

# **Plug Power Inc. (PLUG) Special Call (Unlocking the Future: Hydrogen Mobility Fueling Solutions) (Transcript)**

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**Body**

Plug Power Inc. (PLUG)

Special Call (Unlocking the Future: Hydrogen Mobility Fueling Solutions)

March 05, 2024 12:00 PM ET

Company Participants

Meryl Fritz - Manager, Marketing & Communications

Tim Lowrey - Director, Sales at Plug Cryo

Adam Van De Mortel - Sales Engineering Manager

Conference Call Participants

Presentation

Meryl Fritz

All right, and I believe we're live. Hi everyone and welcome to this month's episode of Green Hydrogen with Plug. My name is Meryl and I'll be your moderator for today's session.

In today's episode, we're diving into hydrogen mobility fueling solutions as we look at various mobility applications and highlight Plug's portable refueler. I'm very excited to introduce today's speakers who both joined Plug in 2021 through the acquisition of Applied Cryo Technologies adding significant capabilities and expertise to Plug's Liquid Hydrogen and Hydrogen Mobility Fueling businesses.

Our first speaker today is Tim Lowrey, the Director of Sales at Plug Cryo. Tim has over two decades of experience in driving product portfolio expansion across various sectors such as energy, technology, manufacturing, and cryogenic gases.

Prior to joining Plug, Tim served as Vice President of Sales and Marketing at Applied Cryo Technologies where he specialized in providing customized solutions to store and transport cryogenic liquids.

Tim graduated from Texas Tech University, holding a degree in Telecommunications with a minor in Marketing. He's widely recognized for his relentless dedication and forward thinking. Tim co-founded Applied Cryo Technologies in 2012, a venture that significantly embarked his career, culminating in its acquisition by Plug Power in November 2021.

Our second speaker today is Adam Van De Mortel, Sales Engineering Manager at Plug. In 2005, Adam began work in the UAB development programs before pursuing work as a sales engineer in 2007, designing and selling cryogenic vaporizer solutions, which led them to joining the Applied Cryo Technologies team in 2015.

Adam joined Plug when ACT became part of the Plug family in late 2021 as the Plug Cryo Technologies Group, driving all cryogenic equipment manufacturing needs for the organization.

Having collaborated with the Plug Cryo team for over a decade, Adam and his team have developed a leading role in pioneering breakthrough technology and energy transition markets for driving adoption of alternative fuels to support the increasingly stringent emissions reduction efforts for mobility power and industry.

Adam is a graduate of Cal Poly Pomona with a Bachelor in Mechanical Engineering and was inspired to pursue a career in energy transition after seeing the shortcomings of petroleum fuels as well as challenges involved in reducing emissions and meeting the world's climate goals.

Before I hand it over to our speakers today, I just wanted to let you know that we have reserved time at the end of today's webinar to answer your questions. [Operator Instructions] And then lastly on the right side, you can find Tim and Adam's Bio along with a post-event survey.

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So, with that I'll hand it over to our speakers to start today's session.

Tim Lowrey

Yes. Thank you, Meryl and thanks to our audience today. Good morning, good afternoon, and good evening. I know we've got some audience numbers all around the world. So, we appreciate you guys carving out some time today. We're excited about this discussion and we really appreciate it.

Adam Van De Mortel

Hello everyone and thank you Meryl for the introduction. It's pleasure to be here today and we're excited to talk about hydrogen mobility dealing solutions we've developed at Plug. Decarbonizing the mobility sector will need hydrogen in the mix. So, we can work on -- we went to work on developing solutions in the space to help drive adoption of hydrogen fuel.

I myself have a long history in product development and spent the last 10-plus years working with Tim and the team here in Houston to develop and deliver solutions for energy transition. So, with that we hope you enjoy the presentation and we'll have the Q&A at the end.

Tim Lowrey

Yes, and Adam and I will be kind of bouncing back and forth with each other here as we go through the presentation. To begin Plug has the most operational experience in the emerging hydrogen industry. Today you can look at the various verticals in the distribution and material handling sectors of some of our customer base. We have over one billion hours of operation and we're dispensing over 40 tonnes of hydrogen per day to over 200 private fueling stations.

Adam Van De Mortel

Plug is an incredible organization tackling green hydrogen adoption. As you can see we're reaching middle markets to decarbonize industry and have a tremendous amount of experience and expertise from producing hydrogen to using hydrogen Plug is involved at every step in the value chain.

Tim Lowrey

Absolutely. In this presentation we'll be discussing why hydrogen is the best option when it comes to a zero carbon solution. We're also going to discuss why Plug's liquid hydrogen portable refueler is an innovative solution that makes hydrogen adoption easier, smart and sustainable. And we'll also discuss how Plug Power is taking an ecosystem approach towards its business model to create a comprehensive and integrated hydrogen economy that supports clean energy solutions across multiple applications.

Adam Van De Mortel

Emissions reduction from mobility is historically hard to abate industry sectors. So hydrogen will play such a pivotal role in the energy transition for mobility as you will see going through the presentation.

Tim Lowrey

So why hydrogen? Why is hydrogen the best-fit carbon solution for mobility applications. It has several key attributes that make it uniquely suitable. One is it has a high energy content which is especially beneficial for applications in transportation and industrial processes. It has zero emissions at the point of use and it's extremely versatile. So it can be used across various sectors cars, trains, buses and even ships and planes.

Adam Van De Mortel

Yes. Hydrogen is abundant. It can be renewably produced and it allows means of energy capture and storage as well where overcapacity exists. So when you talk about renewables the wind doesn't always blow the sun doesn't always shine. There are peaks and valleys in the supply side of that as well as the demand side. So hydrogen really serves as a buffer for aligning these peaks and valleys to be able to capture and store and utilize that energy.

Mobility is a particularly ideal application because where you have a concentrated need for energy delivery to ultimately power electric vehicles there are no bottlenecks in the process when compared to charging batteries which relies on the local electric grid. So hydrogen fuel cell electric vehicles are not susceptible to those factors and they also have a very low raw materials requirement when compared to mining lithium and cobalt for battery electric vehicles.

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Tim Lowrey

Yes. Great points Adam. And so we've answered why hydrogen and now why choose liquid hydrogen for delivery. And the answer really comes down to the increased density of liquid hydrogen versus gaseous hydrogen. So what this leads to is a lower cost of transportation and a lower cost of infrastructure at the end user site on a $1 per kilogram basis of stored hydrogen. So a rough example of this you see illustrated there in the top right. It takes approximately eight gas high-pressure tube trailers to deliver the same amount of hydrogen as one liquid cryogenic hydrogen trailer. So as the hydrogen economy continues to grow and evolve LH2 is critical -- economical and to the point a space-saving form.

Adam Van De Mortel

Yes, of course. Not only does it reduce the logistics of.

Tim Lowrey

Do you have anything to add on that before I move on?

Adam Van De Mortel

Yes the on-site storage as well is reduced in footprint. In deliveries, you get around 60-megawatt hours of energy per load. It's in low pressure liquid form and also part of the reason for fast fueling in that we're helping in project liquid form, which is very mechanically efficient to compressing gas. It's about 10 times more energy efficient to pump liquid. And this was really pioneered in previous years through LCNG stations where compressed natural gas was a fuel that companies were using for energy transition to decarbonize their fleets. You have a cryogenic liquid storage tank. You have a cryogenic liquid pump that's increasing the pressure and producing flow through a cryogenic vaporizer and ultimately delivering high-pressure gas to the point of dispensing.

Tim Lowrey

I know you're excited to get into the refueler portion here. But first to touch on applications. There's a variety of applications that are being pioneered right now. But as we look at the different markets that really rely on liquid hydrogen, we have our traditional material handling markets where we're actually transporting delivering and storing the liquid hydrogen on-site outside of these large distribution centers.

We see a similar model really playing out in stationary, power and commercial transportation where we'll be transporting and storing liquid hydrogen on-site to fuel these fleets in vans and semitrailers.

As we look towards the future, we have heavy-duty industries coming online. These are things like Class 8 trucks, which we'll touch on ships rail and mining applications as well. These are applications that require liquid hydrogen onboard the vehicle to get the required energy density for widespread commercial adoptions. So we see demand for liquid hydrogen overall increasing over the next several years as these industrial applications come online.

Adam Van De Mortel

Yeah. Hydrogen is essential and energy transition for mobility. It's making headlines with many pilot projects. And I think we're only seeing the tip of the iceberg.

Tim Lowrey

Yeah. I think Plug agrees and most of the people in the audience. So hydrogen adoption for commercial transportation, it really does depend on hydrogen to decarbonize. And Adam is going to touch on some challenges here that the industry faces, but you've got the really two main points I'll say high level. One is the fixed infrastructure these fleets switching to fuel cell electric vehicles are dependent on having a strong refueling infrastructure and Plug is playing a major role in that with their liquefaction plans as well.

And then you have -- really having to commit to building these fixed refueling stations is highly resource-intensive when many of our customers beginning these pilot programs they're developing that market. So they're developing the customers.

So with that I'll point to Adam to give the highlights and walk us through the refueler as a product and how it all comes together. Adam?

Adam Van De Mortel

Thank you. So developing bridge solutions with interim equipment packages is crucial to get the ball rolling. It really helps to drive adoption in our experience making hydrogen and excellent zero-emission fuel alternative.

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Tim Lowrey

Adam, I'm having a little bit of a video difficulty. Can you hear me okay?

Adam Van De Mortel

Yes. Hopefully you can hear me and we can also…

Tim Lowrey

Okay, just to…

Adam Van De Mortel

Start facing the chat if needed.

Tim Lowrey

I can not. You sound -- yes. You sound amazing, but I'll keep my video off, just so I can keep the audio going. Hopefully that will resolve the issue.

Adam Van De Mortel

So the solution we developed, I'll give you an overview of the major components to kind of talk through a high level summary of points here. This is a self-contained project dispensing system on a trailer. It's transportable. It's easily relocated to other sites, leaving those branded assets a pilot project is something that is pursuing a temporary situation and the client decides to move on to something else.

It can be easily redeployed, and it also allows convenient refueling of hydrogen-powered vehicles. This can be delivered anywhere very quickly and deployed in a number of days depending on the customer's particular application. So, it's really an optimal solution for pilot projects and small fleets where clients are looking to convert a portion of their fleet to beta test, hydrogen adoption as a few alternatives. So -- but going through the overview of the system, you have a cryogenic liquid storage tank. That feeds to a cryogenic liquid pump, which then flows products and increases pressure through a cryogenic vaporizer, ultimately delivering high-pressure gas to the hydrogen dispenser.

There's also a temperature control loop of our proprietary design to allow temperature control of that gas to meet the SAE J2601 fueling protocol standard. You have a number of safety features, including emergency stop -- remote emergency stock capability, grounding capability, various sensors for flaming gas detection that would shut down the process in a safe manner. And ultimately, the development of this product was done with a large focus on safety, right? So, we've essentially taken our experience and knowledge from our traditional of hydrogen refueling system and condense the footprint to a custom drop deck trailer with smaller liquid hydrogen tank.

We've gone through a thorough process hazard analysis, design qualification and testing involving multiple third parties, electric panel certification, declaration of compliance as well as getting the center of hydrogen safety involved and producing a hydrogen safety panel report to get just a number of different entities involved in our due diligence. So, going back to the earlier slide on Plug's experience in project portfolio, the number of projects and installations is really a testament to our expertise in this regard.

Tim Lowrey

So, it's really, I mean, just a high level, this is kind of a starter kit for our customers in their pilot programs. It's a filling station on wheels. Would that be kind of maybe a very simple description, Adam?

Adam Van De Mortel

Yeah, absolutely. This ultimately is geared towards allowing the customer speed to market, ease of adoption for beta testing, hydrogen fuel cell vehicles. And permanent infrastructure is going to be far more complex and costly. There are things to consider when you're looking at an interim solution with a bridge solution like this. You're basically limited to the confines of a trailer in terms of the space that's available. So we really focused on the essential needs of this system to be able to perform as intended.

Tim Lowrey

And maybe touch on Adam for the audience. We have many strengths within Plug and then within our group, but how the controls and programming process comes into dialing in the operation for our customers?

Adam Van De Mortel

Yeah. That's an interesting point and it's really been a collaborative effort between our controls, departments, the dispenser folks, the dispenser OEMs as well as the fuel cell electrical vehicle OEMs as well. So there are a lot of collaborative discussions in coordinating our strategies to ensure a safe and reliable fueling experience.

So from our scope, we have a control system with a PLC that is governing operation of the tank, the liquid pump, various actuated valves and controls on our system. We're monitoring everything on the trailer where all the process equipment is, including having various detectors in place and emergency stop buttons that actually interface with the rest of the system.

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So we are essentially providing high-pressure gas up to the point of the dispenser. And then the dispenser itself actually functions as this last layer of protection for the vehicle fuel tank. So the dispenser actually is what governs and meters and regulates the flow out to the fuel cell electric vehicle or the hydrogen powered vehicle. So it really is the last line of defense and has its own PLC that's has programming in it that's tailored for the fueling operation that it's intended.

Tim Lowrey

So, a couple of questions for you. I'm sure some of our audience might want to know, if can this particular product support liquid supply delivery, as well as gas supply delivery?

Adam Van De Mortel

Yeah. So delivering liquid to the site, it does have that capability, right? It can be filled at a plant and it can transport payload. It does have DOT certification as well as ASME Section VIII, Div 1. So the liquid tank can be used to transport liquid to the site.

In many cases, the customers elect to receive the unit either inverted or with hydrogen blanket and essentially no liquid product on board. They then set it up as a temporary fueling station in a semi-permanent fashion where the only liquid being delivered to the site will come in the form of liquid deliveries from cryogenic transport trailers.

So it would just receive a delivery, which obviously has the capability to receive deliveries on site as well. And then the dispense application is always going to be a high-pressured gas.

Tim Lowrey

Okay. Thank you for clarifying that. And for the audience's benefit, can you touch on the advantages of having a liquid tank on board and building pressure on what that process looks like through vaporization versus a compressed gas solution?

Adam Van De Mortel

Yes, absolutely. So when you're pumping liquid, cryogenic liquid pump is a far more mechanically efficient means of building pressure and flow versus compressing gas. So, if you were receiving deliveries in the form of high-pressure gas tube trailers, you would essentially need to boost that pressure with a compressor to reach the volume and pressures needed for on-site storage, which would also require a greater footprint, as well as this far more energy to actually compress that up to the pressures needed to fuel a dispense operation. So the cryogenic liquid pump is really the key driver for this equipment package and providing a high-pressure gas stream in compact equipment package that can deliver high pressures and high flows.

Tim Lowrey

God it. Thank you, Adam.

Adam Van De Mortel

So, going through the rest of the specs here around the unit, it has different dispensing pressure designs for different vehicle applications. You have the 350 bar or H35 dispensing, as well as a 700 bar or H70 dispensing. These two strategies are kind of dependent on what the customer vehicle fleet is intended. In some cases, they want a more flexible asset that has a variety of different vehicles that can be fueled, whether there's some cars. In some cases, it's strictly municipal bus fleet transit authorities with a particular constant vehicle platform that they're fueling. And there's different fueling protocols that govern, this essentially SAE J2601 is the fueling protocol followed, when you're filling having the liquid hydrogen is really key to being able to facilitate these different dispensed pressures because that's a commonality among both designs.

So having that low pressure liquid hydrogen storage tank to feed a 350 bar application versus 700 bar application, you're really just talking about some slight differences in the pump design from one to the other, as well as the dispenser itself. And potentially going forward, we could potentially homogenize those and offer dual pressure dispensing.

Having that liquid payload, you also have a greater volume in mass on board. So 6,500 gallons approximate storage is almost 1,600 kilograms. With that high flow rate of up to 3.6 kilograms a minute, you're talking about five to 10-minute fueling duration for those vehicles. And really the output temperature which is governed by our temperature control loop is going to have to be between minus 40 degrees C and minus 17.5 degrees C to be able to meet that standard. So there are different versions of the standard that are in different phases of being released. There's J2601-5 which is essentially improved standard that is being proposed for heavy-duty vehicle fueling and it's a work in progress. But they're adding non-inflationary to kind of demystify and make more clear what those standards are so that we can have improved standards for fueling hydrogen vehicles moving forward.

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And then I guess just touching on a few other points. Again, low infrastructure costs having the portable application. You're not having to do geotechnical design and civil structural work to roll out a portable asset. It also provides speed to market, because it can be placed on site and operational within a couple of days.

Tim Lowrey

Yes. Sorry to cut you out there. Thanks for clarifying those last two points. And when we talk about barriers to entry and removing those barriers to entry to help develop this market. I know we've talked throughout the presentation on it's about a third of the cost of building a permanent station. It allows. I know on my end talking to our customers and prospects, the ability to have the portable solution and have these like I said earlier a starter kit for these pilot programs and really begin to develop those customers and grow those customers. It gives them a better idea long-term where those fix stations need to be built as they develop out their customer base.

Adam Van De Mortel

Yes, absolutely.

Tim Lowrey

And you mentioned earlier on the -- sorry to cut you off, but the kind of the similar fueling times, as there I say the diesel experience. But I think that's a huge point for the drivers. The actual drivers out there that they want something that's familiar to them. And when you compare it against battery electric vehicles, the recharging time is far longer than what we're offering the market with this particular product.

Adam Van De Mortel

Yes, definitely, providing an experience that's similar to what customers and clients are familiar with on diesel and gasoline vehicle fueling is really essential in highlighting the benefit of hydrogen as an alternative fuel, right? The ease of transition to similar fueling times even the experience of handling the nozzle and fueling the vehicle everything is very, very similar in terms of the interface with the dispenser itself and the overall user experience.

Tim Lowrey

Thanks Adam. So when we talk about Plug's expertise through our many projects and trusted customers one thing I've learned within Plug, and it was very similar when we were still under the ACT name. We believe in partnerships. We really do and that word means something to Plug. And customers can be partners or suppliers can be partners. It really does take a true strategic partnership to help develop this market.

And Plug has made strategic acquisitions as they did with ACT. And just to name a few you've got the DOE process guys that we can touch on here in a moment. But with ACT we were founded in 2012 and we're essentially a group of industry experts and our forte is design optimization. Adam highlighted our portable refueler, which as I mentioned is basically a startup kit for customers looking for to do Fuel Cell Vehicle Transit companies, Class 7 and 8 customers for their pilot programs. They can utilize that portable refueler as a bridge to develop their customer base.

A key differentiating factor for ACT is our ability to offer superior payloads which we touched on and I'll highlight again here in a minute, while optimizing equipment that reduces the cost of ownership and increases the net earnings for our customers. Every Cryogenic Trailer model that we've developed it's one of true criteria. It's either an improvement to what the [Technical Difficulty] point or it's a design that didn't exist.

For example, Plug's Liquid Hydrogen Cryogenic Transport Trailer which we use for our internal demand as well as we sell to third-parties, it's actually the lightest Liquid Hydrogen Trailer on the market. It has the largest volumetric capacity and that results in unmatched payloads, so, almost 10,000 pounds of liquid hydrogen.

Adam Van De Mortel

Yeah. ACT is really a collection of industry experts. We are industry leaders in Portable Cryogenic Storage Vaporization and Pumping Equipment. So we've been doing this for over 10 years and it was really a natural fit for our expertise.

Tim Lowrey

Yeah. When you say that, kind of going off script here, but you said Storage Vaporization and Distribution Equipment. And as I look at the rendering of the Portable Refueler that -- it's all right there in one package.

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So we have extensive experience in numerous different projects for Cryogenic Pumping Applications, not just within hydrogen, but other applications as well. So how does that all fit into Plug's green hydrogen ecosystem?

I mentioned another acquisition there with the fuel process, where they design and fabricate the liquefaction plants to even a couple of years before that the acquisition of United Hydrogen, ultimately the acquisition of ACT as well. They've become a vertically integrated company which really gives us an edge, in many different aspects of the hydrogen market.

We have this entire ecosystem that Plug can provide. I saw one question what differentiates us from our competitors? There are so many things. But I would say that's probably the biggest one.

When you look at essentially we have the technology, the deployment, the infrastructure in place to support the entire supply chain; from hydrogen liquefaction, to the storage and delivery assets, to the delivery of the fuel itself which is a key --key piece. Adam, do you want to add anything to that?

Adam Van De Mortel

Yeah. Absolutely, it's definitely been a great fit us joining into the Plug value chain from storing and handling hydrogen to dispensing. Clearly we're bridging that link in the chain and helping drive hydrogen adoption for mobility applications. So this product is really the culmination of that.

And really driving use of hydrogen is what Plug built this company starting out and allowed us to build out the rest of the value chain. So as we drive more adoption and use applications, we can increase the amount of production that's needed to meet that demand. So that really brings a full circle for us.

Tim Lowrey

Yeah. I think standardization is a keyword that we talk about a lot and between all the different groups within Plug, but I've come under the Plug family, standardization is how we're going to get the cost down overall.

I was talking with Ben Victor last week over at the [indiscernible] building. And then we're talking about at one point it was 15 tonnes per day of liquefaction capacity then it was 30 and then 45. Don't be surprised if they're talking 100 tonnes per day of liquefaction capacity. So standardization is a key focus within our product portfolio today and in the coming years as well.

So just to highlight, Plug's hydrogen generation network and Adam talked about driving end-use applications obviously, liquid supply is a key – plays a key role in that upstream. We have a goal to be at 1,000 tonnes per day by 2028. And you see some plants that are being developed throughout the country.

So only with Plug and Adam jump in where you'd like to here, but there's only one company that's vertically integrated like Plug is within this sector. We have the experience and the technology. We're the only company to really provide a comprehensive end-to-end solution. We're the world's leading liquid hydrogen buyer and supplier and of course, unparalleled customer service but we're really on the tip of the spear in developing this market. And that obviously, produces a lot of lessons learned, which only adds value to the process as a whole.

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Adam Van De Mortel

Yes Plug really is incredible in having built out the complete turnkey scope of services and goods for hydrogen from producing the molecule liquefying it storing and transporting to end-use applications in the future. And from what we're starting to see today additional applications in the mobility market. There are ongoing pilot projects for a number of different applications in mobility and Plug is involved in that as well.

Tim Lowrey

So we hit a few points there. Obviously, a huge market opportunity, unmatched market knowledge because we are on the tip of that spear, unmatched products as we've developed out that product portfolio and continue to do so. We have unmatched infrastructure and obviously, a ton of customer feedback because Plug has been doing this for a long, long time. So you don't know where you're going unless you know where you've been. So we have a very clear vision of our future.

Adam Van De Mortel

Yes. I appreciate the capacity of the organization to offer as much or as little of that entire hydrogen ecosystem as the clients are interested to work with us on. So if you're interested in sourcing hydrogen or if you're interested in sourcing equipment, if you're interested in leasing for a pilot project. Whatever the case may be, Plug has a solution in place that can fill the need to bridge those gaps and really help drive adoption of hydrogen for energy transition.

Tim Lowrey

Okay. With that [Technical Difficulty] Q&A session.

Question-and-Answer Session

A - Meryl Fritz

Great. Thank you both very much. I know we have a very active and busy Q&A session, so we'll jump right in. First question today. Is it correct that no on-site mechanical refrigeration of the hydrogen is required during fueling of the vehicle?

Tim Lowrey

Yeah. I can take that. Can you repeat it, you cut out just a little bit. I think I heard it, but can you read that one more time please?

Meryl Fritz

Yeah. No problem. Is it correct that no on-site mechanical refrigeration of the hydrogen is required during fueling of the vehicle?

Tim Lowrey

Yeah. That's correct. So these are cryogenic vessels which are double-walled vacuum insulated. So you're really just protecting the temperature of the liquid so to speak. You do have -- you do introduce heat when you run the unit, which is typical of a cryogenic system, but there's no mechanical refrigeration process involved.

Meryl Fritz

Perfect. Thanks, Tim. Next question, what energy sources are you using to make and process the hydrogen wind, solar, hydro? Or are you producing the electricity using one of your own fuel cells?

Adam Van De Mortel

So regarding the production, it's not actually occurring at the point of use for the refueling applications. Obviously, Plug has various liquefiers on the map as shown, where there are hydrogen production sites that utilize either electrolytic hydrogen that's produced by our electrolyzers, which is essentially taking water molecules and splitting that with electricity to create hydrogen gas and releasing oxygen in the atmosphere. In other cases, there is hydrogen that is being produced with other technologies. But the focus for Plug is green hydrogen and that's really what the plants that we're offering to the market are intended.

Meryl Fritz

Perfect. Thanks, Adam. Next question, can both dispensers operate at the same time? Are both dispensers delivering gas at the same pressure?

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Adam Van De Mortel

So currently, we only have dispensers for one pressure class or the other. It is part of our potentially our product road map to develop a dual pressure capable dispenser and have a dual pressure capable unit. However, I don't think that it would be a simultaneous operation. I think you would be either feeling at one pressure or the other due to the nature of maintaining system pressures, but that's yet to be determined.

Meryl Fritz

Awesome. Thank you. Next question. Can the system support both liquid hydrogen delivery or gaseous hydrogen, depending on which form is required by the products in use?

Adam Van De Mortel

Yes. It is versatile in that way. It can deliver liquid as well as gas high-pressure gas. So, it does have the capability to haul and transport liquid over the road. However, because it's a relatively small liquid hydrogen tank, the general feedback that we get from customers is that the preference would be to use this as an affordable fashion where they're essentially maintained this asset at a fixed location and then refilling it on site with a liquid transport trailer.

As Tim mentioned earlier, our liquid hydrogen transport trailer design is the lightest highest halo trailer on the market. So, that's really the objective when you're looking at the logistics of moving hydrogen around is optimizing payload to reduce logistical movements.

Meryl Fritz

Perfect. Thanks Adam. Next question. Dispensing is H35 and H70? What's the flow rate capabilities hence what's the back-to-back HD refueling ability?

Adam Van De Mortel

So, currently the limiting factors really the dispenser and the programming that's put into that. As these pilot projects are starting to be beta tested, we're starting to learn more about moving to higher fueling rates.

Currently, 3.6 kilograms a minute is the peak flow that the J2601 standard will allow using the communication fill versus non-communication fill, MC formula method for filling, which is basically a dynamic fueling process for the pressure ramp rate.

Those are still being developed as far as what the max flow rates can be. And again as I said before, there is a new standard that's a work in progress and it's a draft form right now using the J2601-5. So, that would ultimately allow a more standardized higher flow capability but it is not yet released in a finalized form.

Meryl Fritz

Okay. Thank you. And then going [ph] of the liquid hydrogen storage tank is that with or without the pump upon?

Adam Van De Mortel

That's without. Yes, that would be just a pressure transfer operation from the delivery trailer into the onboard liquid hydrogen storage tank.

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Meryl Fritz

Great. Thank you. Next question I feel like you guys touched on this a little bit, but can you talk a little bit about how Plug differentiates from the competition?

Adam Van De Mortel

Yes, I mean Tim alluded to this and maybe he can elaborate. Really Plug is an end-to-end solutions provider. We're vertically integrated and that really does set us apart aside from the number of installations that we do have with hydrogen pads for our existing customer base.

Tim Lowrey

Just to add to that, and what that really equates to in experience, and being able to really kind of guide our customers into different solutions, is huge in the early stages of this market and huge with -- a lot of the times, the customer doesn't know exactly, what they need and just for us to be able to really pull on that experience and that historical resume is key, in communicating the best solution for the customer.

Meryl Fritz

Great. Thank you, both. Next question, is there a special training required to operate the refueler or can driver refuel on his/her own?

Adam Van De Mortel

Yes. The training is very simplistic for the actual vehicle, fueling itself. There's some considerations that any client should make for safety. And really, that's in large part, up to them. We do have generally, a pre-start-up, safety review process that we would go through for any new installation. So, Plug has a robust service team and resources to manage the preventive maintenance, and actual operation of the system as far as support services, providing any training that the customer is going to be involved with. But as far as the actual dispense application, it is really as simple as anybody, that's going to the gas station now, right?

The dispenser operation, you're essentially pushing a button, and moving the nozzle to connect to a vehicle. So, that is an extremely straightforward process. So other than that obviously, refilling the cryogenic liquid tank, the logistics and bringing liquid to the site, that's all services that Plug can handle in-house. So, we do offer that. In some cases, customers want to have a little more involvement with the system, at which point, there would be more operational training involved and them taking custody of certain portions of the operation.

Tim Lowrey

And just to kind of clarify that. Operationally, with our customer tons of support there, tons of training there for our customers' customer, the driver they fuel their own truck very straight forward process, as Adam mentioned.

Meryl Fritz

Thank you both. Somewhat related question, in cryogenic are there protocols different from LNG for dispensing.

Adam Van De Mortel

For dispensing, no not really. For LNG, that is a project liquid you would have like face shields and gloves for PPE, necessary personal protection equipment. But when you're dealing with a high-pressure gas, it's really more like a CNG fueling operation, which is warm high-pressure gas. And once you make the connection from the nozzle to the receptacle, there's no exposure to high pressures or temperatures that the user is experiencing. So, LNG is going to be actually more stringent from a dispense application, because you would typically require more PPE.

Meryl Fritz

Great. Thank you. How much power is required from the customer to operate the infrastructure?

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Adam Van De Mortel

So it ranges from about 100 to 125 kilowatts depending on the model purchased or being used. For the 700 bar application, there's a little more electricity involves. There's an additional booster pump to raise that final discharge pressure from 700 bar fueling. So that would be the higher requirement and then the 350 bar is closer to 100 kilowatts.

Meryl Fritz

Thank you. How do you control/regulate the dispensing pressure?

Adam Van De Mortel

So that is controlled by the dispenser itself. It has a flow control valve and sensors and control system within itself that is essentially limiting the pressure ramp rate into the vehicle fuel things. So that is driven by the SAE fueling protocol standards. So they have to meet those pressure ramp rates at the fueling speeds that we're delivering.

Meryl Fritz

Thank you, Adam. From logistics point what is max distance from hydrogen storage to a hydrogen mobility fueling station. That's one part of the question. So we'll do that first and then there's the second part.

Tim Lowrey

So regarding reasonable distance for delivering fuel, I mean that's really centered around the liquid delivery. So I mean I think roughly a 500-mile radius is generally what we would consider reasonable for the liquid deliveries.

Meryl Fritz

Great. Thank you. And then second part of that question is what are external utility requirements for the mobile application?

Tim Lowrey

That's a great question. It is really just the electricity and then for some actuated valves that utilize pneumatic source. Really the preferred method would be nitrogen, dry nitrogen. Plug does offer a solution for that. It's very low consumption there's like a purge on the cryogenic pump that is in the motor of the pump. So that would be preferred to be a nitrogen source. We are exploring pneumatic air supply, which is used in other applications. But our preference is really the nitrogen because consumption is very minimal.

Meryl Fritz

Thank you. What have you seen as an average tank size for these vehicles?

Tim Lowrey

So I think about 25 to 40 kilograms is sort of the range that we're typically seeing for fills. So that would be for like a transit bus or for Class 8 trucks. I'm sure for passenger vehicles it would be a smaller volume, but we haven't really gotten into those particular applications with this equipment.

Meryl Fritz

Great. Thank you. Next question. What is the likely storage capacity time if no refrigeration is required?

Adam Van De Mortel

So essentially the oil off rate for the tank -- our tank design has 0.73% per day of oil off rate. In addition to that you do have some initial cool-down and really this product is geared towards providing a bridge solution, right? So speed to market ease of adoption when you're feeling a pilot fleet of vehicles it's best to prove those together in a back-to-back fueling configuration so that you're minimizing the amount of cool down that is needed on the front end because when you're going to start fueling window you're going to have to cool down all the metal mass between the cryogenic pump and the dispensary circuits or really up to the vaporizer.

So up to that point you have piping controls, the pump itself and cooling all of that down can take some time on the front end. So in the current configuration you are essentially venting to cool that to cool all of that down. But once you are able to start the process there's little to no venting occurring and you're basically able to utilize the remaining payload of liquid to do fueling in a back-to-back scenario.

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Meryl Fritz

Great. Thank you. As a refueling station developer, does Plug look for partnerships in growing the hydrogen refueling station infrastructure?

Tim Lowrey

Yes, I'll take that.

Adam Van De Mortel

You always going to take that?

Tim Lowrey

What's that? Yes. I mean -- we're big believers in partnerships. So I'd say they're open-minded in that regard as a general statement.

Meryl Fritz

Thank you, Tim. Next question how could gases and hydrogen refueling technology affect demand for liquid green hydrogen amid a wave of refueling station closures.

Adam Van De Mortel

I think it supply benefit there. They're factory produced. We do have backlog to make this product available to the market in short supply.

Tim Lowrey

And that's the point behind the portable refueler is that a lot of these fixed stations --maybe they should have been built in a different location and the portable refueler really allows you to dial in where the customer base is going to be. And then as these -- as our customers develop out their customer base that grows demand and then that's when the more long-term fixations come in in my opinion.

Meryl Fritz

Great. Thank you, both. In the current transit bus design, how many buses are fueled before needing to fuel the mobile refueler tank?

Adam Van De Mortel

Yes, it would be fairly large quantity. So assuming, you were fueling up to 25 to 40 kilograms per bus. I mean that's probably about 25 to 30 buses before you're really going to deplete the usable liquid inventory of the tank.

Meryl Fritz

Perfect. Thank you. We'll do two more questions here. Do you expect the same liquid hydrogen infrastructure in Europe as it or will be in the US?

Adam Van De Mortel

Yes absolutely. I mean I think that's definitely part of the product road map. I think really aligning the codes and standards for overseas applications is the main challenge when you come to European markets or Asian markets. Obviously, we're doing work in South Korea. So, that's really the primary hurdle in bringing products to those markets. But obviously, we are close to the port of Houston here, where we manufacture this equipment, so delivering equipment worldwide is entirely within the real possibility. And I would say, definitely part of the product road map considering the objectives and mandates in Europe to meet climate goals that are in place.

Tim Lowrey

Yes, and just to add to that, I think availability of liquid capacity will drive what types of products are needed. Whether it be for a liquid hydrogen transport trailer compared to an LH2 ISO container, just depending on where the liquid would be getting delivered. And to which country would drive that as well.

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Meryl Fritz

Awesome. Thank you, both. And I think that brought us right to the end. So we can thank you to Tim and Adam, our speakers today, and to all of you that joined us. I will hand it back to you too to close out.

Tim Lowrey

Thank you very much. So yes, I just wanted to say thank you once again for everyone joining today. We appreciate all of the questions. If you have additional questions or interest in purchase or quote, Adam and I are your guys, you can e-mail me at tlowery@plugpower.com So thank you.

Adam Van De Mortel

Yes. We look forward to helping you with your hydrogen fueling solution. Thank you everybody for joining, and we look forward to further discussions.

Tim Lowrey

Have a great rest of your day.

Meryl Fritz

Thanks everyone.

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