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PRESENTATION

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(presentation)

N. Thomas Linebarger - *Cummins Inc. - Chairman & CEO*

Hello, I'm Tom Leinberger, Chairman and CEO of Cummins. Today, I'm excited to share how Cummins is participating in the emerging hydrogen economy and how we envision our role within it developing over time. As you've heard from Franklin, we believe there's an incredible opportunity for Cummins to continue to build a strong business in hydrogen production and fuel cell technology, contributing to the lowering emissions and protecting our planet. Throughout the day's presentation, several members of our leadership team will discuss the hydrogen economy and related key technologies, our view on the economics of hydrogen and our view on market adoption. You'll also hear how Cummins is well positioned to lead in this space.

At the end of today's presentations, we will have a Q&A session. Feel free to submit your questions using the button mark submit a question, and we will do our best to get to as many of these questions as possible.

While I know many of you are eager to jump into the hydrogen discussion, I'd like to begin by sharing a high-level overview of our company, our values and how our unique culture is a critical component of our past and future success. For those of you who may be new to Cummins and our business, we are a global technology leader that designs, manufactures, distributes and services a broad portfolio of power solutions. Our products include diesel, natural gas, electric and hybrid powertrains and powertrain-related components.

In 2019, we generated $2.3 billion in profits on sales of $23.6 billion. I'm privileged to be only the sixth CEO in our 101-year history. Since our founding, Cummins has always been at the forefront of social justice, environmental, sustainability and technology development. We are very comfortable driving change to push forward issues that we care about. Our former CEO, Owen Miller, was part of Dr. Martin Luther King's historic 1963 march on Washington. Cummins was one of the first companies in the U.S. to provide benefits to same-sex couples. We were one of the first in our industry to publish a sustainability report, and we were the first company to embrace more stringent emission standards in the U.S. and have been proactive in helping countries around the globe do the same thing. As many of you know, we have a long history of technological leadership in diesel and natural gas engines and components. And for several years now, we have been focusing on solutions that use materials and technologies that have less impact on the planet to deliver value and prosperity for our customers and our communities.

Over the past 5 years, the company has developed and acquired significant capabilities in electrified powertrains, battery design and assembly, battery management, fuel cells and hydrogen generation. This, of course, will be the focus of today's discussion.

Through our stakeholder model, technology leadership and our position as one of the largest companies in the world, cummins is ready to drive the changes and solutions that will power a more prosperous world today and tomorrow, and that brings us to an important focus for Cummins as a company, the transition to renewable and low-carbon power. There are many areas to dive into today. So let's start with a quick review of the landscape.

As many of you know, we must lower greenhouse gas emissions drastically to limit the earth's warming to 1.5 degrees from pre-industrial levels. To reach this goal, 189 parties representing the producers of 83% of global emissions have ratified the Paris Climate Accords. In addition, 66 countries have now stated their intentions to be carbon-neutral by 2050 with several codifying this into law, including the European Union. Cummins supports these climate goals. And in 2019, we published our ambitious Planet 2050 plan, which includes science-based targets aligned with the Paris Climate Accords and a target to be carbon neutral by 2050. One of the key ways the world can hit these targets is transitioning to low-carbon power. And we believe that hydrogen will play a meaningful role in that transition.

There are a variety of reasons why we believe hydrogen will play an essential role in decarbonizing the global economy. For one, hydrogen is the most abundant element on Earth. It's light, it's durable, it's reactive and high energy per unit mass. Hydrogen is versatile. It can be transported as a liquid or gas, converted into electricity to power homes, transformed in a methane for feedstock or used as fuel for transportation. Hydrogen is energy dense. It offers ways to decarbonize energy-intensive industries like long-haul transportation, shipping and industrial processes. Hydrogen enables renewable energy. It can balance the variable supply and demand of solar, wind and hydro power, and it can carry renewable energy long distances to power different regions. Hydrogen is green. It can be used and produced without direct emissions of air pollutants for greenhouse gases. This final point is key. Without hydrogen being green, it cannot be a meaningful part of the solution as we move towards carbon neutrality. There are differences in definitions, but for today, we'll discuss production in terms of gray, blue and green.

Almost all of the approximately 70 million tons of hydrogen today is gray hydrogen. It's generally produced by steam methane reforming, utilizing significant amounts of power through the use of natural gas. This produces over 830 million tons of CO2 a year, which equates to more emissions than all of Germany. Blue hydrogen represents 1% of global production and is essentially gray hydrogen, where the CO2 created in production is sequestered underground, generally in oil and gas fields. This reduces the CO2 emitted into the environment by 90%. Green hydrogen uses electrolysis to turn hydro, wind or solar power into hydrogen with 0 CO2 emissions. While only 1% of hydrogen produced today is green, this is the future of hydrogen production.

Electrolyzers are the key technology that enables green hydrogen production, and Cummins is a key manufacturer. To replace the gray hydrogen used today with green hydrogen, the world would need roughly 3.2 terawatt hours of renewable power, resulting in over 350,000 megawatts of electrolyzer build-out. Just to put that in context for you, that would be worth $350 billion at today's electrolyzer prices. This is before we even look at the impact of other industrial processes, such as steel production and transportation industries on hydrogen demand.

That brings us to the next important point, the transition to a hydrogen economy will impact many industries. Power producers will be able to fully utilize renewable electricity during peak production by producing low-cost green hydrogen with electrolyzers. There's no need for any green energy to go to waste. This hydrogen will then need to be stored and transported to its final destination to be utilized across various industries. We first expect green hydrogen to replace gray hydrogen, which is almost exclusively used today in refining operations and as part of the production processes to create ammonia utilizing fertilizer.

As green hydrogen costs come down and technology improves, there are other industries where hydrogen can play an important role. One example is steel production, where the production of a ton of steel today generates 1.4 tons of CO2. If this process transitioned to a hydrogen model, it would create an incremental demand of 47 million to 67 million tons of hydrogen a year, almost equal to the current production levels across the whole world. We may also see a move towards hydrogen being converted into synthetic methane, ammonia and other synthetic liquid fuels. These opportunities are in addition to any hydrogen prospects in transportation industries for utilization of fuel cells. To be clear, the demand for electrolyzers over the next 10 years is supported by replacing the current processes of production of gray hydrogen. This demand level does not require the adoption of fuel cells within transportation markets. The cost of green hydrogen will decline as the scale develops. This, in turn, will help enable the transition to fuel cells, given the lower cost and increased availability of hydrogen. This shift will require investment from the private sector and support from the public sector, both of which we are starting to see. Investment by companies such as Cummins are increasing, resulting in competitive technology that provides the building blocks for commercialization. Governments around the world are supporting the adoption of hydrogen technologies in a variety of ways. In some instances, green hydrogen production targets are materializing, such as Germany, which plans to spend $9 billion on hydrogen infrastructure this decade with 5 gigawatts of electrolyzer capacity by 2030. In other countries, such as China and Korea, fuel cell vehicle and hydrogen production targets are currently developed. In the United States, Cummins has won 5 Department of Energy Awards this year worth $13 million, the most of any company to work on advancing electrolyzers, fuel cells and solid oxide technology, which we will discuss later. Commitments to reducing emissions through increased utilization of renewable power will also result in greater green

hydrogen availability. The movement towards renewable power for electricity and green hydrogen for transportation and industrial applications will be key in helping us reduce CO2 emissions to achieve the Paris Accord goals.

In summary, Cummins will lead in low-carbon technologies just as we do in diesel today. There's a lot more to say about how we're going to do this. So let me hand it to my colleagues to talk about how Cummins is positioned to win. First, there's Amy Adams to share more about hydrogen products.

Amy Adams

Cummins is invested in positioned to succeed as a leader in the world's energy transformation to the hydrogen economy. We have a strong product portfolio of distinctive technology platforms for both electrolyzer systems to produce green hydrogen and fuel cell systems to power zero-emission buses, trucks and trains. I'm currently standing in our Canadian facility's fuel cell testing center, where we run our fuel cells through rigorous tests. But before we talk about our fuel cells, let's start with our electrolyzer product lines, where Cummins has the unique capability to offer both alkaline and PEM systems through our acquisition of Hydrogenics.

First, Cummins has a turnkey containerized high stat line of pressurized alkaline electrolyzer. To date, we have more than 500 installations around the world. Both robust and reliable, our alkaline electrolyzers are used for on-site hydrogen generation and industrial sites in manufacturing plants and at hydrogen fueling stations. In places where it's harder to economically deliver hydrogen like in Russia, Eastern Europe, India and South America, these on-site generation systems are a cost-effective alternative. These plants typically produce between 100 to 750 kilograms of hydrogen a day. Our alkaline electrolyzers are well established and relatively low cost with an energy efficiency of 55% to 70%.

Cummins also has a portfolio of PEM electrolyzers, which we began developing over 20 years ago. However, the real market need emerged in 2009 when the interest in green hydrogen accelerated as the world began focusing on decarbonizing the transport and natural gas sectors. While our high stat alkaline electrolyzers are extremely well suited to small-scale industrial hydrogen generation, the size of a commercial green hydrogen plant ranges from 20 to 100 megawatts or 8,000 to 40,000 kilograms a day. Some developers are even talking about gigawatt scale plans.

Our PEM high laser product line has the highest power density electrolyzer stacks and the smallest plant footprint of any electrolyzers in the world. In fact, we are in the process of commissioning a 20-megawatt electrolyzer for Air Liquide in Becancour, Canada. Our PEM technology also delivers 30 bar hydrogen outlet pressure and has an overdrive capability to allow one line to be shut down for maintenance. The dynamic response of a PEM electrolyzer is very fast, and it can also be used to provide ancillary services to help stabilize the power grid.

These factors that I've just discussed are key considerations when customers choose Cummins electrolyzers. Thanks to decades of research and development and product leadership in both technologies, Cummins works closely with our customers to select the most appropriate electrolyzer system, whether PEM or alkaline, for their needs based on cost, capacity and use.

A third electrolyzer technology is also on the horizon, solid oxide electrolysis or SOEC. Although it is still in the pre-commercialization stage, Cummins is invested in the technology, and we continue to make exciting advancements to improve durability and efficiency. SOEC can be used in the production of synthetic hydrocarbons or other industrial processes with waste heat that can improve the overall efficiency. Cummins is unique in that our portfolio has both hydrogen production from electrolysis as well as fuel cells. This enables us to offer a full differentiated hydrogen solution from start to finish seamlessly integrated for customers.

Now that you know more about our products that make hydrogen, let's discuss the products that use hydrogen to make power. Like our electrolyzers, Cummins fuel cell systems consist of multiple technology platforms to meet the unique needs of different industries and applications. Cummins has 2 key fuel cell products, PEM fuel cells and solid oxide fuel cells.

PEM or proton exchange membrane fuel cells, are used in zero-emission vehicles of all sizes. They are ideally suited to transport operations because they operate at relatively low temperatures, have a quick start-up time and fast dynamic response. PEM fuel cells also have favorable power to weight ratio.

Alternatively, solid oxide fuel cells, also called SOFC, run at higher operating temperatures, making them a better fit for stationary applications like data centers which run around the clock. They provide a higher efficiency than PEM, up to 80% in combined heat and power applications. Solid oxide fuel cells are modular in nature and can be scaled to power large buildings. They can run on a variety of gaseous fuels, including hydrogen. Much of the current focus of SOFC development is on utilizing natural gas, but the ability of SOFC to utilize hydrogen presents the opportunity for SOFC to be a bridging technology, enabling the development of power systems that are hydrogen-capable. Just like SOEC, this technology is also in the pre-commercialization stage.

Now we'll look at the features of our robust PEM fuel cell products, which are already installed in more than 2,000 on and off-highway applications across the globe. For over 20 years, Cummins has been developing and innovating our PEM fuel cell power modules into a distinctive product offering that is well known in the market today. Cummins fuel cell power modules have a low-pressure fuel cell stack design, an integrated balance of plant. Also, the membranes of any PEM fuel cell must be humidified during operation, but unlike many of our competitors, our fuel cell systems are self-humidified, utilizing the water produced during operation.

Another key differentiator of our fuel cell power modules is their flexibility and reliability. Our systems provide patented unlimited start-stop cycles. They can even be deployed in fleets running in subzero conditions without the need to be plugged into heaters when the vehicles are not in operation. Our systems have a high energy density with a simple balance of plant, improving packaging and reducing weight. They are also a flexible architecture and can be combined in parallel for larger power vehicles. As we discuss with potential customers how we can support their plans for fuel cell-powered equipment, these product leading attributes represent key considerations in purchasing decisions.

Cummins has fuel cell power modules ranging from 8 to 45 kilowatts of continuous power with efficiency over 50%, outpacing diesel and natural gas engines, particularly in urban fleet cycles. These fuel cell power modules have been deployed by our customers in forklifts, Vans, garbage trucks, buses, drayage trucks and commuter trains. Our broad product portfolio ranges from our standard fuel cell power modules to customized fuel cell compositions to integrated fuel cell and electric powertrains. This gives us the opportunity to work with a diverse customer base from OEMs to integrators.

Let's look at 3 use cases. First, we supply HD 30 fuel cell power modules to vehicle integrators and OEMs. For example, a typical 40-foot city transit bus requires 60 kilowatts or 2 HD 30s. We can deliver combinations of either our HD 30 or larger HD 45 fuel cell power modules to meet higher power output requirements.

We also supply the fuel cell composition for Alstom's Cordia Island, the world's first zero-emission fuel cell electric train. This configuration is rated at 200 kilowatts and includes our fuel cell power modules, the frame, radiators, fuel air and water interconnections and master control system.

And lastly, our product can also be found in a Class 8 drayage truck for the California Energy Commission, where we supplied a fully integrated package that not only included the fuel cell composition, but also the hydrogen storage, battery system and electric drivetrain. No matter what our customers need, Cummins can partner with them to figure out the right solution for their application. We also continue to develop new fuel cell products based on our deep experience of our markets and feedback from our customers.

To continue to accelerate the viability and adoption of fuel cell technologies in commercial markets, Cummins recently added high-pressure storage solutions to our product line through a joint venture with NPROXX. A leader in hydrogen storage and transportation, NPROXX got its start designing and manufacturing highly efficient gas centrifuges used for the enrichment of uranium for nuclear energy. The joint venture will provide customers with hydrogen and compressed natural gas storage products for both on-highway and rail applications. NPROXX' advanced type our carbon fiber pressure vessel creates a superior strength and stiffness to weight ratio, resulting in a potential 450-kilogram weight reduction of gas containment systems in buses and trucks. This leads to greatly improved fuel economy and expanded range. NPROXX provides 350 bar onboard storage solutions for bus, truck and commuter train OEMs and 700-bar tanks for fuel cell electric passenger vehicles. NPROXX uses the same pressure vessel design in its certified transport containers that are used for storing and delivering compressed hydrogen gas to fueling stations. NPROXX is also in advanced stages of developing a new hydrogen storage system that can store more than 1,000 kilograms of hydrogen at a nominal working pressure of 500 bar. Overall, Cummins is strategically investing in a range of technologies to be well positioned throughout the hydrogen supply chain from alkaline and PEM electrolyzers for green hydrogen production to tanks and dispensing solutions to a suite of fuel cell power modules, Cummins now has a broad and differentiated hydrogen portfolio. Our technology is unique and scalable, and we are selling into commercial applications today.

Moreover, we are continuing to invest to increase our technology leadership position in the hydrogen ecosystem. I'll hand it over to Thad Ewald to talk more about the economic drivers of hydrogen adoption.

Thaddeaus B. Ewald

There are several reasons we are excited about the opportunities to use hydrogen to create power. When compared to diesel or natural gas, hydrogen is incredibly energy dense. 1 kilogram of hydrogen has the general energy equivalence of roughly 3 kilograms or 1 gallon of diesel fuel. So compared to diesel or natural gas, hydrogen will be able to power a vehicle the same distance using less fuel. On top of that, the efficiency of a fuel cell system is approaching 60% today compared with around 30% for diesel engine and less for a natural gas engine. This means more of the energy input into a fuel cell is used to power the vehicle, further reducing the amount of hydrogen needed to do the same amount of work when compared to diesel or natural gas.

The challenge with hydrogen, however, is that while it is energy dense in terms of weight, it has low volumetric density. Essentially, although it's very light, it takes up a lot of space. This makes onboard storage a critical component of hydrogen-powered vehicles. In order to store enough hydrogen in vehicle to meet range requirements, you have to shrink the hydrogen down into a tighter space through either compression or liquefaction. Both are technically challenging today and represent a significant input into the cost of fuel cell vehicles. That's why Cummins invested in advancing the technology through our recently announced joint venture with NPROXX, a leader in hydrogen compression tanks and storage. We're really excited about hydrogen as a fuel source for transportation, and we're continually learning from both our fuel cells in the field and from our ongoing work to better the enabling technologies that make it a viable solution.

Despite this excitement, the reality is that hydrogen today, green, renewable-based hydrogen, is much more expensive than diesel or natural gas. And not only is it expensive, there isn't much of it available. As Tom showed earlier, there are roughly 70 million tons of hydrogen produced each year, which is equivalent to around 2/3 of the diesel demand in the United States from an energy perspective, and only approximately 1% of that hydrogen is through electrolysis.

There are 3 key cost drivers that will drive down the price and increase the availability of green hydrogen: energy prices, electrolyzer prices and distribution costs. The price of renewable power continues to decline, and we would expect that trend to continue as only around 25% of global electricity production is now renewable. So there is continued opportunity in this space. For example, the capital cost of solar have come down a bit over 8%, and wind has declined almost 40% over the last decade. The price of hydroelectric power has remained stable at around $0.05 per kilowatt hour over the last 10 years and remains, in general, the lowest cost renewable source of electricity today. The capital investment in electrolyzers is another large input to the cost of green hydrogen.

PEM electrolyzers, which Amy previously discussed, will likely be the technology of choice for large-scale electrolysis. And while the cost of this currently runs around $1 million per megawatt, production today is done in very low volumes and without a commercial scale supply chain. As we see demand for electrolyzers increase, we expect to see the cost of electrolyzers come down meaningfully. This is consistent with what we've seen for solar and wind CapEx trends over the last 10 years.

Distribution is the final cost challenge and will vary based upon the distribution method in distance from hydrogen production to its end use. Let's dive into this dynamic a little more. With a local distribution model, hydrogen is produced on-site or in a city and won't need to be transported very far, keeping distribution costs low. However, you'll need smaller electrolyzers in more places, eliminating some scale advantages and increasing capital cost. The cost of renewal power will vary depending on the site's access to wind, solar and hydroelectric power. Alternatively, a global model will consolidate electrolysis sites in renewable-rich regions, keeping electricity and electrolyzer CapEx low by increasing the cost of distribution, potentially using pipelines and requiring infrastructure build-out, for example, utilizing solar power from North Africa or Australia and producing hydrogen to be utilized in Europe or Japan. A regional model falls somewhere in between these with large-scale regional hydrogen production and distribution utilizing existing infrastructure where possible. Essentially, there will be trade-offs between the cost of electricity and input and the cost of distribution. As the hydrogen economy progresses, we'll likely see a combination of distribution methods developed. Countries and regions with more limited access to renewables will look to import green hydrogen, while renewable-rich regions, like Australia and Chile, will have access to export. Localized models are already developing in smart cities in Europe and Saudi Arabia, where electricity,heat, transportation and

almost all other power will be provided by local renewable energy and hydrogen. Electrolyzers can and will continue to support any of these models.

So let's put some numbers to these 3 different inputs and talk about where green hydrogen costs could end up. Renewable energy costs have fallen over the last 10 years to a range of roughly $0.05 to $0.10 per kilowatt hour with significant regional variability. Using electrolysis, it takes roughly 50-kilowatt hours a kilogram of hydrogen. So on average, it costs $2.50 to $5 of electricity to produce a kilogram of green hydrogen. The cost of electrolyzer is another meaningful input. Today, PEM electrolyzer's initial purchase cost is roughly $1 million per megawatt, which, over the useful life of the electrolyzer, results in around $0.60 of cost per kilogram of hydrogen produced, combining the cost of renewable energy in the electrolyzer. Current hydrogen costs range from $3.10 to $5.60 per kilogram prior to distribution. The best comparison to this price is the pre distributed cost of diesel on the market today with the assumption that distribution and fueling station costs converge over time. Today, with an oil price of about $50 per barrel, the equivalent diesel input costs are around $1.35, significantly lower than the input cost of green hydrogen. The cost of distributing hydrogen today are also significant, in large part due to the lack of infrastructure and low volumes, which results in a cost of the pump of upwards of $10 per kilogram. We expect the cost of hydrogen, however, to come down over time. For example, if renewable energy averages $0.05 per kilowatt hour, and we lower electrolyzer CapEx cost by 50%, that $3.10 to $5.60 per kilogram turns into $2 to $3 per kilogram before distribution and can be reduced further with increased electrolyzer efficiency as well as further reductions in electrolyzer costs and even lower renewable energy prices. These lower costs, along with likely increases in the cost of diesel potentially from carbon pricing, result in higher demand for fuel cell applications over time.

I want to transition now to another opportunity that Amy touched on briefly, where Cummins is positioned to lead: solid oxide technology. We recently won several Department of Energy grants related to solid oxide technology, both for fuel cells and electrolyzers. We have been developing the technology for several years now. There are several aspects of a solid oxide fuel cell that could make a compelling choice for some application. Solid oxide fuel cells have high energy resilience and power availability high electrical efficiency driving lower running costs, fuel flexibility, low environmental impact and produce no noise. We have a lot of unique features specific to our solid oxide technology. Our cell utilizes stainless steel versus more expensive and brittle ceramics. And our thermal spray technology enables higher manufacturing yields over ceramic processing, resulting in more reliable fuel cells and larger cell areas. These advantages lead to a higher reliability and reduced complexity, which ultimately drive lower costs. Due to the current power density and load following limitations that saw it oxide fuel cells, they aren't really suitable for transportation applications. However, we do think they are great candidates for high energy stationary applications.

Here, we're showing how a system could power an off-grid data center. This technology could also be used to supplement energy grids during periods of high demand and potentially for producing the energy for metal production or solid oxide electrolysis, which could be used to create synthetic fuels. Also because of the flexibility of solid oxide fuel cells, they can also be powered by natural gas and can also operate when hydrogen is available. While there remains work to do to improve solid oxide fuel cell and electrolyzer technology, there are many interesting use cases we see developing over time.

In summary, I'm very excited about the opportunities we see for Cummins to participate in the hydrogen economy. There are a number of drivers that will lower costs and make the hydrogen economy viable in the future. The biggest challenge is ensuring the availability and low cost of the hydrogen itself. Availability will increase as countries continue to develop renewable power grids and invest in electrolyzers. Many of these efforts are already underway, which Amy Davis will discuss. With cheaper and more available green hydrogen, we'll have the opportunity to switch to green hydrogen as a fuel source to decarbonize industries, particularly transportation.

I think it's also important to underscore how well Cummins is positioned to win in these areas, whether it's with our existing portfolio of PEM-based electrolyzers and fuel cells or with emerging technologies such as solid oxide. As we are transitioning from simply developing our technology capabilities in hydrogen to manufacturing product and supporting our customers in the field, we named Amy Davis to lead the New Power segment several months ago. Amy has a long history at Cummins that includes time managing portions of our on-highway engine business, leading our distributorship on the East Coast of the United States and running our filtration business globally.

Now I'll hand it over to Amy to share why she is excited to transition our hydrogen technology business from a development and investment phase into a commercialization phase.

Amy Rochelle Davis - *Cummins Inc. - VP & President of New Power*

Cummins has long been known as a diesel engine manufacturer, but we are much more than that. For over 100 years, we've cultivated a deep understanding of powertrain technology broadly. This has allowed us to successfully innovate and optimize key elements of the powertrain, including the expansion into systems beyond diesel, such as natural gas and hybrid solutions. Our ability to innovate and adapt continues to help us successfully provide customers with an expanded suite of technologies to meet their needs while offering solutions to better the environment in the future.

Specifically, over the past 5 years, we've built capabilities in battery electric, fuel cell electric powertrains. We are applying our deep experience and relationships with customers to strategically plot their paths to deliver zero-emission vehicles. This work is exciting, but it's complex and at times difficult to navigate. And with advanced diesel, natural gas, mild and heavy hybrid, battery electric and fuel cells all playing a role in the transition to purely carbon-neutral technologies, we are well positioned to help our customers navigate through this transition and are seizing the opportunity by investing in and producing the technologies for a carbon-free future in our New Power business segment. I think about the diverse customers and applications we have come and serve from trucks, transit, school buses, tractors, excavators, mining trucks, prime and standby power applications. All these customers rely on us to provide high-performing and dependable products. They need to find solutions that work and get their job done. Even in the most demanding applications and environments. They must have the power to do the work, regardless of the conditions where the work must be done through the readily available fuel or power sources all at a total cost of ownership that is competitive to internal combustion engine alternatives. This is quite a tall order. We know there isn't a one-size-fits-all solution to filling this order. And as such, our goal is to have the right products to meet customers' needs at every point of the transition, which is why we've invested in multiple solutions up front.

For the majority of Cummins existing end markets, we expect fuel cells will be the best option. Fuel cells have a long list of advantages, including being energy dense low weight, quick to refuel. They offer flexibility of equipment for the end user. We plan to pair these fuel cells with our leading battery electric systems and controls, which can also be used on battery electric, hybrid diesel and natural gas applications. Hybrid electric vehicles, whether powered by an internal combustion engine, a battery or a fuel cell, all require a motor generator, electronic controls, power electronics and traction control. By bringing together fuel cell and battery technologies. Cummins is not only accelerating our learning and with this our product capabilities, but we are also able to build scale on common drivetrain components.

Cummins already has fuel cell electric vehicles running in the field today as well as electrolyzers making hydrogen for many applications. Most uniquely, Cummins has the global distribution network able to provide critical service and support to end users. This is one of our biggest advantages over our competitors. Cummins has more than 800 people dedicated to alternative power technology. We have engineers on 4 continents as well as global manufacturing capabilities with sites in 6 countries. We recently announced our intentions to build a new facility in Europe to support the production of fuel cell systems for the hundreds of hydrogen trains we plan to power over the next several years in Europe as we continue to build our capabilities in this space. We are also leveraging Cummin's existing global purchasing function that has deep experience in building up stable supply chains. While it may be easy to produce 1 or 2 of something, producing it repeatedly, reliably, day in and day out is not straightforward. We are utilizing our existing skills to develop a complete supply chain and processes to manufacture both electrolyzers and fuel cells at commercial quantities and with leading quality standards. The pace of commercialization for these products will vary by market and region.

There are 3 factors that will drive these adoption rates. The first is infrastructure. It will take time and resources to develop a system of hydrogen fueling stations especially for on-highway markets. It is likely we will see adoption begin in markets where fueling can be done centrally, whether at back-to-base operations in on-highway markets or in other off-highway applications like rail, where the number of refueling stations required to service equipment is modest. Secondly, hydrogen solutions need to have a total cost of ownership that is competitive with internal combustion engines. We must see continued improvement in electrolyzer and fuel cell designs to drive increased levels of efficiency and to allow for use in demand in commercial applications. Increased volumes will drive scale, resulting in significant cost improvements over time.

Lastly, underpinning all of these topics is regulation. Currently, hydrogen technology does not do the work as efficiently or cost effectively as internal combustion engines, and early adoption of hydrogen technology will require government support in some form. I'm encouraged to see government interest in this space increasing in order to support new and less carbon-intensive technologies.

To address infrastructure, we need green hydrogen. The first item we must have in order to produce green hydrogen is renewable electricity. There has been an incredible increase in renewable electricity generation over the last 20 years, and we expect to see this continue. Renewables now account for around 25% of electricity generation and may reach 50% in the 2030s. This is all necessary to support green hydrogen production with electrolyzers. Governments around the world have announced some exciting and ambitious plans, committing to time lines of hydrogen, infrastructure or usage. When we translate these goals into electrolyzer demand, it looks to be significant. Europe is planning for 40 gigawatts of capacity by 2030, while China is estimated to require 300 gigawatts to hit their hydrogen use pools by 2050. Globally, there have been 8.2 gigawatts. And of projects announced, representing approximately $8 billion growth of electrolyzers at current prices. Targets developed by governments around the world add up to approximately 70 gigawatts of electrolyzer capacity by 2030. And we are already seeing increased interest around the world, mainly from hydropower operators who can act now. These goals are driving new projects forward. In fact, we are about to complete a 20-megawatt electrolyzer system project in Canada, which will stand as the largest in the world. This PEM hydrogen electrolysis plant will be capable of producing 3,000 tons of hydrogen annually. Separately in the United States, we are providing our 5-megawatt PEM electrolyzer to enable renewable energy for the Douglas County Public Utilities district in Washington state. The largest of its kind in the United States, this green hydrogen PEM installation is expected to be operational in 2021. We have an active pipeline of projects in the 100-plus megawatt range and expect to produce hundreds of megawatts of electrolyzers over the next 5 years. And the market for electrolyzers extends beyond hydropower. Today, we have electrolyzer installations running at wind and solar farms and governments around the world are continuing to announce goals related to how much electrolyzer capacity they would like to see installed.

So what is the total potential opportunity for electrolyzers? I've seen a lot of big numbers out there, but we can confidently say that, over time, the opportunity is significant.

Let me share a few data points. Today, over 70 million tons of hydrogen are produced primarily for use in making fertilizer. Moving this production to green renewable hydrogen with electrolyzers, would result in demand for $350 billion of electrolyzers at current prices. Transitioning the energy source used to make steel and iron from primarily natural gas to hydrogen, could result in a market of $300 billion.

Looking further down the road to transportation, the current global usage of diesel fuel equates to roughly the energy of 500 million tons of hydrogen, which would require $2.5 trillion of electrolyzers to produce at current prices. Like I said, these are big numbers. The increased demand for renewable electricity to support such a significant shift will require massive investments in electricity grids around the world. Simply switching the 70 million tons of hydrogen we use today to green hydrogen would require 3.2 terawatt hours of renewable electricity, equivalent to roughly half the total renewable electricity produced globally today.

To put it in perspective, replacing diesel with hydrogen would require roughly doubling total electricity production from current levels. You may wonder how long this will take to play out. It's hard to predict, but we do believe it will happen, and we know from our pipeline of projects that the opportunity starts now.

Many are starting with a focus on replacing gray hydrogen with green hydrogen and others in existing industrial applications where clean energy is available. This means that demand is not dependent on fuel cell adoption in the short or medium term. It also means that we can leverage our sales and electrolyzers to fund fuel cell technology investments and build scale across the supply chain, lower-priced and more widely available hydrogen will drive increased utilization of fuel cells over time. Because the cost of fuel cells and hydrogen is projected to remain above that of internal combustion engines for at least 10 years, we anticipate adoption of fuel cells to begin in markets where the cost of these items as a proportion of their total cost of ownership are the lowest. This is why we have focused on a market like trains, where the powertrain and the fuel costs represent 50% of the total operating cost, much lower than the heavy-duty truck market, which is above 80%. There will be further considerations that end users will also have to make, which will vary by application. Trains also run on fixed routes and require lower infrastructure in terms of hydrogen refueling. This will be another key factor. In addition, support for public subsidies exist and the incremental cost to purchase a hydrogen train are lower than the cost of electrifying rail lines.

All of these factors drive varied adoption rates with greater adoption in early years and applications such as trains and buses with heavy-duty trucks falling farther out on the curve. The hydrogen council estimates in 2030 that fuel cell adoption will remain modest, and it's just not yet clear how the constraining factors will be addressed and over what time frame. Specifically, they estimate fuel cell penetration in heavy-duty trucks globally will be 2.5% in 2030 while buses will reach 10% and 10% of trains currently powered by diesel engines will transition to fuel cells. Cummins already

has fuel cells installed in all of these applications, positioning us well for partnerships and product differentiation. Not only do we have fuel cells installed in these applications today, we have participated in these markets for decades with existing technology and provided customer support with our distribution business. And we see increased adoption of fuel cells over time. We will build on existing customer relationships and application knowledge and leverage our unrivaled distribution network to provide global product support. Governments are becoming impatient, awaiting economics to play out and are announcing fuel cell targets across industries, whether it be for passenger cars or commercial vehicles. We expect to see continued targets provided over time with the European Union recently unveiling plans to push toward fuel cell commercial vehicles in Europe. This increased interest by government policymakers and associated targets provide us even greater comfort that fuel cell will play a meaningful role in the future of transportation.

Since stepping into this role, I've spent the past several months assessing our business, its competitors, our strategy and our pathway to success. What excites me is our scope of supply. I don't know if any other player who has Cummins capabilities in electrolyzers, fuel cells, tanks and powertrain, along with electrified components. We have unique advantages in solutions and scale. We have the experience of over 600 electrolyzer installations and 2,000 fuel cell installations worldwide. Our electrolyzers are in fueling stations on 5 continents, including the first fueling stations, Scotland, Sweden, Norway and Southeast Asia. We're actively engaged on bids for electrolyzer installations of over 100 megawatts. We have fuel cells running in applications from trucks to trains, to boats, to buses and stationary power. This includes the first hydrogen power public train in the world. Put simply, we have real products and real experience. We like that position. I'm excited about leading our technology portfolio and our plan to further improve the performance of our products. These 2 things go hand-in-hand because having all the real-world products to learn from will ensure faster and better iterations of our technology to include our products. As technology, infrastructure, regulations and customer demand continue to evolve, Cummins is positioned to deliver quality hydrogen solutions now and in the future.

Many companies aspire to shape tomorrow's hydrogen economy, but very few will have all the elements required. We're bringing together Cummins' 100 years of experience in executing product introductions, partnerships and best-in-class customer support with a leading technology. This is a winning combination that customers value, safe in the fact that they are working with a technology leader who has existing deep knowledge of their applications. We're working with a wide range of customers around the world on numerous fuel cell applications and have partnered with leading companies such as NPROXX on tanks to help further support customers' installations of fuel cell powertrains in their equipment. Interest in electrolyzers continues to grow. We have a strong and knowledgeable partner in Air Liquide here and are working with many potential customers and partners to support their plans to increase hydrogen production. These conversations include integrated oil and gas companies, electricity producers of all sizes and companies looking to construct hydrogen fueling stations. As the new President of this business, I couldn't be more excited or optimistic about what our future holds.

Now back to Tom.

N. Thomas Linebarger - *Cummins Inc. - Chairman & CEO*

Thank you all for joining us to learn more about how Cummins is positioned to win. As you heard from my colleagues today, there are many factors at play as a low-carbon landscape takes shape. I hope you will leave today's event with a clear understanding of how Cummins will leverage our existing products, and our other unique capabilities in early adoption markets and beyond. While we know the widespread adoption of carbon-neutral fuel cell solutions will take time, Cummins is already leaning into the opportunity now. Our company's financial strength provides us with the ability to invest in and develop broad portfolio of technologies across advanced diesel, natural gas, mild and heavy hybrid, battery electric and fuel cells that will move the world towards a carbon-neutral future. This allows us to meet our customers no matter where they are in their journey, all while leveraging our core manufacturing expertise and service and support competencies. As producers in early adoption markets, we can use our learnings to improve the enabling technology, bring down costs, improve performance and, ultimately, drive additional markets to transition.

With this backdrop, our current projection is that our electrolyzer business alone will have annual revenues of approximately $400 million in 2025 with demand driven by the transition from gray to green hydrogen, supported by the government's target electrolyzer build-outs that we covered earlier. By 2025, we also will have shipped fuel cell systems for at least 100 trains, primarily in Europe, representing the first true commercialization of fuel cell technology in the transportation space. Cummins is already shipping fuel cells for truck and bus applications. While we expect this to grow through 2025, volumes will remain modest with shipments primarily for the purpose of testing the technology in various end-use applications.

The shipments we make will continue to drive opportunities for us to learn and improve our products, preparing us for commercialization in future years but will not make up a large proportion of revenues in 2025.

All in all, hydrogen technologies, particular electrolyzers will be a fast-growing and increasingly important part of our business over the next few years. As momentum increases worldwide for the use of hydrogen solutions, we will continue to leverage our industry-leading hydrogen technologies, our deep customer relationships and our extensive service network to enable adoption. Simply put, Cummins is ready for a world in which hydrogen adoption accelerates, and we're well positioned to drive this change forward. Now I invite my colleagues to join me on screen for a Q&A session.

QUESTIONS AND ANSWERS

James Hopkins - *Cummins Inc. - Executive Director of IR*

The session today. I hope everyone has had the opportunity to explore a virtual environment this morning, which includes several interviews with our partners in the hydrogen space and our Ask An Expert Corner.

Before we move into Q&A, a reminder that some of the information that you will hear today consists of forward-looking statements within the meaning of the Securities Exchange Act of 1934. Our actual future results could differ materially from those projected in such forward-looking statements because of a number of risks and uncertainties. More information regarding risks and uncertainties is available in our filings with the Securities and Exchange Commission.

With that out of the way, I can go ahead and introduce our panel for today. We have with us today our Chairman and CEO, Tom Linebarger; our CFO, Mark Smith; the President of our New Power Business, Amy Davis, our Vice President of Strategy, Thad Ewald, and Vice President of Fuel Cell and Hydrogen Technologies, Amy Adams. Welcome, everybody.

So let's get started here, jump right into Q&A. Tom, one of the areas we've received a lot of questions on so far is how important we feel government support will be to drive adoption of green hydrogen production and fuel cells.

N. Thomas Linebarger - *Cummins Inc. - Chairman & CEO*

Thanks, James. And let me just add my welcome to everybody. Thank you so much for joining us today. And you started with an important one, James. There's no question that government support for hydrogen will be a key to the speed of adoption. In order to support adoption, governments should, I think, focus on 3 areas. First, of course, is infrastructure. It's an infrastructure industry, energy and transportation, and infrastructure will be important; development of the technology and then, of course, deployment. And in the infrastructure area, we need to ensure that our systems can support the broad deployment of hydrogen. That means, of course, that government has to invest in infrastructure, both directly and also through incentives indirectly, even using government convening power to bring infrastructure players together on a schedule to ensure infrastructure is created. There's a lot of work to do there. It's a really important area, and we'll definitely need government.

On the development area, policy should support both industry and government research into the technology. There's a lot of work left to do on the technology, especially with regard to driving down cost and improving efficiency in order for it to compete with existing technologies. And then on deployment, anything that encourages both through incentive and direct funding, deployment of the industry into hydrogen across various industry sectors will help speed the deployment across all sectors because as each sector builds out, it makes cost better for every other sector. So deployment will be really important.

I can't leave this question, though, without talking about the cost of carbon. There is no question for technologies like hydrogen and fuel cells to compete on a level playing field with existing technologies. There will need to be a cost placed on carbon. So governments will have to play a role, figuring out how they want to do that to make sure that the costs associated with carbon are internalized into the technologies deployed.

James Hopkins - *Cummins Inc. - Executive Director of IR*

Great. Thank you, Tom. And a follow-up to that, that we're getting. So as we look at the COVID situation we find ourselves in today, what role do you think the transition to hydrogen can play in spurring some economic and job growth, given that fact?

N. Thomas Linebarger - *Cummins Inc. - Chairman & CEO*

James, this is a question I've been thinking about for some time. It's an interesting one because it fits our mission as a company. I do think that any close look at how our economic and political situation looks in the U.S. says that we need to do more to include more people in our economy and the benefits of our capitalist system. Too many people are being left behind. So I think whatever solutions we put in, they need to be more inclusive.

And then the second point is we need to make sure that as we do economic growth, we also create sustainability for our planning because, of course, economic wellbeing and prosperity are both economic in terms of salaries and incomes and opportunities to purchase things, but they're also clean air, clean water. So we need to figure out a way to do both. And really, this is what the mission of Cummins is all about, is trying to figure out how to build a more prosperous world, and prosperous for us means more economic growth, but also doing more with less, having less impact on the planet.

So what I think the opportunity here is we are going to make a number of investments in infrastructure. We're going to put in policies to stimulate the economy. Why not use those dollars to drive things that will solve some of these problems in the future. Investments in green power, new energy, fuel cell or hydrogen, this will allow us to bring not only to stimulate jobs and economy but make sure that we're doing it in a way that's sustainable for the planet.

So I think if I was sitting there figuring out how I was going to spend my infrastructure money, I would be thinking about how I bring more people into the economy and how I invest in the future so that we have cleaner power, more sustainable technology in the future. And I think hydrogen can play a significant role in that.

James Hopkins - *Cummins Inc. - Executive Director of IR*

Great. Thanks, Tom. I appreciate that answer.

Second, we have interest, and maybe this one is a good question for Amy Davis. So in order to gain more confidence that this hydrogen technology is viable and Cummins is in a good position. What kind of milestones are you looking for going forward?

Amy Rochelle Davis - *Cummins Inc. - VP & President of New Power*

Thanks, James. Great to see everybody. There's really 3 deliberate areas that we're looking at setting milestones for. One is technology. The other is commercial and then also in the production area. So looking forward, we have a lot of exciting pilots ahead. We love pilots because pilots give us the opportunity to test specific technology boundaries but also forge commercial relationships. So for example, if you think about our Alstom relationship, really that began with a pilot train in Austria. And now we have over 100 systems that we'll be selling by 2025.

So looking ahead, we have 5 DoE projects that I'm particularly focused on. Just to name a couple. Two of those are in the solid oxide space. One in electrolyzer and one in fuel cells. So that will give us some really key technical learning. We also have one that we just announced last week with Navistar and Warner Trucks, where we'll be testing specific things around range but also efficiency, and it's a great opportunity to be running trucks in the U.S.

Also in the production space, we just announced that we'll be breaking ground in Germany for our production site. And that will be a key site for gaining efficiency in our supply chain for Alstom and other customers in Europe. And in the electrolyzer space, we have a couple of key commissioning

projects that will be happening in the future, one in Becancour, Canada, which is the largest PEM 20-megawatt hydrogen producing site in the world. And then we have one in Douglas County, Washington in the U.S. which will be commissioning, and we'll be watching those closely because I think that will lead to some key commercial wins, given our pipeline that we see in electrolyzers in 2021.

James Hopkins - *Cummins Inc. - Executive Director of IR*

Great. Thank you, Amy. So the next question here, more of a financial focus. I think this one probably well set for Mark. So the question is, how does this focus on hydrogen impact the EBITDA losses in your new power business? And when will new power breakeven?

Mark A. Smith - *Cummins Inc. - CFO & VP*

Thanks, Jim, and good morning, everyone. Well, first of all, there'll be no change to our projections for this year. We're expecting an EBITDA loss for the full new power business in the range of $160 million to $170 million. Next year could run closer to around a $200 million EBITDA loss. But overall, we're expecting the losses over the 3-year period 2020 through 2022 to run around that $500 million that we discussed at our last Analyst Day. And to put that in context, this represents less than 10% of our current operating cash flow, and we think that's a good -- an important investment in our future. And again, given our financial strength, our liquidity, our current cash flow of our base business, we think we can do all that without constraining the investment in our core business, and we're still able to return capital back to shareholders.

The timing of breakeven, we're all interested in that. That's primarily going to be driven by the pace of the technology adoption. We certainly expect electrolyzers to be gross margin positive which will help those financials. But it's also possible that the engineering spend could go up if market reduction accelerates from .

James Hopkins - *Cummins Inc. - Executive Director of IR*

Great. Thanks, Mark. And a follow-up to that, what are your thoughts on the level of capital expenditures that the company is planning in the new power business to support revenue growth in this space?

Mark A. Smith - *Cummins Inc. - CFO & VP*

Okay. Yes. So we do not see the new power business as a huge consumer of capital within the overall coming portfolio. This year, we'll spend around $25 million. And we anticipate a modest increase next year. But overall, the capital builds for new power should be manageable within the framework we've given for Cummins total spend in the 3% to 4% of sales range. Quite frankly, in the nearer term, the engineering spend is the largest commitment as it is in our core business. And of course, as I've already said, we have the financial strength to both fund that engineering and the capital expenditures. And again, we've been investing successfully globally for 101 years. So we've got a lot of existing infrastructure network and relationships that we can rely on that make the incremental investments a very manageable in the context of the overall company's financial position.

James Hopkins - *Cummins Inc. - Executive Director of IR*

Great. Thank you, Mark. So the next question here is around end market growth. So maybe Amy Davis, this is one you could maybe cover for us here. And the question is which end markets and regions do you expect to see initial adoption, specifically of fuel cells in?

Amy Rochelle Davis - *Cummins Inc. - VP & President of New Power*

Yes. Thanks, James. Fuel cell adoption, I think, is really going to be driven by a couple of things. I talked about it a little bit in our prepared remarks, infrastructure, availability of hydrogen, cost and probably also government incentives. And those combinations have really led trains to be early

adopters. And I talked about this, but really the cost of electrifying train lines is comparable to fuel cells. So actually, the cost makes sense in that market and you have fueling that can happen at base. So it's a market that we see adoption happening. And by 2030, we probably 10% of where there's diesel today, you'll see fuel cells. Another market that we see similar in 2030 to that 10% share is actually buses. While buses have been early adopters in BEV, there's a lot of routes and other things that need a bigger range, and so they'll be looking for fuel cells. And so I think that will be around 10% in 2030 as well. Something like heavy-duty trucks, which a lot of people talk about, we really don't see, and I think even the hydrogen council talks about around 2.5% of heavy trucks in 2030 having fuel cells. So a much longer adoption rate, largely driven by just the huge diversity in duty cycles and applications in heavy truck and the infrastructure needs there. There's still a lot of other segments that are interesting, and we'll be adopting at that sort of long rate, but you're going to see in marine and in aerospace as well as stationary power actually are going to be adopting over this longer period, and we have installations in all those applications actually today.

And I'd probably just add one more thing about the region. So I think the real driver in some of the regions is going to be the government incentives. Tom talked a little bit about that. And so in Europe and China, and even Korea, we see a lot of aggressive government announcements that could lead to adoption rates increasing there.

James Hopkins - *Cummins Inc. - Executive Director of IR*

Great. Thanks, Amy. So the next question for Tom. What excites you most about Cummins opportunity in hydrogen technologies? And are there any things you can think of that may delay adoption?

N. Thomas Linebarger - *Cummins Inc. - Chairman & CEO*

James, let me first say what I'm excited about for the world with hydrogen. Hydrogen provides a solution to this fundamental challenge we have as an entire globe. We've got to reduce the use of carbon in our energy, and that means we need to use more renewables. But we know renewable energy comes when it comes, and it's -- and we need it when we need it, and they don't always match up. So the solution to that problem to make the energy dispatchable when you need it is storage. And hydrogen provides a pathway to store energy from renewables and then be able to be used again as electricity or as fuel or as industrial gas. So it's a very flexible, movable energy dense storage material that can solve a number of energy problems at global scale. So it's a fundamental building block to a low-carbon world. That's exciting, I think, for all of us.

And I think the size of the opportunity for Cummins is also substantial. It's difficult to quantify today for sure. And there's a lot of work left to do, but we know it's big. We know that it's a fossil fuel for power -- sorry, it replaces fossil fuels for power in the transportation sector, but it also does heat. It does industrial processes, it does storage, as we said. So it has a broader scope than diesel and other fuels that we've been dealing with. And we think a lot of these technologies, transportation, energy will move to hydrogen and fuel cells over time. So that's why we believe this is a very substantial opportunity for the planet and for Cummins. And for Cummins, it represents not only new technology to do the things we already do, but it's also potential growth for the company. We can now begin to produce hydrogen through electrolyzers. We can enter new markets that we aren't in today and expand our position in some of the markets we are in, like rail and marine. But most of all, what I'm excited about is this is the pathway by which we can fulfill our mission statement about making people's lives better by powering a more prosperous world. I mentioned that for us, prosperous means we keep driving economic growth. People still get more jobs. They have more income. They have -- they can still accomplish things. They need to accomplish to build their families. But we can do it in a more sustainable way that keeps our air and our water clean for our children and our grandchildren. That's the things we need to invest in the future. So for us, this is an exciting pathway for the company, too.

And in terms of what might slow down adoption, I talked about this in your first question, we need infrastructure. No question about it, and that means we need government to play a role. A lot of private sector players want to play a role here. But we need government to convene those players to provide some incentives to make sure that infrastructure can be built where it needs to be built. So there is a role for government to play. And I think this cost of carbon issue will be there until we address it. We need to find a way to internalize the externality, which is carbon and climate change. And so policies from governance will be necessary. Those are the things, I think, that are -- that need to be addressed to move the industry along, but there are a lot of major companies, financial institutions that are ready to invest when these conditions are right.

James Hopkins - *Cummins Inc. - Executive Director of IR*

Great. Thanks, Tom. Next question related to solid oxide technology. So this one probably well posited with that. The question is, what has to happen to make solid oxide fuel cell technology ready for commercialization. When do you expect this will happen? And do you have any commercial projects lined up already?

Thaddeaus B. Ewald

Great. Thank you, James, and good morning, everybody. Let me -- James, if you're okay, why don't I just step back and talk a little bit about solid oxide, and what it's used for. We've talked a lot, and there's a lot of focus on the transportation sector and that sector. And really, we see solid oxide more in the sort of the stationary sector, so more for prime power applications. And solid oxide also, as Amy mentioned earlier, we won DoE grant to actually work on solid oxide electrolysis as well, so both for hydrogen generation as well as stationary power. And just in its simplest form, it's the same kind of process for a fuel cell, but I think probably some key differences runs at a much higher temperature than PEM fuel cells. And so it actually lends itself to combined cycle kinds of operations, which is what you drive efficiencies up, which is what you find in stationary applications. And also as opposed to PEM, you can actually reform very efficiently onboard. So you take natural gas straight into hydrogen or you can bring hydrogen directly into it as well into the solid oxide fuel cell. So that's just a brief primer on the technology. I would urge everybody to go to the genius bar if you've got questions and ask more about that.

But if I just go to the second part of your question, which was, if you remind me, was kind of commercialization? And what do we see? Is that what it was? Yes, the question was. The -- there's some -- the technology is still pretty new. We feel pretty good about the technology that we have. It fundamentally has some advantages, we believe, other things that are currently in this nascent market. Although all of this stuff is, even though it's been worked on for a long time, it's quite new. Effectively, we can -- we use steel as a broad plate rather than growing ceramic place. We have a higher efficiency process. So we have some process technology here. It gives us better process efficiencies and, therefore, lower costs over time. As well as because of the process we use, we have big -- a larger surface area than the competition. So we feel very good about the technology, and it's on its way to finding some in the fuel cell side, so actually producing power. We expect to have some initial projects out there in the market and demonstrated projects with people in the next 12 to 24 months for solid oxide, for the fuel cell side. And of course, the electrolyzer side, that's the DoE project that we're getting started on. So we feel very good about that. And I think a solid oxide continues to -- it will find its place in the stationary world, and we feel very well positioned with the technology that we have. That is all some set of the questions there. I think I got it all.

James Hopkins - *Cummins Inc. - Executive Director of IR*

I think so. Yes, very good. Excellent.

So

the next question for Amy Adams related to electrolyzers. So throughout the prepared remarks, you mentioned that, currently, PEM electrolysis selling for about $1 million per megawatt. How do you expect to see the cost of electrolyzers come down over time, I mean?

Amy Adams

Thanks, James, and thanks to everyone for joining this morning. I think there are a number of factors that will drive the cost down. One of the ones we mentioned before is increased system size. So we see the projects getting larger and larger, and there's some efficiencies to be gained from that. We talked about 100-megawatt projects even up to 1 gigawatt scale projects, and then we see a lot of opportunity in the supply chain. So first of all, large-scale manufacturing with automation, a more mature supply chain, which means the cost of the components and the materials are expected to come down. And then we're still continuing to see technological improvements, for example, increased stack power density. I think most people feel PEM as a less mature technology. If you take everything into consideration, it generally has more margin for cost reduction over time. If there's different views out there, but the IEA, for example, says that alkaline might come down 2% annually, PEM around 5%, I think

the Hydrogen Council has some slightly more bullish numbers where PEM could come down 13% annually. But all of those numbers are kind of aligned with what we've seen for our renewables, for example, in wind and solar over the past decade. So we're confident we can see those costs come down.

James Hopkins - *Cummins Inc. - Executive Director of IR*

Great. Thanks, Amy.

Next question related to returns. Maybe Amy Davis, you could comment on this one. The question specifically is, are you confident that the returns in the new power segment can be equal or better than those in internal combustion technologies for Cummins.

Amy Rochelle Davis - *Cummins Inc. - VP & President of New Power*

Yes. Thanks, James. Obviously, it's -- these are pretty immature markets, but there are some fundamentals that make me optimistic. The first thing I would say is that these technologies are complex, which leaves a lot of room for differentiation. So I think there's going to be technical differentiation. It could be an area of fuel economy, durability, those kind of things that we're very familiar with, having worked with these customers and many of these segments already. So that's one. I think building on that, our technology baseline that we're starting from and our expertise here, I think, makes us a good candidate to be the differentiator with these technologies, whether it's in the base system or in the supporting balance of plan.

I also am encouraged by our portfolio. So I don't know of anybody who has a broader portfolio. We have battery electric vehicle components today as well as batteries, fuel cell technology. And then we just talked about electrolyzer and solid oxide. So that entire portfolio not only will help us differentiate in the transportation segment but also will give us new opportunities. And I think Tom talked about this in profit pools. We don't really have access to today. So I think that's pretty exciting.

In some of our traditional markets, our product support is actually a big deal. I think it's really going to help differentiate us with customers, where we have deep relationships, and we're giving them support today. And so if you got into some of the testimonials with some of the customers they talk about the long relationship with Cummins as being a kind of consultant partner with them in their duty cycles and other things. And that and our service is going to be, I think, a big deal in helping us win. So overall, I'm really encouraged by the opportunity for good long-term returns.

James Hopkins - *Cummins Inc. - Executive Director of IR*

Great. Thanks, Amy.

Tom, a question here about partnerships. So the question is, it appears that OEMs are more willing than ever to outsource ice manufacturing, which is good news for the next 10 years or more. But what's the case for them also outsourcing some of these new power technologies?

N. Thomas Linebarger - *Cummins Inc. - Chairman & CEO*

Yes. We are, of course, very excited about the opportunity to work with our partners on diesel engines, hybrid diesel engines and other parts of our core business. We think that's a significant opportunity. And of course, as we invest in those technologies, we are bringing down their both criteria pollutants and their global warming impact. So significant improvements are also being made in those technologies, and so we're excited about those equally. But I want to say that for -- in the new power technologies, hydrogen fuel cells, we are going to have to compete with those customers just as we do today. Those customers today make a lot of their own diesel engines and a lot of their own components, and yet we still participate actively in the industry. And in fact, we're the largest producer of engines in the industry. And the reason we do that is because we invest in the technology, lead in the technology and partner with those customers in ways that help them succeed. So if they make an engine, we provide components and they do the system, and where they don't make an engine, we provide the engine. We believe the future will be much the same. For us to lead in fuel cells, we will need to have the best technology. And we will provide systems, we will provide components, and we

will help our customers succeed in whatever technologies they need to win, both traditional and new. And to do that, of course, we have to invest. That's why you're hearing so much about how we're investing. We believe that to be a relevant player in fuel cells and transportation, for example, we are going to have to lead in that technology, and that's going to take a sustained investment in development of the technology. So we have been investing for a number of years now and we'll be investing for a number of more years as this transition takes place to make sure that we can be a leading provider. And as you heard, we are already in the market. We are providing fuel cells for trains. So we will have thousands and thousands of hours on train applications before a single truck maker decides to do production -- large-scale production. We will already have experience, already have systems out there deployed for a decade before the trucks start running.

What's more, in electrolyzers, the demand is low. So we'll be producing technologies related to fuel cells through electrolyzers for, again, more than a decade before the first large-scale production of occurs. So we will be investing in these technologies. We'll have experience in them. We'll have systems out there. We'll have -- we'll be on our fourth or fifth iteration of production technology before trucks are in there first. And I think that's going to provide us with some advantage and allow our customers that use our product to get ahead of their competitors. And that's why I think we'll have a role to play.

In addition, we have a global footprint, a service network that's going to help a lot of early adopters get started. It's hard when you're rolling out buses or trains or other things for the first time to be able to service and support these products, and we can provide support across the globe on this.

And just to give you a sense of the importance of a global footprint, we just signed our letter of intent with Sinopec in China to be able to work together on electrolysis. And this is a significant opportunity for both companies. Today, Sinopec produces over 10% of the hydrogen produced in all of China for their refining operations. So this is a big hydrogen producer. So by using electrolysis to produce that hydrogen, they can save significant carbon impact. And of course, the government of China is interested in that, so is Sinopec. So we are going to work with them to help them figure out a way to decarbonize this hydrogen. That's a big opportunity for the country, big opportunity for them and for us to deploy our technology in China. And China has made a major commitment to hydrogen beyond just the refining industry. They have laid out very aggressive plans to deploy hydrogen across a number of industries, including transportation. So we would, of course, like to get a footprint in China and be able to deploy the technology there as another way to scale up the technology, bring down the cost, improve the quality and then begin to help our globe get to a low-carbon future.

James Hopkins - *Cummins Inc. - Executive Director of IR*

Great. Thanks, Tom. Talking about revenue and opportunities into the future. The next question here for Amy Davis is related to that. Specifically, what are the assumptions behind the $400 million electrolyzer revenue projection for 2025?

Amy Rochelle Davis - *Cummins Inc. - VP & President of New Power*

Sure. That's pretty straightforward. We assumed a market size in 2025 of 3.5 gigawatts. That's pretty consistent with what the Hydrogen Council would say. And we assumed a market share of 15% of those sales. That's 15%. And we assumed a cost for those electrolyzers of $750,000, 2025, $750,000 per megawatt. Now I know Amy earlier said that it's running right now about $1 million per megawatt. So we are expecting costs to come down about 5% a year to get to that $750,000 per megawatt cost.

James Hopkins - *Cummins Inc. - Executive Director of IR*

Great. Thanks, Amy.

The next question, more technology-related for Amy Adams. What's the current life expectancy of an electrolyzer or a fuel cell today?

Amy Adams

Yes. Thanks, James. I think it depends on the technology. So for the alkaline electrolyzers, they have a life of roughly 15 to 25 years. And during that time, we would refurbish the stacks every 7-or-so years. But that said, we have stacks running -- we have projects running in the field for well over 20 years right now. With PEM, it's a little different because it's newer technology. So we project a life of roughly 64,000 to 85,000 hours of operation. So if those are running full-time 24/7, that would be about 8 to 9 years. And I think it's fair to say that's a preliminary estimate because there aren't many PEM electrolyzers that have run that length of time in the field.

For fuel cells, our rough estimate is around 20,000 hours of operation. The variability comes with the application, whether it's on-road or off-road, et cetera. So as we continue to have more of these pilots out, as Amy said, and more products in the field, we continue to get better data, and we'll be able to learn more about the operating life of the fuel cells across all of these different applications and use cases.

James Hopkins - *Cummins Inc. - Executive Director of IR*

Great. Thanks, Amy.

Next question for Thad here. The questions about synthetic fuels, it looks like. So it looks like there's been a lot of recent discussion around synthetic fuels. How do you view this market developing over time? And would Cummins play a part in this market?

Thaddeaus B. Ewald

Thank James. We've thought about this as we've thought about hydrogen for quite some time now. And I think it's important to step back and say, "Hey, so why would people want to do synthetic fuels?" And there's 2 main rationales basically use that is that if you do that, you can increase the energy of density of hydrogen. We talked about that in kind of my opening remarks about the energy, like the volumetric density. It allows you to transfer -- if you did that, you could then transport it. I mean, a lot of people talk about ammonia. In this regard, you could transport it in the existing sort of infrastructure that's there today without a lot of extra costs. It's more capital-efficient. You can use it in that way to transport it.

And then it can be -- second is it can be used as a feedstock for all the other processes that we talked about. So I think -- so it's -- definitely, as we've thought about that and thought about our role in producing hydrogen through green hydrogen, we thought about these things. I think it's still a little ways off. I mean there are projects that have started today. So there are basically 3 ways to do is the -- like I said, ammonia, methane or synthetic diesel basically are the 3 that we spend time thinking about. And so while there are projects that exist out in the world that I think there's some opportunity. Like a lot of these things, I think it remains to be seen as to what role will it play. It will likely play some role because you see projects today already. The question is how big a role will it play and over what time period. Where will this -- where would the synthetic fuels fit in the industry? And how cost-effective, capital-efficient are they? So I think there's still yet some ground to cover here for that. But I do expect them to have some part in it the way we see it today. What that is, it's a little hard to say at this point.

James Hopkins - *Cummins Inc. - Executive Director of IR*

Great. Thanks, Thad.

Next question for Amy Adams is related to the aftermarket with some of these new technologies. So the question is, what is the aftermarket opportunity on electrolyzers and fuel cells. And how does it differ from your current technology portfolio?

Amy Adams

Thanks, James. I think it's a little too early to tell exactly what the aftermarket opportunity will be with PEM electrolyzers and PEM fuel cells because there aren't that many in the field that have significant hours. But having said that, there are maintenance and service that will be required to support the products. And as I mentioned in my earlier comment, the stacks will be refurbished and replaced over time, so a little similar to how a

diesel engine would undergo an overhaul or a rebuild. So that part is a bit similar. And we do know from our experience in heavy-duty applications that things break sometimes. And so I think we're well positioned because we have the deep relationships with our end users. And in some cases, today, in those market segments already, on the diesel side, we have service and parts agreements. We have preventative maintenance contracts. So we have a network that's sort of geared at servicing those applications now and could it be trained easily to support them in a fuel cell electric vehicle, battery electric vehicle, et cetera.

James Hopkins - *Cummins Inc. - Executive Director of IR*

Great. Thanks, Amy.

The next question relates to, well, technology around fuel cells versus battery electric, it looks like. So Amy Davis, on this one, I'll pass this to you. The question is why do you believe fuel cells are a more likely solution for high-power applications than battery electric.

Amy Rochelle Davis - *Cummins Inc. - VP & President of New Power*

Sure, James. Yes. So I think about, I guess, 3 things that really differentiate, in my mind, range, weight and maybe charging time as 3 -- at least 3 kind of key factors that I think about when it distinguishes what use case would go more for battery versus fuel cell. So if I think about some of the applications, if you think about a line haul, heavy-duty truck operation, which is traveling long distances, and they are compensated for their payloads, so they want to be able to carry as much as possible, those would obviously be much better suited for fuel cells. And there's other kind of long-haul operations that would be similar to that but also even in some bus applications where there's longer routes and the range and the charging time actually make a big difference.

So for example, we just announced an agreement with a company in Australia, Bestech, where we're selling both battery and fuel cell solutions to them. And so it's again where I like our positioning of having a full range of products because I think many fleets will have mixed solutions probably to meet the variety of use cases that they have.

James Hopkins - *Cummins Inc. - Executive Director of IR*

Great. Thanks, Amy.

Next question will give to Tom here. So the question is when do you hope to land a major truck customer for your fuel cells.

N. Thomas Linebarger - *Cummins Inc. - Chairman & CEO*

As we discussed, we have announced a number of partnerships, and I think those partnerships reflect where the action is today. So we've announced our fuel cell partnership with Alstom. We've announced our electrolyzer partnership with Sinopec. These are the -- this is the place where the action is today. Today, those are -- that's where fuel cell and electrolyzer technology is being deployed. So we, of course, are focusing our partnership actions on those first. Needless to say, though, we believe that transportation sector will be a major user of fuel cells, and we would like to work with truck partners on developing that. And our thinking about that is a lot's going to happen over the next 5 or 10 years in the development and deployment of fuel cells. And so the technology is still moving. People's decisions about how they want to play in this are moving. So a lot left to go. While we'd like to have partnerships today, we recognize that any partnership formed today, like the one we did with Navistar to do the DoE project, is likely to evolve over time as the technology and people strategies evolve over time. So we're not in a big rush.

What we are in a rush to is leading the technology. You will see us investing to make sure that we've got the solutions that customers need. Wherever they are in their transition between carbon technologies and low-carbon technologies, wherever they are in that transition, we are going to meet them there with the very best technology for their products. And that's been Cummins' strategy for 100 years. It will continue to be our strategy. We are not focusing on vehicles. We are not focusing on autonomous trucks. We are not focusing on how to make sure that we have the best

telematics solution for a vehicle. What we are trying to focus on is how to make the best powertrain for those customers to win. And we think with that focus and that investment, the partnerships will come when it's time for them to come. That's what we believe. We are already -- we stand ready to work with whoever would like to work with us, but we are definitely focused on trying to deploy the technology in the places where there is action today where the economics make sense, where the customers are ready to deploy. And we'll work with them, and we'll be ready to work with others as the technology evolves and their strategies evolve accordingly.

James Hopkins - *Cummins Inc. - Executive Director of IR*

Great. Thanks, Tom.

One of the exciting partnerships through a joint venture structure that closed last week is actually with NPROXX. Thad, I was wondering if you could comment on if there are any projections around revenue, profits for that business?

Thaddeaus B. Ewald

Yes. Thanks, James. Well, before I go to the projections of revenue, I get head to step back and just echo Tom's come. I mean, this is exactly a great example of getting another piece of technology in the chain to make sure that customers have what they need in order to make their vehicle go forward, whether it's a train or a truck or actually the transport of hydrogen in those vessels, right, to make sure that's available and put together as a system or as an individual component for people by having the best, and we feel like we have that with our joint venture with NPROXX. And whether it's even today, you can use it for natural gas applications.

So I think as we step back, I think we're looking at, I would say, in the early days, it will be the mids of tens of millions of dollars, but we see rapid expansion sort of from there, and it kind of depends. Like I said, we're looking at all pieces of the market, not just what's on vehicle, but as a potential to -- as we talk about hub-and-spoke models of how to distribute green hydrogen to places. So we think the -- we know the technology is capable of that, and it's a really good technology, type 4 700-bar tank. So that's the rationale to why we did, why we spent time investing in that.

And I think we saw in the natural gas market early on, this was slow adoption of natural -- on high re natural gas engines to not have a complete system to make sure the thing function effectively took a number of years those technologies to -- as simple as the sound. It's not that simple and even less so with hydrogen. There's more to be done there. So to help move the industry forward, and we think there's opportunity to create a better system by having that. So early days. We just closed and initially focused on Europe, but we'll move out of those geographies as well, which will add to revenues in the short run. Because as I said, you can use it with natural gas as well as hydrogen. Right. That answers your question.

James Hopkins - *Cummins Inc. - Executive Director of IR*

Next question for Amy Davis. How important is developing scale for Cummins and ensuring success in hydrogen technologies?

Amy Rochelle Davis - *Cummins Inc. - VP & President of New Power*

Yes.

I mean, the scale is going to be important, just like it is in our diesel business. And in other businesses, scale is going to help us spread our R&D investment over lots of volumes and accelerate our cost out of our supply chain and, also, I think Tom talked about it earlier, help us get iterations of technology out there faster. So it's going to be really important. I feel well positioned. I think some of these points have been touched on, but again, being an incumbent in many of these market segments around the world, we have installations in a lot of different applications already, and we're scaling already across these technologies in certain applications. So we -- that should help us as well as our geographical diversity and being in many of these regions where it's going to be adopting at different places that will help us get stuff in the field and get volumes out there.

So I think in general, I guess I'd make one other point that a lot of people don't really understand that there are some common components or technologies across electrolyzers, fuel cells. And so the fact that we have both, and Tom talked about electrolyzers coming a little earlier, that may also help us scale up faster in our production in those technologies. So I guess those are kind of 3 areas that I think will help us, and it's definitely going to be important.

Thaddeaus B. Ewald

Amy, the way if I'd just add to that, the way I think about it, and we've talked about it before is square meters of membrane and square meters of gas to fusion, they are square meters. So it all adds. So it's -- that's a little different than the way you think about such specific components of an engine necessarily. But that -- in the early way, that's a great way to create scale, having both a PEM electrolyzer and PEM, like a very simple example, I'd say.

Amy Rochelle Davis - *Cummins Inc. - VP & President of New Power*

Exactly. Thanks.

James Hopkins - *Cummins Inc. - Executive Director of IR*

Great. Great. Well, I think with that, we've come to the end of kind of the Q&A session today. I really appreciate the panel going through a lot of these questions, certainly a lot of interest in hydrogen. And before we wrap up, I wanted to pass it over to Tom here for any concluding remarks.

N. Thomas Linebarger - *Cummins Inc. - Chairman & CEO*

Thanks, James, and thanks again to the panel. I really just want to say that you can certainly hear in my voice how excited I am about this. There are a lot of challenges ahead to develop and deploy this technology in a way that's cost-effective, high quality and can replace all the existing technology. There's a lot of work to do. And I think this transition is going to go over a significant period of time, but we are investing to be ready now. So we will be ahead of the infrastructure. We will be ahead of whatever carbon cost regulation comes in. We will be ahead of when all the hydrogen is available. We will be ready for whenever the industry. Whenever the government is ready, we will be ready. And we will be investing to make sure that Cummins plays a significant role in low-carbon technology deployment across sectors. So for us, this is kind of what we're about. We love developing new technology. We love addressing challenges like how to take carbon out of the industry. This is kind of what we were formed to do more than 100 years ago. So for us, this is the work we were put in place to do. This is the work we're excited about doing. What we're trying to do now is build more participants, more energy around this so it gets deployed both quickly and effectively. We really appreciate all of you tuning in and sticking with us for this significant investment in time to learn about the technology. But the more of us understand it and see its opportunity. I'm convinced the more that we'll get behind it and begin to drive adoption. So thanks for everybody's attention. I really appreciate it. Have a great day.
