

Technology Development and Commercialization – Gate 3 Executive Summary

Applicant Information		Docket Number: 22771	
Project Title: Commercialization of a High-Efficiency, High-Performance, Low NOx Emissions, Medium-Duty, Propane Engine			
Lead Vendor: Cummins Inc.			
Organization: Cummins Inc.			
Amount Requested: \$12,000,000			
Start Date: 1/15/2021		End Date: 12/31/2025	

Executive Summary (completed by PERC staff)				
Project Summary				
<p>In partnership with PERC, through docket 20905, Cummins Research and Development organization developed an engine optimized for high-efficiency and near-zero emissions operating on propane. Through this project, Cummins will commercialize a propane derivative engine with unmatched performance and efficiency. The propane-powered engine will bring unparalleled performance to the medium-duty vehicle market while also providing a pathway to a high-performing engine for off-road applications.</p> <p>This project will involve all aspects of a successful new engine launch, including final optimization of the propane-engine, performance testing, emissions certification, OBD certification, manufacturing and production preparation, development of training and support materials, identification of vehicle OEM partners, and launch. Based upon the proposed timeline, the propane engine would launch in 2024.</p>				
Strategic Importance				
<p>The 2020-22 PERC Strategic Plan has a strategic priority to grow the autogas market through industry adoption, the development of certified applications, service networks, and commercialization support of applications in the market. This engine will create new market opportunities for propane autogas as the engine will deliver diesel-like performance and durability with efficiency unlike current propane engines on the market. The engine is targeted for use in various medium-duty vehicle platforms.</p> <p>The PERC Strategic Plan also prioritized new mobile agriculture equipment, new material handling offerings, and an increased emphasis on power generation solutions. The engine commercialized through this project will provide power and efficiency at a higher level than currently available in off-road applications.</p> <p>This project aligns with the strategic intent while achieving specific metrics of the plan.</p>				
Budget Impact				
Category: Autogas, Off-Road, and Agriculture				Total: \$12M total
Three Year Funding History for Similar Dockets				
Year	Docket	Budget \$	Actual \$	Results
2016	20905	\$6,083,000	\$6,083,000	Engine successfully developed
Success Measures				
<p>Significant outcomes include the addition of 1-2 new propane OEMs into for the medium-duty truck market and expansion into truck the truck market for 1-2 OEMs currently offering propane for non-truck applications. Also included in success measures would be Cummins distributors offering customer service for the engine applications.</p>				

Technology Development and Commercialization – Gate 3 Details

Project Title: Commercialization of High-Efficiency, High-Performance, Low NOx Medium-Duty Propane Engine

Docket #: 22771

Detailed Business Case (Completed by applicant)

1. Product

Cummins previously completed the demonstration of an advanced propane-based engine concept under a previous docket. Currently, that demonstration is in the field being utilized as a propane delivery vehicle. Cummins will continue the development and commercialization path of that engine under this docket.

The engine concept utilizes many diesel production parts from current diesel engines. Cummins would develop the propane specific components to meet the following goals:

- Deliver world class efficiency
- Deliver diesel like durability
- Deliver unmatched rating capability
- Deliver low NOx

The initial product is targeted for on-road applications, although Cummins will consider requirements for off-road applicability for future compatibility. We do not anticipate any patents being required although it is possible new IP is developed by Cummins during the conduct of the program. Cummins will own any IP developed as part of this project.

2. Market

Broadly defined, medium duty is Class 4-7 vehicles that represents about 200,000 vehicle sales annually. Today, the penetration of propane in these classes represents about 15,000 units. Cummins is positioned as well or better than any other organization to penetrate this market with current customers throughout the medium-duty space. Cummins has a well-developed and growing distributor business that is present throughout North America to support products. A Cummins product of this type would be serious competitor in the space. Existing engine options in this market would be challenged in their value package to match this proposed approach. An expected outcome would be some manufacturers switching from currently available offerings; however, the proposed value package would enable substantial expansion in sales and potentially at a faster rate. Doubling or tripling the propane engine sales for medium-duty applications appears viable.

There are additional uses for the engine beyond the medium-duty truck market. Many other off-road and marine applications could be excellent targets for the technology palette proposed including power generation, agricultural equipment, and material handling applications. Cummins will evaluate those opportunities as part of this program.

3. Project Scope

Cummins proposes to complete its new product development process for this engine concept. The process is divided into multiple phases demarcated by gates to manage the development process. The program is led by a cross-functional team representing all facets of the program including engineering, manufacturing, purchasing, reliability, supply chain/logistics, service, marketing and finance.

These are the process phases with each phase primarily focused on the engineering efforts to commercialize a propane engine. This list is provided to give an overview of the process and is not intended to be an exhaustive list of all work required for Cummins to launch a powertrain system.

- Chartering and Project Commencement
- Concept Development
- Product Design
- Product Verification
- Production Validation

- Product Launch
- Post-launch Program Close-out

The preceding list is only a small portion of the high-level work across all of the Program Team functions, but serves as an indicator of the level of effort and sophistication associated with the development process. Engine test work would run through most of the phases whereas vehicle-based field testing is concentrated in the Verification and Validation tasks and may extend through the Product Launch phase. Customer field test units are typical in the Product Validation phase and would be expected for this program as well.

The Propane Education and Research Council will be involved primarily to educate the market about the engine, connecting with vehicle OEMs about supporting the integration and launch of vehicles using this engine, working with Cummins on market opportunities, and promoting the engine launch through market outreach.

4. Risk Assessment

Risk	Likelihood	Impact	Risk Resolution and/or Contingency Plan(s)
Projected volume fails to meet initial assessment	Low	High	Early feedback from OEs and customers is critical to ensure accurate volume projections
Program timing changed based upon CMI product plans	Low	High	CMI will actively engage with PERC on the planned introduction date so that any changes are identified in a timely manner
Resource constraints delay the program	Low	Medium	A shortage of resources could mean an increase in development time or a need to secure external assistance from consulting firms

5. Vendor Capabilities

The Cummins organization and supply chain contain all relevant experience necessary to complete the proposed project. The analysis, design, procurement, and development process are a standard project workflow within Cummins and previously delineated in the Project Scope.

Furthermore, the group within Cummins proposing the work effort has substantial experience delivering similar scope projects having launched many engine programs globally for on and off-highway applications. The Cummins Engine Business Unit manufactures diesel and spark ignition engines at our Rocky Mount Engine Plant in North Carolina and therefore has the manufacturing expertise to successfully complete this program. Cummins has a long history of offering competitive warranty terms and stands behind our products in the field. We expect customers to be comfortable looking to Cummins for the class changing application. Our distribution expectation is covered in Section 10.

It is typical for Cummins to have both Program Leader and a Technical Project Leader for a program of this scope. Although each have a broad list of responsibilities on the program, the Program Leader oversees the project team and all functions including Marketing, Finance, purchasing and Service groups. The Technical Project Leader holds responsibility for the Engineering functions including hardware, electrical and software from performance to certification. At this point in the process it is too early to identify those leaders, but Cummins will assign capable individuals to complete the program and support them to ensure a successful launch.

6. Cost/Benefit Analysis

A portion of the volume projected in the Outcomes section is expected to represent new gallons sold for Autogas use. At this point in the program that would be approximately 50% of the identified volume. Using a 5 mpg assumption and 25,000 miles per year Medium-Duty truck assumption or 5,000 gallons per year per truck, that represents new propane consumption growth of 7.5-17.5M annually.

7. Budget

	2020	2021	2022	2023	2024	2025	Total:
Total PERC Contribution	-	3.5	3.5	3.0	1.5	0.5	12.0

8. Timeline

Product launch in 2024.

Commercialization Plan (Completed by applicant)

9. Positioning strategy

The installation cost and complexity of diesel powertrains has increased considerably over the last ten years. This has driven a portion of the market towards more cost effective and simpler alternatives like gasoline and propane. However, there are trade-offs that are borne by the consumers with this change, namely in power density and efficiency. These translate into diminished capability of the vehicles to perform the same work as with diesel powertrains. The Cummins positioning strategy is to provide a modular platform that overcomes these unfavorable tradeoffs for the customer - best in class efficiency and power density for the end user combined with integration ease with multiple fuels on one platform for OEM.

The outcome of this project is the launch of an advanced spark ignited engine with capabilities that enable the full potential of propane as a fuel. Currently two types of propane engines are available in the marketplace: 1) conversions of existing gasoline engines and 2) conversions of diesel engines. Each of these engine categories has significant limitations which prevent entitlement efficiencies and ratings from being achieved using propane. Even modern turbo-charged light-duty gasoline engines are not designed with sufficient robustness to fully optimize for and take advantage of propane's properties. While many diesel engines do exhibit the necessary robustness, diesel's basic combustion system design is fundamentally different than an optimized propane combustion system.

Cummins proposes to commercialize an advanced combustion engine optimized for propane operation with sufficient robustness to take full advantage of propane's excellent fuel characteristics while also being highly desirable for commercial engine application. The project includes an integration into a medium-duty vehicle to be launched at the same time as the engine is launched to the market.

10. Potential distribution and channel approach(es)

There are expected to be challenges in reaching the market in the form of capital cost (incremental price of fuel systems and tanks on vehicles, infrastructure of fuel availability). In many cases, the fuel is new to the average end user and education will be required. The same would be applicable to maintenance in some cases to a lesser extent. Fortunately, Cummins currently has a very strong distribution network - over 4000 locations of authorized support centers. This will allow education of a support network in a consistent manner.

Many of our current OEM partners are already involved in propane power. A priority will be put on identifying new OEMs to integrate this engine. The modular platform concept will allow Cummins to leverage the commonality of parts between the diesel and propane engines with respect to parts availability in the channel, service tools to diagnose and provide prognostic capabilities to our end users.

11. Potential marketing, communications and promotional requirements

There are multiple commercial vehicles currently in use, which are powered by propane. As with any new product, there will need to be further education on the capability of the product and its potential applications in the commercial vehicle sector. Due to the unmatched performance and efficiency capabilities of this engine, sustained and wide communications on the enhanced benefits of the new product will be required.

Cummins has been involved in the commercial vehicle powertrain sector for 100 years. It has developed strong functional capabilities in communicating to the appropriate segments. This is exhibited every year in the variety of media that we utilize – print, events, web, etc. This capability applies across the multiple fuels – diesel, natural gas, propane and more recently from our New Power business segment for electrification and fuel cells.

Cummins will promote the propane engine based on its low total cost of ownership, reliability, durability, simple aftertreatment, and low emission levels. Cummins will partner with PERC to further refine the marketing message and support PERC with final product messaging and promotional materials.

The propane engine will meet or beat CARB's Low NOx requirements in 2024, which are the most stringent NOx regulations in the world. Cummins will promote and sell the propane engine nationwide in the US and Canada. Outside of CARB regulated states, the propane engine will produce NOx emissions at a lower level than required by the EPA.

12. Preliminary training needs

It is expected that customer service staff, maintenance, and channel partners (for example OEM dealers and other authorized service providers) would require training. The training would center on service procedures. Safety procedures in use would be another aspect of the training. The service tools are planned to be similar to those used today for diesel and natural gas as part of the common platform approach.

13. Customer service and support needs

Cummins will utilize its well-established Distribution Business Unit to fully support customer service and commercialization support requirements from within existing resources.

14. Expected launch date

The product will launch in 2024

Measurement and Evaluation (Completed by PERC staff)

15. Project metrics

Project Deliverable Metrics	Metrics	By When
Product Launch	Market Release	2024
Lifetime gallons from first seven years of sales	570M (conservative) to 1.245B gallons (realistic)	2042

16. Partner Selection

Cummins is a world leader in the on-road and off-road engine markets. PERC has previously worked with Cummins to support the research and development of the engine to now be commercialized through this project. The matching funds are engine launch expenses that will be incurred by Cummins and financial reimbursement by PERC is milestone based.