



Technology Decision Analysis (TDA): Cummins Inc. and the Shift toward Electrification in Commercial Trucking

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ABSTRACT

The rapid advancement of electrification within the automotive sector poses both a challenge and an opportunity for traditional internal combustion engine manufacturers. This paper provides a comprehensive Technology Decision Analysis (TDA) on Cummins Inc., a leading producer of diesel engines for commercial trucking, as it confronts the electrification paradigm shift. By examining Cummins' strategic responses, including its venture into electrified powertrains, hydrogen fuel cells, and the establishment of the New Power business unit, this analysis highlights the company's adaptability and proactive approach towards emerging technologies. Through a detailed examination of market trends, technological limitations of current battery systems, and the competitive landscape, we assess Cummins' potential to maintain its industry leadership amidst shifting environmental regulations and increasing demand for sustainable transportation solutions. Furthermore, this paper evaluates Cummins' investments in research and development, strategic partnerships, and acquisitions aimed at enhancing its electrification and hydrogen technology capabilities. Our analysis culminates in a discussion on the future of commercial trucking powertrains, emphasizing Cummins' strategic positioning and its implications for the industry's move towards zero-emission vehicles. This paper contributes to the understanding of how legacy manufacturing firms can navigate technological disruptions by leveraging innovation and strategic planning to sustain their market leadership and commitment to sustainability.

Keywords: Technology Decision Analysis (TDA), Electrification, Commercial Trucking, Cummins, automotive sector.

INTRODUCTION

This paper will focus on the disruption caused by Electrification on Commercial Truck powertrain. We will focus on one of the largest Diesel engine manufacturers - Cummins Inc. and its response to this challenge. Cummins was founded in 1919 by Clessie Cummins and William Irwin in Columbus IN. The company has been developing and manufacturing Diesel Engines for commercial applications like on highways trucks, buses, industrial equipment, mining, and power generation. The company recently started to sell powertrain solutions that include engine and transmission. The company sells in approximately 190 countries [1] and territories through a network of more than 600 company- owned and independent distributors. As shown in Error! Reference source not found., the company has five Business Units that operate in different markets. 2020 full year revenue was \$19.8B and EBITDA of \$837M or 14.4 percent of sales, these financials (during COVID-19 pandemic) suggest that this is a well-run company that is making a healthy profit.

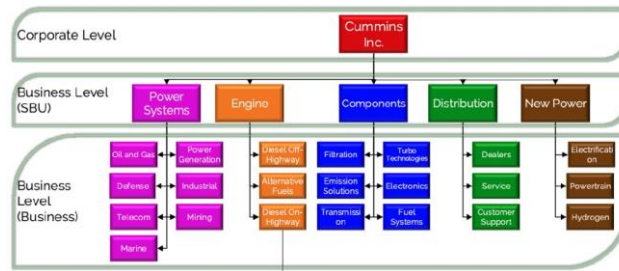


Figure 1: Cummins Inc. Corporate Structure

The largest business unit is ‘Engine Business’ with net sales of \$8.02B in 2020 [2], it is the key driver for R&D (Research and Development) and the base upon which other business units build their sales like parts, service etc. Heavy Duty ‘X15’ (15-liter displacement, Figure 3) is the flagship engine for Class 8 semi-trucks (Figure 2) and will be the incumbent product for this study.



Figure 2: A class 8 truck with Cummins X15 engine.



Figure 3: Cummins X15 diesel engine.

The sales model for Engine Business Unit depends on large OEMs (Original Equipment Manufacturers) like Paccar, Navistar, Volvo, and Daimler Trucks of North America buying hundreds of thousands of engines every year. These OEMs develop and manufacture some (mostly smaller) engines themselves. However, they rely on Cummins for meeting their demand which makes Cummins the market leader in US Heavy Duty engine sales [3] (Figure 4). Large volume of engine sales allows Cummins to invest in R&D and keep manufacturing fixed costs low.

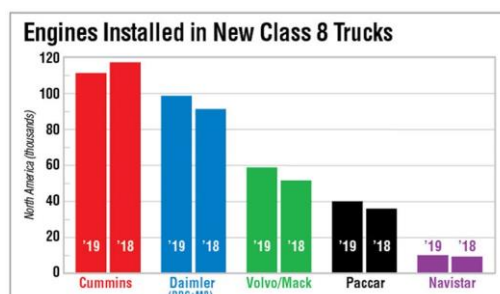


Figure 4: US Class 8 engine market share.**EXPERIMENTATION WITH ELECTRIFICATION**

Cummins started developing electrified powertrains in 2007, however, they could not find any customers and stopped the program during the 2009 recession. In 2013, with the increase of electrification in the automotive industry, Cummins restarted the program. It has now created a separate Business Unit called ‘New Power’ which not only includes electrification, but also ‘Hydrogen Fuel Cells’. They have also announced large investment plans in Hydrogen as a fuel for future (over battery electrification). In this paper we will evaluate decision to shift towards electrification.

CHALLENGES FOR CUMMINS

Electrification has caused a disruption in the automotive industry; an increasing number of automotive companies are investing heavily in new technologies and General Motors recently announced a plan to go all electric by 2035 [4]. This trend is heading towards pick up and commercial trucks as well. Over the years, batteries have struggled to improve on their ‘power to weight’ ratio. Installing more batteries for higher power and range required for long haul applications is a less feasible option as it reduces cargo capacity, leading to a poor TCO (Total Cost of Ownership) for the customer. Battery experts claim that Lithium-Ion batteries are operating close to their chemical limits and there will be little improvement in the future. These factors have slowed the penetration of electrification in the commercial market. As of today, it is limited to applications that have light load duty- cycle and can charge everyday - school bus, city and transit bus would be good examples.

A. OEM’s home-grown solutions:

OEMs prefer to buy Cummins diesel engines because it has become increasingly difficult to meet near zero emission regulations, technology required to meet them is very complicated and requires hundreds of millions in Research and Development costs. A brand-new engine development can cost upwards of \$300M dollars including R&D, restructuring and retooling manufacturing plants, supplier and other functions like parts, sales and service.

Most OEMs develop engines up to 13 ltr internally and buy 15 ltr from engine manufacturers like Cummins, Detroit Diesel and Volvo. In comparison, Electrification and Hydrogen Fuel Cells are not that complicated and easily meet emission regulations. This has led OEMs to develop these technologies internally like Daimler’s Freightliner eCascadia and Volvo’s VNR Electric [5]. Most of them are acquiring startups in areas where they are lagging to accelerate development, as manufacturing their own powertrain will be a big saving for them. This is the biggest challenge for Cummins as they risk losing out on the large volume from these OEMs.

B. Technology Limitations:

With increased strict regulations, it is challenging for Cummins to come up with near-zero carbon emission solutions with diesel or alternative fuel technologies. Internal combustion engines produce large amounts of pollutants that are later cleaned in aftertreatment devices like catalysts, these devices can cost as much as the engine and are complicated machines. This has led Cummins to investigate bringing in electrified technologies into their powertrain solution. It will still be challenging for Cummins to meet the upcoming regulations with the limitations of battery technology. To get better drivable range, it requires a higher capacity battery pack which adds weight and reduces hauling capacity [6].

C. Planet 2050 Zero Emissions:

Cummins has its strategy for sustainability Planet 2050 Zero emissions goal [7]. Apart from making the manufacturing process sustainable, Cummins plans to make their products sustainable. This will not be possible by using traditional internal combustion engines (ICE), hybrid systems or even Battery Electric Vehicles (BEV).

D. Competition:

In the electrification space, because of ease of integration of power electronics components, various technology startups are entering into this market space [5]. With Tesla’s 2019 announcement of ‘Semi’ [8], a Class 8 Battery Electric Vehicle (BEV), it created direct competition for Cummins core business. Similarly, another startup Nikola Motors created a threat for Cummins in the overall on-road vehicle market by announcing a class 7 and 8 FCEV (Fuel cell electric vehicle) truck called ‘Nikola Two’ [9]. Non- automotive manufacturers and technology companies like Google, Microsoft, Apple pose a threat to Cummins service and support business. Inspired by Tesla’s success, a lot of the Silicon Valley startups have moved from ‘Tech’ to ‘Automotive Tech’. Almost feels like the hub of automotive research is moving from Michigan to California!

CUMMINS SOLUTION

As of now, diesel engines continue to be the bread and butter of the company. Exhibit 1: Cummins Inc. 2020 Income Statement by Business Unit, shows that Engine Business sales were \$8.02B compared to \$72M for New Power business. It continues to invest in Diesel Engines with the assumption that they will lead for a foreseeable future as high cost of electrical components make EVs expensive for now.

However, as mentioned above, diesel engines continue to become more complex and expensive. They have also suffered bad public perception of ‘Dirty Diesel’ after the VW diesel scandal of 2014 that led to resignation of their CEO Martin Winterkorn and more than \$33B in damages [10].

Looking at the technology and market trend, Cummins decided to expand its product offerings from just an engine supplier to a complete powertrain solution. Cummins partnered with Eaton in 2017 to provide an integrated solution with transmission [11], this would also have an advantage of a X15 engine optimized with Eaton transmission for better performance and fuel economy. To mitigate the threats from electrification startup companies and capitalize its investment in R&D for electrification, in 2018 Cummins launched a new business segment called New Power.

Despite losses in New Power (\$172M. loss in 2020), to realize PLANET 2050 net-zero emissions strategy, Cummins has been making strategic investments in key technologies. To increase capabilities in this area, Cummins acquired several small companies:

- ‘Brammo’ - a producer of electric traction motors and traction batteries [12].
- ‘Johnson Mathey’s Battery technology’ [13] - a subsidiary of Johnson Mathey that specializes in high-voltage automotive grade battery systems for electric and hybrid vehicles.
- ‘Efficient Drivetrains, Inc’ [14] - Silicon Valley- based company that designed and produced hybrid and fully- electric power solutions for commercial markets.

For future growth beyond 2030, Cummins invested in Fuel Cell technologies. Cummins has been developing its fuel cell capabilities for more than 20 years with heavy research in Silicon Oxide Fuel Cell (SOFC) as an auxiliary power source for stationary applications. Recently Cummins received a grant from the U.S. Department of Energy (DOE) to research on Reversible-SOFC that will act as that will run as traditional SOFC or as a solid oxide electrolyzer cell (SOEC) that can split steam to separate hydrogen and oxygen [15]. It acquired a Canadian company ‘Hydrogenics’ [16], which is a fuel cell and hydrogen production technologies provider. With the acquisition of Hydrogenics and support from a French gas supply company ‘Air Liquide’, Cummins has accelerated their ability to further innovate and scale hydrogen fuel cell technologies across a range of commercial applications [17].



Figure 5: Cummins roadmap of powertrain solutions.[17]

With the investments in key technologies, Cummins revamped their product portfolio and solutions offerings. For its vision Planet 2050, Cummins created the roadmap (Figure 5) of powertrain solutions to any industry based on customer needs and achieved a path to Zero-Emissions [17].

While Cummins will offer different combinations of powertrains [18] (Figure 5), it sees Hydrogen as a key enabler for path to zero-emissions targets, hence they are investing heavily in this technology and partnering with Air Liquide to shape the transportation industry [17]. Cummins will focus on renewable and clean Hydrogen generation technologies to build the infrastructure, fuel-cells technologies for source of energy, battery technologies for storage of energy, motor generators to create the power and joint venture with Eaton to integrate the transmission.

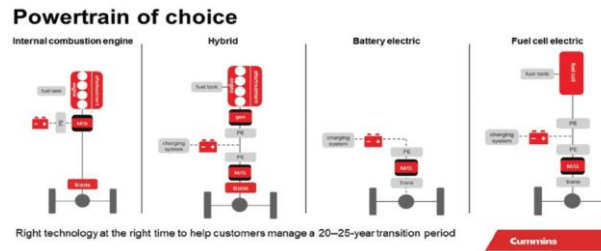


Figure 6: New Power Drivetrain Options.[18]

CONCLUSION

Based on the extensive analysis and evidence presented in the Technology Decision Analysis (TDA) paper, it is evident that Cummins Inc. has strategically navigated the electrification disruption within the commercial trucking sector. Cummins' proactive shift towards electrification, and its substantial investments in new power technologies, including hydrogen fuel cells, aligns with global trends towards sustainability and reduced carbon emissions. The decision to diversify its product offerings to include electric and hydrogen-powered solutions, alongside its traditional diesel engines, demonstrates Cummins' commitment to innovation and its foresight in anticipating industry shifts.

The challenges Cummins faces, such as the technical limitations of battery technology and the increasing competition from OEMs and technology startups, are significant. However, Cummins' comprehensive approach, which encompasses partnerships, acquisitions, and internal development, positions it strongly to overcome these hurdles. The creation of the New Power business unit and the strategic focus on hydrogen as a clean, renewable energy source underscore Cummins' agility and its readiness to adapt to a rapidly evolving market landscape.

In conclusion, Cummins Inc.'s strategic maneuvers towards electrification and zero-emission technologies reflect a deep understanding of the industry's direction and a clear vision for the future. While challenges remain, Cummins' approach is well-founded, balancing immediate business needs with long-term sustainability goals. The company's ongoing investments in research and development, coupled with strategic collaborations, lay a solid foundation for future growth and leadership in the transition towards a more sustainable and electrified future in commercial trucking.

As the transportation industry continues to evolve, Cummins' adaptability, innovation, and commitment to sustainability will be crucial factors in its success. The company's journey towards electrification and zero emissions is not only a testament to its resilience but also a model for how traditional manufacturers can effectively respond to technological disruptions and lead in the transition to a more sustainable world.

FUTURE RECOMMENDATION

As Cummins Inc. navigates the complexities of the commercial trucking industry's transition towards electrification and sustainability, it is imperative for the company to adopt a forward-thinking and flexible approach. This section outlines several key recommendations designed to bolster Cummins' strategic positioning, foster innovation, and secure its leadership in the evolving market landscape.

A. Accelerate Digital Transformation:

Cummins should intensify its efforts in digital transformation to enhance operational efficiency, customer engagement, and innovation. By leveraging advanced analytics, artificial intelligence, and IoT technologies, Cummins can gain deeper insights into market trends, customer use cases, and powertrain performance. This would enable more informed decision-making and the development of intelligent, connected products that enhance user experiences.

B. Expand Electrification and Hydrogen Fuel Cell R&D:

Despite the current technological limitations of battery technology and the nascent stage of hydrogen infrastructure, these areas represent the future of transportation. Cummins should continue to invest heavily in research and development for electrification and hydrogen fuel cell technologies. This includes exploring next-generation battery technologies, solid-state batteries, and advanced hydrogen storage solutions to overcome existing challenges and leapfrog competitors.

C. Strategic Partnerships and Collaborations:

To accelerate the development and deployment of electrification and hydrogen solutions, Cummins should seek strategic partnerships with technology companies, research institutions, and startups. Collaborations can provide access to cutting-edge technologies, foster innovation, and facilitate the sharing of risks and rewards in developing new solutions. Moreover, partnerships with infrastructure providers could help address the critical challenge of hydrogen fueling and electric charging infrastructure.

D. Diversification into Adjacent Markets:

Given the uncertainty in how quickly the commercial trucking sector will transition to zero-emission vehicles, Cummins should consider diversifying its product portfolio into adjacent markets that are also moving towards electrification, such as marine, rail, and stationary power generation. This diversification would reduce reliance on the traditional trucking sector and open up new revenue streams.

E. Advocate for Supportive Policies and Infrastructure Development:

Cummins should actively engage with policymakers, industry associations, and other stakeholders to advocate for supportive policies, incentives, and investments in infrastructure development for electric and hydrogen-powered vehicles. By leading the charge in shaping the regulatory environment, Cummins can help accelerate the adoption of sustainable transportation solutions and ensure a level playing field.

F. Sustainability and Corporate Responsibility:

As Cummins advances its Planet 2050 sustainability goals, it should also prioritize corporate social responsibility initiatives that support environmental, social, and governance (ESG) objectives. This includes investing in sustainable manufacturing practices, engaging in community development, and ensuring an ethical supply chain. Such initiatives will enhance Cummins' brand reputation and align with the increasing expectations of customers, investors, and regulators.

CONCLUSION

In conclusion, while Cummins Inc. faces significant challenges in the shift towards electrification and sustainability, these recommendations provide a roadmap for the company to navigate the transition effectively. By staying at the forefront of technological innovation, expanding its market reach, and actively shaping the future of the industry, Cummins can secure its position as a leader in the next era of commercial transportation.

2020 Income Statement by Segment

SM	Engine	Distribution	Components	Power Systems	New Power	Intersegment Eliminations	Total
Year ended December 31, 2020							
Net Sales	8,022	7,136	6,024	3,631	72	(5,074)	19,811
Sales growth vs 2019	(20)%	(12)%	(13)%	(19)%	89%	(15)%	(16)%
EBITDA	1,235	665	961	343	(172)	76	3,109
Segment EBITDA %	15.4%	9.3%	16.0%	9.4%	NM ¹		15.7%
Year ended December 31, 2019							
Net Sales	10,056	8,071	6,914	4,460	38	(5,968)	23,571
EBITDA ²	1,472	693	1,117	524	(148)	73	3,731
Segment EBITDA % ²	14.6%	8.6%	16.2%	11.7%	NM ¹		15.8%

¹NM: Not meaningful information
²2019 EBITDA includes the impact of restructuring charges that reduced Engine Segment EBITDA \$16 million, Distribution Segment EBITDA \$17 million, Components Segment EBITDA \$20 million, Power Systems Segment EBITDA \$12 million, New Power Segment EBITDA \$1 million, and Intersegment Eliminations EBITDA \$21 million.

Exhibit 1: Cummins Inc. 2020 Income Statement by Business Unit

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