CANADIAN BATTERY INNOVATION ROADMAP

Executive Summary



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About This Roadmap

This Battery Innovation Roadmap outlines a strategy to establish Canada as a global leader in battery technology by 2035. It offers an in-depth analysis of Canada's current position in the global battery landscape and details key actions needed to build a thriving battery ecosystem. The roadmap addresses critical areas including innovation infrastructure, industrial policy, and skills development. It is designed to guide policymakers, industry leaders, and researchers in collaborative efforts to maximize Canada's potential in the rapidly evolving battery sector. This document serves as a blueprint for enhancing Canada's competitiveness, fostering innovation, and contributing to the global clean energy transition.

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About Accelerate

Accelerate is Canada's ZEV industrial alliance. Our members and collaborators work together and with the public sector to develop the tools, relationships, and policy and investment priorities that will build and integrate a world-class zero emission vehicle supply chain and industry.

We activate key industry, public sector, Indigenous, labour and research stakeholders and build off Canada's advantages in mining, cleantech, finance, skill development, clean energy, and vehicle parts and assembly, to shape effective action that will result in a competitive, integrated ZEV sector.

Together, we are building Canada's Zero Emission Vehicle supply chain so that it becomes a central part of Canada's future wealth and prosperity.





Introduction

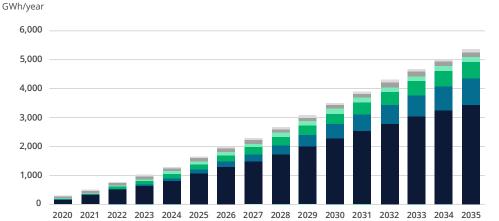
Batteries are a critical platform technology in the energy transition. They will enable cheap and deep decarbonization of the power and transportation sectors. As battery technology improves and supply chains scale, batteries will be used in even wider applications than they are already, enabling a clean, wireless, and connected future.

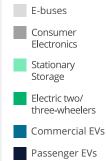
There is a global competitive race to create innovative technologies that will shape this future. The countries that benefit economically will be those that make strategic, focused investments in battery technology and supply chains. The countries that fail to take advantage of this moment will be consumers of batteries, taking on considerable economic and geopolitical risk in the process.

Canada finds itself at a pivotal juncture in this global competition. With a rich legacy of battery innovation and significant recent investments in battery production, Canada has the potential to establish itself as a world leader. This roadmap presents an ambitious vision for Canada to become a global leader in clean, innovative battery technology and a hub for sustainable battery production in North America by 2035. To realize this vision, we must leverage our strengths, address the challenges, and implement a comprehensive strategy that aligns government, industry, and academic efforts.

The countries that benefit economically will be those that make strategic, focused investments in battery technology and supply chains.

Forecast of Global Battery Demand by End-Use Application (GWh) 2020-2035









Canada's Battery Legacy and Current Landscape

Canada was an early mover in lithium-ion battery innovation. Vancouver-based Moli Energy was a leading lithium-ion battery maker in the 1980s, leading the charge to commercialize the lithium-ion battery. Moli was the first manufacturer of lithium-ion batteries in North America. But Canada lost its critical edge because it failed to see the economic, geopolitical, and environmental value of this technology at the right moment. After a Moli-made cell caught fire, the Province of British Columbia called in a loan and forced its sale to a Japanese consortium for \$5M. The company had assets worth \$58M and had received \$120M in government support.

Despite this setback, Canada's legacy of battery innovation persists. We continue to produce world-class researchers, exemplified by figures like Jeff Dahn, whose work at Dalhousie University has kept us at the forefront of battery technology. Building on this foundation, a new generation of firms has emerged, developing innovative processing techniques, advanced materials, control systems, and precision testing equipment. These companies represent the potential for Canada to reclaim its position as a battery innovation leader.

"Canada's battery research community has always been at the cutting edge. With the right support and investment, we can translate this scientific excellence into homegrown industrial capacity."

- Jeff Dahn, Professor Emeritus, Principal Investigator – NSERC/Tesla Canada/Dalhousie Alliance Grant

Battery innovation presents an enormous opportunity for Canada. Canada has made a huge bet on batteries with strategic investments in up to 195 GWh of battery production across three facilities. The task now is to maximize the value of these factories by building the production networks around them into an innovative ecosystem that increases efficiency and advances the core technology. In doing so, Canada can add value to its local economy, build homegrown firms, and lead the way in clean battery innovation.



History of Canadian Battery Innovation

1978

The World's First Commercial Li Battery

Moli Energy is formed in 1979 in Burnaby BC and goes on to produce the world's first commercial rechargeable Li battery in the following decade.

1999

FEC Boosts Battery Life

Researchers from Canada's National Research Council (NRC) discover and patent fluoroethylene carbonate (FEC) as a small addition to the electrolyte that dramatically increases the cycle life of lithium-ion batteries.

2000

High Power Potential of Li-ion Batteries Revealed

E-One Moli researchers show for the first time that Li-ion cells designed for power can outperform other battery chemistries. E-One Moli is now the main supplier of battery cells to Dyson.

2007

Advancing Solid-State Batteries

Researchers from the University of Calgary discover a new garnet-type material that would enable solid-state batteries which offer the promise of higher energy storage, improved safety and longer lifespan. For more than 40 years, Canadian innovators have made groundbreaking contributions to the advancement of battery technology. Below is a selection of Canadian contributions across academia, industry, and government.

1990

Ethylene Carbonate Jump Starts Li-ion Batteries

Researchers at Moli Energy Ltd. report on the role of ethylene carbonate (EC) in making Li-ion batteries viable. Every commercial battery cell today includes some ethylene carbonate in the electrolyte.

2000

Carbon Coating Revolutionizes LFP Batteries

Université de Montréal / Hydro-Québec researchers report on carbon coating of lithium iron phosphate batteries, which was critical to making LFPs work. BASF, Sony, Mitsui licensed the technology soon after.

2001

NMC Changes the Battery Future

Researchers from Dalhousie University in partnership with 3M develop and patent certain grades of lithium nickel-manganese-cobalt (NMC) oxide compounds. NMC material is now being used around the world in power tools and electric vehicles.

2009

Renewed Promise of Lithium-Sulfur Batteries

Researchers at the University of Waterloo improved the lifespan and capacity of lithium-sulfur batteries. They're now made with cheaper, easy-to-find materials, making them a promising option for the future.



RECENT INVESTMENTS IN CANADA IN CRITICAL MINERALS, BATTERIES AND ELECTRIC VEHICLES

In 2019, the federal government launched the Mines to Mobility initiative to establish a passenger EV battery value chain in Canada. Working in close collaboration with provinces and territories, Mines to Mobility had catalyzed over \$46B in announced investments by mid-2024.

r	Rio Tinto: \$737M to decarbonize Rio Tinto Iron and Titanium operations, including a large-scale demonstration plant for a new spodumene concentration process
· P · · · · · · · · · · · · · · · · · ·	Anglo American: \$24M into Canadian Nickel to develop Crawford nickel project
• (Jmicore: \$1.5B to produce cathode active materials (CAM) and precursor chemicals (PCAM)
• (Jltium CAM (GM/POSCO): \$500M to produce CAM
× • \	/ale Canada: Providing a long-term supply of battery grade nickel sulfate to Ultium CAM
MIDSTREAM	Nouveau Monde Graphite: \$923M to produce anodes
₹ • E	Electra: \$80M raised to produce cobalt sulfate in Canada
• [BASF: \$692M to produce CAM
• F	Ford, EcoProBM, and SK On Co consortium: \$1.2B for battery materials production in Quebec
• [NextStar (Stellantis/LG Energy Solutions): \$4.9B to produce battery cells
• 5	Stellantis: \$3.6B to produce EVs and fund automotive innovation
	GM Canada: \$2.0B to produce EVs
• •	Ford Canada: \$1.8B to produce EVs
DOWNSTREAM	ion Electric: \$185M to assemble battery packs for e-buses (and build a battery innovation centre)
	Honda: \$15B for comprehensive EV supply chain in Ontario (EV assembly, battery manufacturing, materials processing)
• 1	Northvolt: \$7B for EV battery manufacturing in Quebec
• \	/olkswagen: \$7B for EV battery manufacturing in Ontario
• [Nano One: \$66M spent in Canada on innovative approach to CAM production
• E	E3 Lithium: \$59M raised to produce battery-grade lithium products
	NOVONIX: \$36M spent in Canada on innovations related to advanced battery testing systems and electrode materials development
• F	Flex'N'Gate: \$20M to create a battery research facility

The Global Battery Innovation Landscape

The global battery innovation landscape is characterized by intense competition from jurisdictions who have secured technological leadership through deliberate strategies, including China, the United States, the European Union, Korea, and Japan. Canada's industrial policy for battery innovation can be improved by learning from these examples.

These jurisdictions have successfully practiced 'networked industrial policy' to align public and private investments to capture leadership in value-added niches in global supply chains by scaling up the technological capabilities of domestic firms. Scaling up domestic firms is the primary goal of their industrial policy efforts. This overarching goal animates their approach to related policy domains, such as trade policy, foreign direct investment attraction, labour market policy, etc.

This approach conceptualizes a more active role for the state in driving innovation, moving beyond simply fixing market failures with non-targeted, market framework interventions (tax credits for R&D underspending, regulations for environmental harm, and education spending for skills shortages). Instead, networked industrial policy takes a technology-specific, targeted approach to catalyzing and de-risking collaboration among a cohort of innovative battery firms over time. This mobilizes a broad policy mix, including supply-side inputs to innovation (ex: R&D support and infrastructure, skilled labour, upstream materials) and demand-side market pull for innovative products (ex: procurement, consumer incentives, regulations). The state's emphasis shifts from ad-hoc support for individual projects to a holistic approach that strengthens systems, creates networks, develops institutions, and aligns strategic priorities.

Battery-specific coordination forums facilitate private-public information sharing, enabling collaborative goal setting and optimal policy design. While the main focus of many of these organizations is facilitating cooperative R&D projects (ex: Japan's NEDO or the EU's Batt4EU), the collaborative space opened up by these public-private forums also enables information sharing and dialogue to coordinate how the broader mix of demand-side and supply-side policy instruments can be optimized to enable the scaling up of innovative battery firms and the achievement of innovation targets.

For Canada to compete effectively in this landscape, it must adopt a similarly strategic and collaborative approach, tailored to its unique strengths and challenges.

Global Best Practices

The global landscape of battery innovation is shaped by the strategic efforts of leading nations to advance their battery technologies and secure a dominant position in the market. Countries like China, the United States, the European Union, South Korea, and Japan have set ambitious production and innovation targets to drive their battery industries forward. These nations have implemented comprehensive policies and investments to enhance their capabilities across the entire battery supply chain. Understanding these global best practices provides valuable insights for Canada as it seeks to develop and implement its own strategic roadmap. The following table highlights the key production and innovation targets of these leading countries, illustrating their commitment to advancing battery technology and securing a competitive edge in the global market.

The state's emphasis shifts from ad-hoc support for individual projects to a holistic approach that strengthens systems, creates networks, develops institutions, and aligns strategic priorities.



Global Battery Strategies							
* China	United States	European Union	šouth Korea	Japan			
		SETTING TARGETS	5				
		Production Targets					
Raise domestic content of core components and materials to 40% by 2020 and 70% by 2025	Capture 60% of domestic demand by 2030	 Capture 90% of domestic demand (550 GWh) by 2030 2030 targets for domestic critical mineral extraction (10%), processing (40%), recycling (25%) 	 40% of global battery market and 20% of materials/parts/equipment market by 2030 4x cathode production capacity and triple exports of battery-making equipment the next five years 	 600 GWh (or 20% share of the global battery market) by 2030 150GWh domestic production by 2030 			
Innovation Targets							
Next-gen battery energy density of 500 Wh/kg by 2025	Solid-state and Li- metal production cost <60 \$/kWh, 500 Wh/kg, cobalt/ nickel-free by 2030	 Increase energy density (+60% compared to 2019 values) Reduce cost by 60% compared to 2019 values Improve cycle lifetime (at least by a factor of 2 compared to 2019) 	 800 km single charge by 2026 Lithium-sulfur batteries commercialized by 2025, solid-state by 2027, and lithium-metal by 2028 Recycling 100% domestic secondary battery closed-loop by 2030 	Full commercialization of solid-state batteries by 2030			
		BATTERY ROADMA	PS				
 Made in China 2025 (2015) Action Plan towards the Development of Automotive Power Battery Industry (2017) NEV Industry Development Plan (2020) The 14th Five-Year Plan > National Key R&D Program (2021) 	 Energy Storage Grand Challenge Roadmap (2020) National Blueprint for Lithium Batteries (2021) 	 Strategic Action Plan for Batteries (2018) Batteries Europe: SRA (2020) BEPA Batt4EU: SRIA (2021) Green Deal Industrial Plan (2023) EU Batteries Regulation (2023) Update of the SRIA (2024) 	 K-Battery Development Strategy (2021) Innovation Strategy on Secondary Battery Industry (2022) Post-IRA Public-Private Joint Strategy for Battery Industry Development (2023) 	 Green Growth Strategy Through Achieving Carbon Neutrality in 2050 (revised in 2021) Battery Industry Strategy (2022) 			



Global Battery Strategies							
*)		\odot					
China	United States	European Union	South Korea	Japan			
	INDUSTRIAL PO	LICY MIXES AND COO	RDINATION FORUMS				
		Supply Push					
 Joint Venture FDI requirements R&D investments Loans for mineral supply chain 	 DoE R&D funds DoE Loan Program IRA tax credits 	 Horizon Europe R&D European Investment Bank Important Projects of Common European Interest 	 Public-private 'battery alliance' R&D fund Loans & guarantees for critical minerals Battery-specific tax credit bonuses 	NEDO R&D consortiums			
		Demand Pull		1			
 Transit procurement Purchase subsidies EV mandate & credit system 	IRA EV consumer incentive thresholds for domestic supply chains	 Procurement thresholds for domestic supply chains Fit-for-55 2035 ICE phase out EU Batteries Regulation 	EV purchase incentive technical eligibility criteria	EV infrastructure investment			
		Public-Private Coordina	ition				
China EV100	Li-bridge	 European Battery Alliance InnoEnergy BATT4EU 	Korean Battery Alliance	Storage Battery Industry Strategy Council			







Roadmap Vision and Strategy

The Canadian Battery Innovation Roadmap sets forth a bold vision for 2035: to establish Canada as a global leader in clean, innovative battery technology and a hub for sustainable battery production in North America. This vision recognizes the transformative potential of batteries in driving the clean energy transition and positions Canada to capture a significant share of the economic and environmental benefits this transition will bring.

There are considerable challenges to realizing this vision. While Canada is a leader in early-stage innovation, in part due to strong government expenditure on research and development, these innovators often fail to scale at home. Too often, they are bought by foreign firms, or they stall along the commercialization pathway.

To realize this vision in a competitive global landscape, Canada needs a new approach premised on active, targeted collaboration between government and industry. Such a collaboration is the core of modern industrial policy as practiced in all jurisdictions seeking to build innovative battery ecosystems. **Canada simply cannot be competitive without a strategic approach**.

The first element of this approach is to set the right targets and metrics. Doing this in the context of a shifting technological space can be daunting. This roadmap begins by laying out three kinds of drivers that are shaping the battery technological frontier. By focusing on market, environmental, and geopolitical drivers we can understand where the puck is going and design a strategy that mitigates uncertainty.

Market drivers include improving energy density to increase range, reducing charging time, enhancing cold-weather performance, extending cycle life, lowering costs, and ensuring safety. These factors are crucial for the widespread adoption of battery technologies across various applications, from electric vehicles to grid-scale energy storage.

Environmental drivers emphasize the need for sustainable materials, efficient recycling processes, low-emissions production methods, and second-life applications for batteries. By prioritizing these factors, Canada can position itself as a leader in sustainable battery technology, aligning with global efforts to combat climate change and reduce environmental impacts.

Where Is the Puck Going?





Geopolitical drivers focus on reducing dependency on critical materials like cobalt, ensuring ethical sourcing practices, and building resilient supply chains. These factors are essential for Canada's economic security and its ability to maintain a stable, domestic battery industry.

By focusing on technological advancements, best practices in policy, and a thorough assessment of the current Canadian landscape, the Battery Innovation Roadmap articulates key actions needed to achieve these ambitious targets.

Roadmap Actions

Canada's battery sector is at a critical juncture. Without ambitious structural changes to policy and industry, we risk losing our most promising companies and technologies. This roadmap outlines essential steps to create an environment where Canadian battery innovators can thrive and scale. Our strategy centers on two themes: Innovation Infrastructure and Industrial Policy.



Online Battery Innovation Roadmap

Make sure to explore our comprehensive online roadmap, designed to help navigate key battery innovation policies. This interactive tool empowers policymakers with actionable insights and strategic guidance to drive Canada's leadership in battery technology.



Without ambitious structural changes to policy and industry, we risk losing our most promising companies and technologies.

Innovation Infrastructure

Financial Ecosystem:

Enhance funding mechanisms and align existing programs to support battery innovation across all stages of development.

Goal: \$3B invested in battery innovation through public and private funding.

Physical Assets:

Expand research centers, establish demonstration facilities, and build out national labs to support cutting-edge battery research and development.

Goal: Canada's battery R&D centers and national labs contribute significantly to achieving the innovation metrics goals laid out in the roadmap.

Skills & Talent:

Develop specialized training programs, enhance partnerships with educational institutions, and create a skilled workforce to drive battery innovation.

Goal: By 2035, train and integrate over 10,000 skilled professionals into Canada's battery industry, with at least 500 graduates annually from specialized training programs.

andustrial Policy

Scale-up Support:

Implement targeted policies and programs to help innovative firms grow and remain in Canada, capturing more value within our domestic economy.

Goal: By 2035, increase the number of Canadian-owned firms in the battery sector tenfold, contributing to 20% of the North American battery value chain.

IP Strategy:

Strengthen intellectual property protection and development strategies to ensure Canadian innovations benefit our economy and global competitiveness.

Goal: Secure 1,000 patents in battery technology by 2035.

Across these five areas, we have identified 50 high-impact actions to transform Canada's battery innovation landscape. These actions include establishing new funding mechanisms, creating research facilities, implementing targeted industrial policies, and forming a national battery alliance. By executing these initiatives, we can build a robust, world-leading battery ecosystem, capturing value at every stage and positioning Canada as a global leader in battery technology.







Innovation Infrastructure

Building a world-class battery innovation ecosystem requires a strong foundation of innovation infrastructure. The roadmap identifies three critical components of this infrastructure: the financial ecosystem, physical assets, and human capital. Each of these areas requires targeted interventions and investments to support Canada's battery ambitions.

The financial ecosystem is crucial for supporting innovation at all stages, from early-stage research to commercialization and scale-up. The roadmap proposes several key actions to enhance Canada's financial support for battery innovation. These include aligning and focusing existing funding mechanisms to better support the battery sector, establishing a dedicated Battery Innovation Venture Fund to provide crucial early-stage capital, and expanding the Office of Energy Research and Development's (OERD) funding program to offer larger grants for growth-stage companies. Additionally, the roadmap recommends implementing R&D minimums for public support to ensure that companies receiving government assistance contribute to Canada's innovation ecosystem.

Physical assets form the backbone of any innovation ecosystem, providing the facilities and equipment necessary for cutting-edge research and development. The roadmap calls for significant investments in this area, including enhancing existing research centers at institutions like Dalhousie University and the University of Waterloo, launching new battery research centers across Canada to promote regional diversity, and establishing state-ofthe-art demonstration facilities for testing large-scale battery technologies. Furthermore, it proposes the creation of regional production clusters that bring together R&D centers, firms, and other stakeholders to foster collaboration and knowledge sharing along the entire battery value chain.

Human capital is the driving force behind innovation, and developing a skilled workforce is essential for Canada's success in the battery sector. The roadmap outlines a comprehensive approach to skills and talent development, starting with a thorough mapping of the skills required by Canada's battery industrial and innovation ecosystem over different time horizons. It proposes developing international partnerships with leading organizations focused on battery training, enhancing collaboration between universities, technical schools, and battery companies to co-create relevant curricula, and launching specialized training programs and apprenticeships. Additionally, the roadmap recommends creating a fellowship program to support advanced research in battery technologies, ensuring a pipeline of highlevel expertise to drive innovation.

By investing in these three pillars of innovation infrastructure, Canada can create a fertile ground for battery innovation, supporting the growth of domestic companies and attracting international investment and talent.

"Building world-class research facilities and demonstration centers is crucial. These assets will not only advance our technology but also attract global talent and investment to Canada."

-Karim Zaghib, CEO of Volt-Age Electrifying Society (CFREF) and Professor at Concordia University





Industrial Policy

To fully capitalize on its innovation potential and compete on the global stage, Canada needs a robust industrial policy tailored to the unique challenges and opportunities of the battery sector. The roadmap proposes a two-pronged approach to industrial policy, focusing on scale-up support and intellectual property (IP) strategy.

Scale-up support is critical for helping innovative Canadian firms grow and remain in the country, capturing more value within the domestic economy. A centerpiece of this effort is the establishment of a National Battery Alliance, a central coordinating body that will drive the implementation of the roadmap and foster collaboration across the ecosystem. This alliance will bring together key stakeholders from government, industry, and academia to align efforts, share information, and develop strategies to overcome challenges in the battery innovation landscape.

To complement the alliance, the roadmap proposes creating a dedicated government problem-solving team to address specific issues and opportunities in the battery sector. This agile team will work across departments to implement reforms and coordinate policies effectively. Another key initiative is the development of a Battery Ecosystem Intelligence Dashboard to track progress, analyze the current state of the ecosystem, and inform decision-making.

The roadmap also emphasizes the need to streamline regulatory processes for new battery technologies, reducing barriers to innovation and commercialization. It recommends integrating industrial policy goals into existing programs, such as structuring EV incentives to benefit Canadian firms and technologies.

Intellectual property is a crucial asset in the innovation economy, and the roadmap proposes a comprehensive IP strategy to ensure that Canadian innovations translate into economic benefits for the country. This includes implementing comprehensive IP education for researchers and entrepreneurs, providing financial support for start-ups to secure IP services, and formulating a National IP Strategy for Batteries to guide efforts in this critical area.

To accelerate innovation in key areas, the roadmap suggests implementing a fast-track patent processing system for technologies deemed critical to national interests. Additionally, it proposes developing programs for sharing and pooling non-core patents among Canadian battery companies, fostering collaboration and reducing duplication of efforts.

By implementing these industrial policy measures, Canada can create an environment that not only fosters innovation but also supports the growth and retention of innovative firms, ensuring that Canadian battery technology translates into domestic economic prosperity.

"As a Canadian company scaling up in this competitive global market, we've seen firsthand the importance of supportive industrial policies. They can make the difference between success and stagnation."

−Chris Burns, CEO and Co-Founder of NOVONIX™ "The proposed National Battery Alliance is exactly what Canada needs. It will help align our efforts, share knowledge, and accelerate our path to becoming a global battery powerhouse."

Dan Blondal, CEO of Nano
 One Materials Corp

Key Findings & Next Steps

This roadmap envisions Canada as a global leader in clean, innovative battery technology and a hub for sustainable battery production in North America by 2035. Achieving this vision requires addressing key challenges and leveraging Canada's strengths through a coordinated, strategic approach involving government, industry, and academia.

Key Findings

- >> Untapped Potential: Canada has significant strengths in raw materials and research capabilities within the battery supply chain.
- >> Current Gaps: Challenges exist in scaling up innovative firms, providing continuous financial support, and retaining high-value assets within Canada.
- Strategic Coordination: A coordinated approach involving government, industry, and academia is essential for success.

Next Steps: Establishing the National Battery Alliance

The immediate priority is to establish the National Battery Alliance, a central coordinating body essential for implementing this roadmap. This alliance will unite key players from government, industry, and academia to drive the realization of our vision.

Key Functions of the National Battery Alliance

- » Strategic Coordination: Align efforts across the battery value chain.
- » Policy Advocacy: Champion supportive policies and regulations.
- » Innovation Catalyst: Foster collaboration in research and development.
- » Skills Development: Coordinate training and education initiatives.
- » Investment Attraction: Promote Canada as a destination for battery investments.
- » International Partnerships: Facilitate global collaborations and knowledge exchange.

Near-Term Priorities for the Alliance

- » Formalize its structure and governance.
- » Develop a detailed implementation plan for the roadmap.
- » Initiate the Battery Ecosystem Intelligence Dashboard.
- » Launch working groups on critical issues (e.g., financing, skills, R&D).
- » Begin outreach to international partners.

By taking these steps, the National Battery Alliance will play a pivotal role in translating this roadmap from vision to reality. It will be the driving force behind Canada's ascent to becoming a global battery powerhouse, fostering innovation, creating high-value jobs, and contributing significantly to the country's clean energy future.