025; WOWA.ca construction cost database. Hard costs only — excludes land, soft costs, permits, and developer margin.

Sources: CME lumber futures curve; Natural Resources Canada harvest projections; StatCan IPPI Table 18-10-0203; US BLS PPI WPU101704; Bank of Canada CAD/USD forward assumptions; Environment and Climate Change Canada carbon price schedule.

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FUTURE OUTLOOK

Looking Ahead

This inaugural publication marks the beginning of QIII's journey as a ratified club at Queen's University. In future editions, we aim to expand research coverage, deepen industry partnerships, and develop a mentorship network connecting our members with professionals at the intersection of technical and financial disciplines.

As our club continues to grow, we hope to expand beyond the annual report to include more activities such as networking events, stock pitches, technical seminars, and more. If the work we have done at QIII interests you, please follow our social media accounts on Instagram or LinkedIn to stay up to date on hiring timelines

We invite faculty, alumni, and industry professionals to engage with our work and contribute to the growth of technoeconomic research at Queen's.

Instagram: @qiii.official · LinkedIn: Queen’s Interdisciplinary Investment Insights · Website: https://qiii-official.github.io/QIII-Official/

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