It Takes More Than Markets: Aligning Policy, Climate Finance, and Innovation Governance in Tackling the Clean Tech Challenge

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Abstract

Canada's clean technology sector holds strong innovation potential but faces persistent commercialization and financing barriers, particularly in scaling early-stage companies. Despite Canada's position as a global clean tech exporter, many firms remain trapped in the "valley of death" due to high capital costs, uncertain returns, a lack of patient or risk-tolerant financing. This paper investigates how public policy mechanisms and climate finance strategies—such as blended finance and agile governance—can help scale the clean tech ecosystem. Using a desk-based literature review and a case study of Canada's electric school bus sector, the paper identifies key financing gaps, policy barriers, and enabling conditions. Findings show that loan-based funding and rigid procurement processes can suppress demand, and that blended finance models, paired with responsive policy design, are better suited to Canada's market context. The study contributes to emerging scholarship on clean tech financing by recommending ecosystem-level, policy-finance solutions tailored to Canada's transition goals.

Key Words: *clean technology, financing, barriers, Canada, EV buses, patient capital, commercialization, exits, IPOs, policy design, blended finance*

1. Introduction

Supporting the clean technology sector not only creates competitive economic opportunities but also helps address the country-level need for transitioning to a low-carbon climate-resilient (LCR) economy. For countries like Canada, which have a resource-dependent and carbon-intensive economy (Saravade & Weber, 2024), having a cross-sector clean technology (referred to as "clean tech" from here on) focus provides a competitive advantage when it comes to the global transition towards the LCR economy. Although Canada already has a strong clean technology innovation system, being the fourth highest clean technology exporter globally (Export Development Canada, 2022), this sector's scale-up or commercialization remains a significant challenge. Furthermore, Canada is not the only country experiencing commercialization problems related to clean tech, as highlighted by McDonell (2024) and Killins (2019) clean tech start-ups around the world face significant financing constraints unless they can "exit" to an initial public offering (IPO) or be acquired through mergers with established companies.

Therefore, both globally and domestically, this sector faces financing challenges linked to its inability to commercialize and attract vast amounts of public and private capital that is required to scale-up and meet climate goals (Walter, 2018). Even with countries doubling their spending on energy-related research and development (R&D) over the years, many clean technology firms remain stuck in the early stages of development, also called the 'valley of death', where costs are high and returns are uncertain (Grubb, McDowall & Drummond, 2017). As identified by Owen, Brennan, Lyon & Harrer (2021) such market failures in the global clean tech financing are "driven by a combination of information asymmetries and the undervaluation of social and environmental benefits...with the balance of risk versus reward being tipped against Cleantechs'... [and especially

becoming] more extreme against smaller and early-stage clean tech companies that lack a track record and [financial or asset-based] collateral" (p. 1168).

Without the necessary financing ecosystem to cross this valley of death, this sector remains stunted in its potential (Mazzucato & Penna, 2016). As seen in the Canadian context, 36% of all clean technology firms report access to capital as their greatest overall challenge (Natural Resources Canada, 2022). Globally, this financing gap continues to widen, with Cowling and Liu (2021) highlighting that clean tech companies not only have a higher demand for external capital, but these demands are not being met by traditional providers of capital (like venture capital) and require companies to seek out more non-traditional sources of finance. This showcases the need to consider alternative funding models and patient capital from non-traditional sources, especially those linked to institutional investors. Hence, the research gap emerges to identify what type of ecosystem-level interventions and financing tools can be tapped into to help this sector achieve its potential in the Canadian context.

One previously unexplored financing avenue is that of climate finance – which focuses on redirecting traditional sources of capital (like capital markets) towards more environmentally-friendly and climate resilient projects. Furthermore, compared to the US, where sustainable investing faces political polarization, or the EU where there is tougher scrutiny on impact and disclosures, Canada's climate finance market remains resilient and posed for future growth (Jessop, Kerber & Binnie, 2024; Saravade & Weber, 2024; Sustainable Finance Action Council, 2022). For instance, climate finance instruments like green bonds grew at a steady pace in 2023 and remained robust to inflation and other macroeconomic changes in the past year (Climate Bonds Initiative, 2023) – signalling the potential such tools can have in addressing risk-adjusted

investment opportunities in Canada while helping bridge this climate tech "exit" challenge (Madaleno, Dogan & Toskan, 2022).

Even though private investment in early-stage clean tech firms matters, there is still a need for these firms to have some level of government policy support (Boyer, 2011) to become competitive or even establish a market. This raises the need to identify what type of policy guidance is needed and how can early policy interventions help clean tech companies succeed. As pointed out by Hargadon & Kenny (2012), domestic tailoring of policy strategies and innovative financing frameworks are important when it comes to scaling up clean technology start-ups. In the case of the United States – where large loan guarantees are unlikely to be effective, small business innovation research (SBIR) grants, large scale demonstration projects and/or procurement decisions, university research and development support and certain (de)regulatory actions are shown to be more useful to growing the clean tech sector. In the Canadian context, however, loan guarantees are usually the main method of supporting clean technology start-ups and allowing for market establishment (Natural Resources Canada, 2022; Krupa, Busch, Gladwin & Ellis, 2025; Jiang, 2023). Furthermore, in Canada, clean tech start-ups often experiences regulatory barriers when it comes to fast-tracking financing for scale-up (Williams, 2021). This showcases the need for tailoring financing and policy mechanisms to the country level context. However, the applicability of various policy and private financing interventions in the Canadian context remains unexplored in the literature and highlights a major research gap.

With the growing threat of climate risks and economic trade wars, there is now a tangible need to identify the applicability of agile governance mechanisms towards economically advantageous sectors like clean tech. Although the private sector remains more adept at responding to external risks, the public sector now faces an equally urgent task when it comes to growing

domestic clean tech driven industries that are tied to a low-carbon transition. However, the broad scholarship on clean tech financing and the supporting role of agile governance mechanisms remains under-researched. Here is where our study contributes to the literature by using the case study of the Canadian electric vehicle (EV) bus manufacturer, to identify what types of governance and policy mechanisms are affecting the scale-up of such clean tech companies.

Only a handful more academic studies (Rendall, 2021; Madaleno, Dogan & Toskan, 2022; Sengupta, 2015; Bjornali & Ellingsen, 2014; Bjornali, Giones & Billstrom, 2017) have analyzed the joint role of public and private actors in clean technology, however, none have looked at where a blended approach (public-private partnership) would be useful, especially as it relates to sustainable finance and in the context of Canada. This is where our study provides novelty in terms of working understanding what combination of government and private sector involvement can be used to identify a potential blended finance solution to the clean tech scale-up problem. Hence, our specific research question is as follows:

***RQ**: What is the role of policy mechanisms and climate finance strategies in helping incentivize the scale-up of the clean technology financing ecosystem in Canada?*

This study aims to investigate the role of public policy and financial market instruments—such as blended finance, agile governance mechanisms, and sustainable finance frameworks—in enabling capital mobilization for the scale-up of clean technology firms. Through a desk-based literature review and an exploratory case study of Canada's electric school bus manufacturers, the study seeks to identify policy levers, financial gaps, and enabling governance conditions that can support the commercialization, and successful market exits of clean tech companies.

The remainder of the paper is structured as follows: Section 2 is the methodology explaining the steps taken to identify the literature-based conceptual framework, the choice of case

study and type of data analyzed. Section 3 is the literature-based conceptual framework that highlights the literature review of key themes like clean technology financing, blended finance and agile governance models. Section 4 is the preliminary case study analysis of a particular clean tech firm operating in Canada and the US. Section 5 is the discussion, ending with the expected conclusion.

2. Methodology

This paper uses a qualitative, desk-based research design that combines a thematic literature review with an exploratory case study analysis. This approach enables a structured examination of both conceptual and empirical dimensions of clean technology financing, with particular attention to the role of public policy, alternative investment models (e.g., blended finance, patient capital), and adaptive governance mechanisms.

The first phase of creating a literature-based framework involved the review of relevant peer-reviewed academic publications, policy reports, and grey literature related to clean technology financing, sustainable finance mechanisms, and innovation policy. Total number of sources identified were 35 publications using keyword searches in Scopus, Web of Science, and Google Scholar, which included targeted reviews of think tank publications (e.g., IISD, DEEP Centre) and policy reports (e.g., Climate Bonds Initiative, Export Development Canada or Natural Resources Canada). Key search terms included *clean tech finance*, *blended finance*, *sustainable finance policy*, *venture capital, clean tech funding*, *clean tech SMEs* and *agile governance*. Findings were synthesized around key themes like early-stage financing gaps, the role of policy in shaping markets, the use of blended finance and alternative funding models, and

institutional barriers to financial innovation. These insights helped establish a conceptual framework to assess case-level dynamics.

The second stage involved an exploratory case study analysis of Canada's emerging electric school bus manufacturing sector. This sector provides a compelling lens through which to analyze how clean tech financing and policy interact in practice, given its links to industrial strategy, public procurement, and climate policy. Four companies were purposively selected for analysis: Lion Electric, New Flyer, GreenPower Motor Company, and Nova Bus. These firms represent variation in firm size, ownership structure, and policy exposure (federal vs. provincial programs) in Canada. Using publicly available data, including corporate reports and investor presentations, federal and provincial policy documents and industry analysis by data firms (LSEG data and analytics), the case study tested the various key aspects identified in the literature-based conceptual framework. More specifically, it looked at the type of company and the stage of growth and its financing (start-up or mature company and whether it was public or privately financed), if it had successfully 'exited' (IPO, merger or acquisition), the types of public policy instruments that they had accessed (e.g., grants, subsidies, loans), policy and governance barriers experienced (e.g., lack of agile regulations or milestone based support) and the applicability of blended finance solutions (e.g., evidence of de-risking through public-private partnerships).

3. Literature-Based Conceptual Framework

This section highlights the key literature themes related to the thesis of our paper that clean technology financing requires a combination of appropriate climate finance tools with

policy interventions – namely, it addresses the literature on clean technology financing, the role of alternative mechanisms like blended finance as well as agile governance approaches.

3.1. Financing Gaps in Clean Technology

A recurring challenge in the literature is the persistent early-stage funding gap facing clean tech start-ups, particularly due to perceived investment risk and long commercialization timelines (Olmos, Ruester & Liong, 2012; Williams, 2021; Rendall, 2021). Harrer and Owen (2022) explored this in the UK context by analyzing 82 clean tech start-up pitch documents. They found that despite a maturing financing ecosystem, early-stage clean tech ventures continue to struggle with investor reluctance due to illiquidity, long payback periods, and policy uncertainty. This is exacerbated by the limited availability of tailored financial and environmental metrics to evaluate clean tech value propositions (Owen, Brennan, Lyon & Harrer, 2021; Jagdish, Toledano & Vega, 2024).

Given that most early-stage start-ups in this space are funded by venture capitalists (VCs), they tend to face significant pressure to have successful ‘exits’ within the first five years of its investment, either in the form of an initial public offering (IPO) or through mergers and acquisitions. However, if a “company cannot exit within the first three to give years of raising a major funding round, the VCs are likely to write off the investment and withhold further funding” (Gaddy, Sivaram &O’Sullivan, 2016, p. 4). This further complicates the availability of long-term capital to companies that may fall in the hard tech category (e.g., bio-industrial innovation companies) where upfront capital costs are high, and returns may take several years to materialize (Williams, 2021).

Similarly, Cowling and Liu (2023) emphasizes the reliance of clean tech small and medium enterprises (SMEs) on external credit markets, despite structural financing mismatches. Their econometric analysis of United Kingdom (UK) SMEs highlighted the limitations of traditional credit assessment tools, which often fail to account for the intangible value and long-term impact potential of clean innovations. These findings collectively emphasize the need for blended and patient capital strategies tailored to clean tech's risk-return profile. As supported by the Canadian clean tech survey (Natural Resources Canada, 2022), 36 percent of Canadian clean tech firms reported that raising capital is their greatest overall challenge and require the need for "patient capital, often from public sources to innovate and de-risk the capital" (p. 4).

3.2. The Role of Policy and Public Instruments in Market Creation

A strong theme across both academic and policy reports is the key role of public policy in creating and shaping clean tech markets. Williams (2011), argues that Canada requires a "step-change" in investment strategies—advocating for mission-driven policy frameworks and improved public-private coordination to create stable demand signals for clean tech. Furthermore, as pointed out by Cowling & Liu (2023), even VC funding requires a certain degree of legitimation, one of which is regulatory approval, that allows their investment into an emerging area or technology. Hence, being able to access public funding incentives "becomes key, if not the only, facilitator to the adoption of green technologies" (p. 975) – further underscoring the need for public policy to incentivize the creation of domestic clean tech markets.

The notion that private markets alone cannot drive decarbonization is also echoed in Gasparini, Ives, Carr, Fry & Bienhocker's (2024) critique that current risk-based financial

regulations (including banking capital requirements like Basel III & IV) can inadvertently disadvantage low-carbon technologies by prioritizing creditworthiness indicators biased toward incumbent fossil fuel firms. Their analysis shows that policymakers should support climate-aligned prudential regulations that help establish transition aspects into the financial system, while de-risking newer technology firms that can have a positive impact on clean innovation pathways. Furthermore, Gasparini *et al* (2024) also argue that prevailing financial regulation systems can unintentionally penalize clean technologies due to outdated credit risk models. Hence, calling for a revamp of policy frameworks and financial regulations that evolve in response to both technological progress and urgency to act on climate commitments.

Beyond capital flows, a few studies point to institutional inertia, risk aversion, and fragmented policy frameworks or information asymmetries can act as barriers to scaling clean tech (Rendall, 2021; Olmos, Ruester & Liong, 2012; Madaleno, Dogan & Taskin, 2022). For instance, challenges such as fragmented funding mandates, lack of investor awareness, and absence of clear taxonomies for "green" or "transition" finance contribute to such inefficiencies (Saravade & Weber, 2024; Saravade, Weber & Vitalis, 2025; Bjornali & Ellingsen, 2014). Even in jurisdictions with relatively mature ecosystems (e.g., UK), structural reform is needed to promote innovation-friendly finance (Harrer & Owen, 2022; Cowling & Liu, 2023).

3.3. Alternative Investment Models: Blended Finance and Patient Capital

Several papers identify public-private risk-sharing, and patient capital as emerging mechanisms to overcome the "valley of death" in clean tech financing. While few policy papers rigorously evaluate blended finance in clean tech financing, predominantly in the clean energy sector or within developing country contexts (Tonkonogy, Brown, Micale, Wang & Clark, 2018;

Nassiry & Wheeler, 2011) the academic literature in this space remains under researched. However, blended financing mechanisms like crowding-in private capital requires first-loss guarantees, milestone-based disbursements, and investment-grade risk reduction mechanisms (Williams, 2011; Tonkonogy, Brown, Micale, Wang & Clark, 2018; Krupa, Busch, Gladwin & Ellis, 2025; O'Reilly, an Bhaird & Cassells, 2023) are starting to be mentioned. The literature also stresses the importance of public procurement and de-risking instruments (e.g., loan guarantees, green banks, concessionary capital) in enabling capital flow to technologies that are essential for the low-carbon transition but fail to meet conventional investment criteria (Jung, Dong, Kim & Qiu, 2024).

Overall, the literature review reveals growing consensus that clean tech financing requires more than market forces—it needs deliberate policy design, purpose-and patient-driven finance, and institutional innovation. Yet gaps remain when it comes to identifying empirical research on how public-private partnerships (blended finance mechanisms) can be tapped to further scale the growth of this sector. There is also insufficient empirical and theoretical analysis done on the impact of policy incentives or disincentives at the firm level. By using a case study approach linked to a growing clean tech sector like EV bus manufacturing, this study aims to fulfill these research gaps and explore how public policies, and capital structures interact in practice.

4. Case Study Analysis (Lion Electric)

a. Lion Electric

Lion Electric was founded in Quebec (Canada) in 2008 and specializes in the manufacturing of all-electric medium and heavy-duty vehicles, including EV school buses and

trucks. The company exited in 2021 vis a vis a special purpose acquisition company (SPAC) via a merger with Northern Genesis Acquisition Corp. This allowed Lion Electric to be listed on both New York Stock Exchange (NYSE) and Toronto Stock Exchange (TSX). Its production capacity is now split between Canada (St-Jerome, Quebec) and United States (Jolliet, Illinois) with a total of 5,000 vehicles per year. It also owns a 1.7 GWh battery production plant in Canada.

In terms of government support in funding, it relies on more than five public funding programs based in the US and Canada – including US$5 billion EPA Clean School Bus Program, CARB's Advanced Clean Fleet Regulation, CAD$2.75 billion ZETF, US$932 million EPA Clean Heavy Duty Vehicles Program, US$2.6 billion EPA Clean Ports Program and the US$500 million Zero Emissions School Bus and Infrastructure Program[1]. Despite its growth, the company has faced significant financial challenges linked to reliance on the public grants among other aspects and led to workforce reduction and restructuring. For instance, delays in funding from the Canadian government's Zero Emissions Transition Fund (ZETF) have adversely affected the company's ability to deliver and the subsequent sales efforts[2].

Similarly, based on these recent financial challenges, the provincial Quebec government has also reduced further financial assistance to this clean tech company which it invested CAD$177 million into initially. The company's growth has been supported by private investment as well – with the Power Corporation of Canada owning a 34 percent stake in the company. However, this has proved to be a high-risk investment now that shareholders have filed a class-

[1] https://ir.thelionelectric.com/English/events-and-presentations/default.aspx
[2] https://financialpost.com/commodities/energy/electric-vehicles/lion-electric-takes-earnings-hit-may-2024

action lawsuit claiming the company misrepresented its financial health to investors[3]. This type of financial instability highlights the complexities of public and private financing approaches, especially when the market is still not mature enough and the clean tech company requires a blended approach in meeting its high capital needs. Here is where the need for agile governance and timely disbursement of funds is critical to the success of such financing models.

The procurement demand for EV school buses is also currently low, given that local bus operators must pay high upfront costs – almost 3 or 4 times more expensive compared to diesel counterparts[4] and not factoring in the electric grid infrastructure or charging stations required. Although there is federal or provincial funding in Canada available for bus operators, they are required to undertake a long list of comprehensive financial assessments, detailed project proposal, including showing environmental impact assessments, provide proof of eligibility and comparing various vendor information. This type of rigid and rigorous requirements can not only stifle demand but also create a disincentive for a market to establish at the local or domestic level.

Furthermore, although most federal funding is grant based, some portion is offered a loan – for instance, the Canada Infrastructure Bank (CIB) offers a low-interest long-term loan for public and private operators of zero-emission bus fleets. Such loan-based funding can hinder market growth if borrowers (bus operators in this case) are cash constraint or smaller in size (SMEs or school boards). Given this market hinderance, it becomes imperative to understand the role of government procurement in creating a market for clean technology as well as the role of

[3] https://www.bloomberg.com/news/articles/2025-05-01/quebec-government-won-t-rescue-bankrupt-bus-maker-lion-electric?embedded-checkout=true
[4] https://www.forourkids.ca/electric_school_bus_backgrounder1?utm_source=chatgpt.com

financial incentives and types of policies (like loans vs. grants) in affecting the scale-up of demand for such products.

5. Discussion and Conclusion

The findings from the case of Lion Electric underscore a key insight from the literature – namely that clean tech firms require more than market capital—they require aligned, agile policy frameworks that adapt to the realities of scaling high-cost, low-margin innovations. Although Lion Electric has accessed multiple streams of public funding and successfully exited via an IPO, the company's financial instability highlights the fragility of growth pathways even for relatively mature clean tech firms. This supports existing literature (e.g., Cowling & Liu, 2023; Gaddy et al., 2016) on how financing gaps persist even after commercialization unless public-private coordination ensures consistent market demand, de-risking, and timely capital flow.

Moreover, the case illustrates how loan-based funding mechanisms (e.g., Canada Infrastructure Bank) may unintentionally inhibit demand-side uptake—especially among school boards and SME operators—due to constrained liquidity and complex procurement requirements. This aligns with critiques of overly rigid financing models (Williams, 2021; Gasparini et al., 2024) and suggests that blended finance approaches with milestone-based grants or guarantees may offer more adaptive support.

There is a growing need to integrate novel approaches to support Canada's clean technology sector. These approaches include fostering innovative stakeholder collaborations—such as those enabled by government-backed investment banks like the Canada Infrastructure Bank or Business Development Canada's (BDC) $400 million Climate Tech Fund—raising diverse and patient capital from sustainable finance markets, such as green bonds, and adapting

successful policy and market lessons from other jurisdictions, including the US and EU. However, realizing this potential requires new research on the sustainable finance mechanisms and policy supports that can enable Canada's transition (Tonkonogy, Brown, Micale, Wang & Clark, 2018). Our study aims to fill this knowledge gap by recommending a Canada-specific financing ecosystem that can help more clean tech companies achieve successful exits and greater uptake in domestic and global markets.

From a governance perspective, the evidence also points to a mismatch between policy ambition and delivery mechanisms. Delays in federal disbursements (e.g., under ZETF), lack of milestone-aligned funding models, and provincial withdrawal of support when firms become financially vulnerable suggest a gap in the kind of agile governance necessary to build markets around clean technologies. Echoing Hargadon & Kenny (2012) and Mazzucato & Penna (2016), this reinforces the need for responsive, iterative procurement and regulatory processes, particularly in sectors that require public policy to lead market formation.

While a handful of academic studies (Rendall, 2021; Madaleno, Dogan & Toskan, 2022; Sengupta, 2015) have analyzed the role of public and private actors in clean technology, none have previously explored how a blended finance approach can be effectively applied to drive more sustainable finance (Flammer, Giroux & Heal, 2024) in the Canadian clean technology context. This is where this research offers novelty—identifying the role of both government and private sector players to create potential blended solutions.

Our study's preliminary findings show that while the Canadian context benefits from a relatively stable climate finance market, the lack of tailored, firm-level instruments and blended policy-finance solutions suggests that clean tech scale-up remains under-supported at the ecosystem level. The findings call for a reimagining of clean tech financing models, not only as

financial design problems but as policy coordination and governance challenges—where public and private actors jointly share risk and responsibility.

By addressing critical gaps in the literature and providing policy-relevant insights, this study supports the government's objective of increasing private investment in Canada's clean technology sector—which is one of its strategic investment priorities aimed at protecting Canadian economic interests amid increasing geopolitical uncertainty and a rapidly changing global trade landscape (Government of Canada, 2024).

Beyond academic contribution, this study also aims to operationalize theoretical insights into actionable policy recommendations that foster a productive and competitive clean tech ecosystem. It's robust methodological and multi-disciplinary framework has broader applicability, offering potential to scale green projects and initiatives in other sectors and jurisdictions. As a result, this work seeks to appeal to a multidisciplinary audience of academics, businesses, investors, regulators, and policymakers in Canada and beyond.

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