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Hydrogen Seminar

Friday, 18th September 2020

Operator: Good morning and welcome to the Johnson Matthey Plc Hydrogen call. Today's conference call will be hosted by Johnson Matthey Chief Executive, Robert MacLeod followed by a Q&A. I'll now turn the conference over to Martin Dunwoodie, the Director of Investor Relations. Please go ahead.

Introduction

Martin Dunwoodie

Director of Investor Relations

Thanks, Fiona. Good morning everyone. I'm Martin Dunwoodie, the Director of Investor Relations at Johnson Matthey. I'm very pleased today to welcome our Chief Executive Robert MacLeod, who will be hosting today's call on hydrogen. In this call, we're going to be providing an insight into the role that hydrogen will play in tackling climate change, our hydrogen business and its competitive positioning and the attractive growth opportunities that we see in this area. As usual, we will not be giving a trading update as part of this call, and with that, I will hand over to Robert.

Enabling the transition to the hydrogen economy

Robert MacLeod

CEO

Thank you, Martin. And thanks everyone for joining the call today. With me today, I have Jo Godden, who runs our Fuel Cells business. Jo has actually 25 years in JM – well, ICI and JM today. So it's her 25 year anniversary today. And she has wide commercial and operations experience across the Group, initially in our catalyst technologies business. And I'm joined also by Eugene McKenna, who joined JM nearly four years ago from Shell. Eugene is one of our hydrogen experts and responsible for helping to commercialise our blue and green hydrogen technology. He has deep experience in technology and business development.

But let's start with what I hope is a familiar favourite: JM's vision. Everything we do is about creating a world that's cleaner and healthier. Not just today but for future generations. This drives our strategy and one of the themes that is really shaping our strategy today is climate change, and the move to net-zero. And our role in hydrogen to help solve this challenge is the focus of today's session.

When you look at the world around us, it's clear that action around climate change has increased and there is growing momentum around net-zero commitments. By achieving net-zero together, we can all limit global warming to 1.5° above pre-industrial levels. And to date, 23 countries and regions have put commitments in place to limit their impact on climate change, and that level of commitment is really accelerating. Just 12 months ago, 16% of

global GDP derived from nations and regions with net-zero commitments. This figure is now 53%. And importantly, the recent uncertainty caused by COVID-19 has not slowed this trend. It's a trend that will only get stronger and is going to require significant change.

Net-zero means we need to change our entire energy ecosystem; how we supply it and how we use it. Firstly, we will need to switch from fossil fuels to using renewable energy sources to generate electricity for use in many applications. For instance, heating homes and businesses, light duty vehicles such as cars and vans and many lighter industrial processes. But using renewable electricity doesn't work for all applications, and it is also necessary to have another energy source for electricity and heating during peak periods. And that is where hydrogen comes in. The use of hydrogen will allow us to decarbonise those applications that require higher energy density, such as heavy-duty trucks and long-distance buses, more energy intense industrial processes, such as steelmaking and cement, and in submarine and rail applications. And of course, in generating hydrogen sometimes you're going to need carbon capture storage to decarbonise this process.

So where does JM fit into all of this? We have a strong position in hydrogen production, and Eugene will come on to the methods by which hydrogen can be produced and explain our offerings in clean hydrogen production—being blue with carbon capture storage and green hydrogen as well. We'll talk about that a little later. We also helped to decarbonise transport through hydrogen-powered fuel cells for heavy-duty trucks, buses and cars, as well as trains and marine, which Jo will talk through shortly. So what we are seeing is the transition of hydrogen from its position today as a critical feedstock for chemical processes to its future position in energy, where it would also be a fuel and energy carrier.

This move to hydrogen is already happening today and gathering pace. We're seeing that across the globe led by Europe with the recent EU Hydrogen Strategy and the German and French National Hydrogen Strategy. And in Asia, there was an announcement earlier in the year from South Korea with their hydrogen strategy. And this slide shows some of those commitments. And it's not just the policymakers that are driving this, we're also seeing bold statements from OEMs confirming that hydrogen-powered trucks will be part of their mix.

So before I hand over to Jo and Eugene, I want to summarise what you're going to hear from us today and why I'm very excited about the hydrogen opportunity.

We've been a leader in hydrogen for many years, and I'm proud to be a board member of the hydrogen council, which is the largest industry-led effort focussed on developing the hydrogen economy. So hydrogen is going to be a really significant opportunity to JM. The addressable markets are substantial, and we're really well placed because of our existing positions and our integrated offering. And both of these are backed up by our leading technology. These are our differentiators, which give us competitive advantage. They're largely built on our science and platinum group metal expertise from across the Group, and we wouldn't be in such a good position today without it.

So where are we today? We already have an established and profitable hydrogen business with current sales of around £100 million across both hydrogen production and fuel cells. And we have strong segment shares. Our businesses are selling into a highly complementary customer base that we know well. For example, our customers from fuel cells are largely the same as for our existing heavy-duty diesel business, and in hydrogen production, many are

the same today as they will be in the future. And our ability to move quickly with relatively low capital intensity makes it especially attractive. The hydrogen economy is already taking shape and looking forward, the opportunity for JM is significant. But more importantly, this opportunity is completely aligned to our vision. The world has to move to net-zero, and we have a key role to play in this with our hydrogen-based technologies.

And with that, I'll now hand over to Jo who'll talk to you about fuel cells and after that, Eugene who will talk about our hydrogen production technologies in both blue and green. Over to you, Jo.

Fuel Cells

Jo Godden

Managing Director, New Markets and Fuel Cells

Great. Thanks, Robert. Before we get into the details of fuel cells, let me start with where we play in the value chain because this is really important in understanding why we have a competitive advantage. As we do across JM, we play in the complex part. For fuel cells, this is making the components, as I will come to on the next slide. This is where the clever chemistry lies, and it's the key to delivering a high-performance fuel cell. Although the value chain is still developing, it's similar to what you see today in clean air and battery materials. We're a tier 2 supplier, but we have a very close relationship with the OEMs.

So a fuel cell converts hydrogen and oxygen into electricity from water; therefore, a key technology in the transition to a clean low-carbon economy and the decarbonisation of transportation. You can see from the right-hand side that there are a number of components, but the fuel cell itself is made up of three main layers, an anode and a cathode, which are both platinum-based catalysts, separated by a proton exchange membrane, or a PEM.

At our sites, automated lines produce membrane reel to reel, which is then coated with thin catalyst layers. A catalyst-coated membrane or CCM is then cut to the customer's specific size and sealed. The size of the CCM will depend on the application, but generally, it's around the size of a piece of A4 or A5 paper. A gas diffusion layer is added to the sealed CCM to create the membrane electrode assembly or the MEA. Many of these are then added together to form a fuel cell stack. Producing a fuel cell is essentially supplying a catalyst to a substrate, and this is something that JM deeply understands. It's our bread and butter. The clever chemistry and the piece that gives the best performance is in the membrane and at the anode and cathode layers, the CCM, this is where the smarts are. We know exactly how to layer the catalyst onto the membrane. But we're not restricted to the CCM; we have a strong position throughout. By controlling all of the elements in the value chain, we can influence the performance of the fuel cell; we can tailor exactly to our customer's requirements.

So looking now at our competitive advantage in fuel cells. Firstly, there's the science. You've seen that we manufacture a number of parts in the fuel cell and this is key to making sure the different components in the system work together in the best way. We're unique because we can optimise the catalyst as well as the membrane. No one else can do what we do. But it's not just the science used within the catalyst coating; it's the knowledge and expertise of how these layers are put together to optimise the whole system. We also produce our own

membrane. Again, this is important for giving the membrane electrical conductivity and for delivering enhanced power. Not only this but producing in-house ensures we have total control over the technical steps and importantly, the cost. And it's this holistic understanding of the fuel cell that means we can offer a customised high-performance solution for specific applications. What really matters to customers in terms of performance is durability or really maintaining that performance over kilometres driven. And our science expertise means we can deliver on that. For a truck, this means achieving over 40,000 hours, and we know how to make improvements that will meet and exceed this.

Secondly, we're a world leader in PGMs. If fuel cells have PGMs in them, with our lengthy expertise in this space, then who better to win than Johnson Matthey? We can also recycle these PGMs, so there is potential to have a closed-loop offering. And this process has a lower carbon footprint. The carbon footprint of primary metal is significantly higher than secondary metal.

And we're already seeing from our conversations with customers that our ability to offer sustainable sourcing at a lower-carbon supply chain is really important to them. As well as this, for years now we've been optimising the use of precious metals by thrifting out metal from our catalysts in our clean air business, skills we are applying to fuel cells today. We used our science and know-how to reduce the number of MEAs required without impacting the performance of fuel cells stack, which ultimately reduces cost to the customer.

And then thirdly, we are a trusted partner, and this has been built over many years, which makes it hard to replicate. We have a commercial product today, and our customers come to us because they know that we can deliver the solution that they want.

And finally, we have established manufacturing at scale both in the UK and China. We've been manufacturing fuel cell components for over 20 years. This started as a very manual intensive process, which has been developed and automated over time. Achieving a high yield is not easy. This is really complex chemistry, and the ability to do this without defects is hard. If there is one defect within one MEA, then the whole stack may be compromised. We've also proven that when volumes ramp up, we can manufacture efficiently at a high yield. In fact, we've managed to increase our yield two-fold in the last two years, and we want to go further when we're currently expanding to meet future demand.

So let's turn now to our fuel sales business today. We're a leader in this market with a strong position in the material handling market as well as the emerging transportation sector. Our business is profitable, and we're seeing very strong growth: 30% compound annual growth rate over the last four years. Our customers are across the main segments: auto, truck, non-road and stationary. And we're working with big names including major truck and auto OEMs. And in China, we're working with the two main government-approved system integrators. Indeed, China is a huge growth market, and we're already on a significant number of buses and commercial vehicle platforms. In autos, we've had strong success. 25% of our sales are now into our auto applications. This is an area where we've seen a real shift in momentum over the last 18 months, and now we're working with a low double-digit number of major truck, and auto OEMs on platforms planned to launch over the next few years. And this included the largest truck brands, so we're working with the players that you'd want us to work with.

With the strong increase in demand that we're seeing, we've invested £15 million to double our manufacturing footprint, which will be complete by March next year. We are available to quickly add capacity as this business is relatively capital-light.

So as the world pushes towards net-zero, there is a huge role that fuel cells can play in the decarbonisation of transportation and the major opportunity in the near term is trucks and buses. So why is this? So firstly, cost. Fuel cells technology is expected to become the lowest cost option for heavy-duty trucks compared to diesel and battery from the latter half of this decade. Also, the weight of a fuel cell is significantly lower than that of the size of a battery needed for the kind of ranges required and due to the relatively low energy density of batteries, the range offered by a fuel cell truck is much greater than that of a battery truck and the refuelling time is much lower. So even if the energy density of a battery improves by two to three times, it will still take in the order of hours to refuel, and a fuel cell truck can be refuelled in minutes. So fuel cells in these applications make sense, and we're seeing evidence of this today.

On the truck side, numerous companies have announced substantial investments in this area. One example is the Cummins acquisition of Hydrogenics for just over a quarter of a billion dollars. In terms of buses and commercial vehicles, we've already talked about our progress in China, and this is just at the start. The Chinese government is targeting one to two million fuel cell vehicles by 2030 and over a thousand hydrogen refuelling stations.

So beyond truck and buses, there will, of course, be further opportunities in autos as costs come down through increasing sales volumes as well as thrifting out metal and improving efficiencies but also as hydrogen infrastructure develops and hydrogen prices come down. So as we move out past 2030, battery electric vehicle will make up the majority of zero-emissions passenger car vehicles on our road, but fuel cells will also have a significant presence. We see this as a good opportunity, particularly for larger SUVs and vehicles that regularly travel long distances with high utilisation where the rapid fuelling and long-range advantages of fuel cells will add value, and beyond this, there will be rail and marine applications. There are already fuel cell trains in commercial operation in Europe today, rising to around 60 trains later next year. And we've also seen momentum with fuel cell trains in China. So it's clear that the momentum is gathering in the fuel cells market, we feel this momentum, and we really have a significant opportunity.

So the biggest opportunity is in the automotive market: trucks, buses and cars. We already have a leading market share today in emissions control and fuel cell technology. We know the customers, and we have the solutions. So the potential revenue in this area is significant. Around 5% of trucks are forecast to be fuel-cell powered by 2030. We provided the estimated value of the CCM and the numbers you see there are expected costs in 2030, which include the cost downs. And as I mentioned earlier, we are playing our part in these cost downs. The main areas of focus being PGM thrifting, which is a core competency for us and something we've been doing in clean air for years, improving yield through manufacturing efficiencies such as automation and improving power density using our skills in PGM chemistry we can improve where we place those metals, and with our coating expertise, we can create better catalyst layers. It's the coated layer structure that determines performance.

So the CCM value to us will be around £2,500 per truck and £800 per car. These are big numbers. Multiples of what we supply in a clean air heavy-duty diesel catalyst system today.

So putting this all together you get an opportunity in the region of £1 billion per annum in 2030 and then more than 10 billion per annum in 2040. So hopefully you can see that we have a really strong position in this market and we're really excited by the opportunity that lies ahead.

And now, I'll hand over to Eugene to talk about hydrogen production.

Hydrogen production

Eugene McKenna

Sector Business Development and Innovation Director

Thanks, Jo. So we talked about one of the key uses in hydrogen in fuel cells and now I want to spend some time taking you through how hydrogen's actually produced. So Johnson Matthey is a global leader of hydrogen and has been for many years. So from 1936, for example. Today we mainly focus on new technologies in blue and green hydrogen given that these are the technologies that will become increasingly important as we transition to a low-carbon world.

As you can see, there are a number of routes to make hydrogen, and these have been given different colours to differentiate them. So for example, we have brown which uses coal as a feedstock, grey and blue which use natural gas and green which uses renewable energy to electrolyse water.

Now today the vast majority of hydrogen is manufactured by steam methane reforming. This is grey hydrogen where natural gas is converted at high temperatures into hydrogen and carbon dioxide, which is then allowed to escape into the atmosphere. The largest markets today for hydrogen are for manufacturing clean fuels in refineries and as a feedstock from methanol and ammonia. Johnson Matthey has leading catalyst technology in grey hydrogen with 40% segment share and our involvement is selling the catalyst for the process.

So now moving on to those cleaner technologies, both blue and green hydrogen. The process can be decarbonised or indeed made carbon-free. So you can capture the carbon dioxide from advanced gas reforming technology and store it in a process called carbon capture and storage, and this is blue hydrogen. Carbon capture in storage is a process for storing the vast quantities of carbon dioxide produced in geological formations often onshore using existing assets. It has been demonstrated at multiple sites globally, particularly in the North Sea over decades, and it's widely recognised as an essential technology if the world is to decarbonise. And as the market evolves with the energy transition, we are well-positioned as technology advances towards blue hydrogen production. We know this market well as we have an existing business, understand the customer base, we have strong relationships and the technology expertise to succeed.

So finally, you can also avoid carbon altogether by using renewable energy for electrolysis of water, and this is green hydrogen. Now the estimated costs of production today are higher for blue and green hydrogen but over time as these processes scale further and volumes increase, costs will be driven out quickly, and along with the implementation of carbon taxes, the economics will improve.

As we transition towards net-zero, the demand for energy across the world will not decline. If it's not hydrocarbon such as oil satisfying that need, then there will need to be something else carrying the required energy, hydrogen.

So when we look at the move away from grey hydrogen, it's not really a move away from grey hydrogen that we should be talking about but all the new applications that will require blue and green hydrogen. Of course, those applications that are currently using grey hydrogen today will transition to using blue and green, and this will take some time, most likely incentivised by carbon taxes. For example, BP's energy outlook is assuming carbon taxes rise from around $40 a tonne carbon dioxide emitted today to $100 a tonne by 2030 and $250 a tonne by 2050 for developed countries on a path to net-zero.

So on this chart, you can see a projection of how hydrogen volumes from the different production methods are likely to evolve over time and importantly we can see blue and green hydrogen are both playing key roles. Given the levels of greenhouse gas emissions, brown and grey hydrogen will not be viable solutions in the longer term for their existing applications, with structural increases and the cost of these processes, as they will likely be subject to carbon taxes and they're of no use, of course, at all for the new clean applications. Blue hydrogen will enable the transition towards the carbon-free gas system and remain established in certain geographies where it is the lowest cost option, and we'll go to more of that in our next slide. But ultimately, blue and green adoption will be driven by geology, infrastructure and the cost of renewable energy, and we're also likely to see incentives, particularly for green hydrogen where significant cost downs are needed.

Looking at this chart, you can see the extent of the required cost downs. Additionally, the adoption of blue and green will vary depending on region. For example, blue hydrogen is likely to be a long-term solution in places with the right geology and infrastructure, such as the UK and the US, where there is an existing natural gas infrastructure for the transport of hydrogen as well as depleted oil and gas fields and locations for carbon storage. Green hydrogen will be favoured in some regions more than others, for example, Australia. For wide-scale adoption, renewable energy and capital costs will need to decline.

So now looking at our blue hydrogen technology, as you can see from this schematic, our – we use two processes with a gas-heated reformer and autothermal reformer linked. The process is used in our existing methanol solution at scale, and we've been able to apply the technology to enable rapid deployment of a unique process that produces low-carbon hydrogen from natural gas. Our blue technology differentiates us from our existing competitors in a number of ways and a number of important ways. It's the most energy-efficient. It uses, for example, 9% less natural gas compared to steam methane reforming plus carbon capture to produce a kilogram of hydrogen. For a project the size of phase one of HyNet, which I will introduce in a moment, this will mean a saving per annum of around £6-7 million, and that's a project that tends to scale up by an order of magnitude from there.

We also have the lowest capital costs, 40% lower than conventional steam methane reforming technology with carbon capture. Our greater efficiency and lower capital intensity comes from clever process engineering, where we use heat as efficiently as possible and keep carbon dioxide in the process frame, so we don't have to capture it from the air. This all means that our process is easier and cheaper to decarbonise through carbon capture and storage and indeed, more than 95% of the carbon dioxide produced can be captured for use

or storage. So our existing capabilities have been vitally important in supporting the development of this leading technology, and I'll give some more colour around this in the next slide.

In grey hydrogen, we supply a range of catalysts, and today this business generates sales of around £60 million a year. This is recurring business, and the catalysts we sell are generally in sale for around three to four years before replacement. We have many years of experience in grey hydrogen, a 40% segment share and over 400 customers, including oil and gas majors and industrial gas companies. This underpins exactly why we can be successful in blue hydrogen. In blue hydrogen, our offering is much more comprehensive than in grey. We will supply the catalyst, engineering expertise, and we'll also licence the technology, which means the opportunity is larger for us, something I'll talk to shortly.

Our experience in this area is hard to replicate, and we've built on our expertise in grey hydrogen and in methanol to develop the best technology for blue hydrogen. When people spend hundreds of millions of dollars or indeed billions on new plants, this is at a massive scale, and people want to have the confidence that the technology will work. Customers get that confidence with us. They have known us in hydrogen for years, they've seen our commitment to developing blue hydrogen and seen similar processes in methanol working at huge scales. They also know that we will give them the support all the way through the process and guarantee some performance once the plant is running. This means that we expect to achieve a leading segment share. Customers will choose the best process, and by that, I mean not only that with the lowest technology risk that I've mentioned but also the most efficient and lowest capital cost. For example, one of the largest operating cost in the process is natural gas, so using 9% less than the equivalent process is a huge saving.

On the customer side, we're making good progress with both existing and new customers. Our technology is already starting to commercialise. It's currently being used in a number of projects, including the HyNet project and the Acorn Hydrogen project, which I'll come to in the next slide.

So HyNet is the hydrogen energy and carbon capture utilisation and storage project in the North West of England, and its establishment should create a low-carbon cluster in that region. HyNet's aim is to reduce carbon emissions from industry, homes and transport, and we're delighted to be involved in this high profile project, which will use our blue technology for the first time. This first deployment is an important milestone in demonstrating our leading technology at scale, and the initial plant is the first of multiple plants planned on that side. Phase one will produce 80,000 tonnes of low-carbon hydrogen for industrial and domestic customers, which is already equivalent to a world-scale hydrogen plant, and there are three more phases to follow. To give you an idea of the scale of this project, by the time all of these phases are complete, to produce the same amount of green hydrogen, it would require six times the energy of the world's largest offshore windfarm, so these are massive projects.

So HyNet chose us for three main reasons. Firstly, the technology risk is minimal. We use similar process technology in methanol, so it's already proven at scale, and we continue to invest in R&D to ensure we stay market-leading. Secondly, the economics are attractive. Our technology requires the lowest OPEX and is least capital intensive. And finally, we're a trusted partner to our customers; we have decades of experience and a strong reputation in

this space. We're also involved in a slightly smaller project in Scotland, the Acorn Project for blue hydrogen production from North Sea gas and that will also be based on our low-carbon hydrogen technology. And of course, we're working with a number of customers globally, and we have a strong pipeline of future projects.

So looking towards this low-carbon future, there will be a need for blue hydrogen, and we see a significant opportunity here. If we assume around 30% of the global hydrogen demand in 2030 comes from blue hydrogen, then the total market size accessible to JM would be around £1.5 to 2 billion per annum. Our opportunity is primarily through the licensing of our technology and the supply of engendering and our process catalysts. To give you a few more details, an average one-off fee per plant could be in the region of £50 to 60 million and this will of course vary and depending on projects and the size of those projects. Beyond that, a typical change-out period for catalysts is every three to four years, and this could be around £5 million per refill, so it's a very significant opportunity for us in 2030 and accelerates in the years beyond.

Moving on now to green hydrogen: What is it? Put simply; it involves splitting water into oxygen and hydrogen using electrolysis. So it's very similar to fuel cell technology, effectively the reverse of fuel cell technology in the process, and there are several types of electrolysers that can be used to make green hydrogen, the main ones being alkaline electrolysers and proton exchange membranes, or PEM electrolysers, which use precious metal catalysts. Alkaline electrolysers are more mature. The technology is more mature. They are typically used in larger continuous applications, and the technology is more commoditised, which isn't really where JM competes. The particular advantage for PEM electrolysers is that they can be scaled to the required size; they're very robust and non-continuous use applications, for example, when coupled to renewables such as wind turbines. PEM will also be more cost-competitive at scale. It's a new technology today, and there's plenty of scope of cost downs through, for example, thrifting out PGM content and scaling up manufacturing, something which JM can do very well. PEM electrolysers are a particularly good match for JM, as they use precious metal catalysts in a similar way to fuel cell technology.

So given the economics, this opportunity is slightly further off than blue hydrogen, but we are confident that we will be successful. PEM technology matches to our core science. It plays exactly to our strengths. Jo has just talked about our long heritage and expertise in fuel cells and given the strong similarities between fuel cells and PEM electrolyses, we're able to apply our expertise in this space. We have a competitive advantage in PGM catalysis in particular platinum and iridium chemistries are important for green hydrogen and our ability to optimise the yield of hydrogen per gram of noble metal is a core competence for JM.

We also know how to scale up this business, we've got experience of this from fuel cells and our PGM recycling expertise is also part of JM's DNA, which means that there is the potential to offer a closed-loop service to our customers, where we will design solutions from the outset that take into account end of life options. More importantly, we're experienced in enabling new technologies and have already started testing with leading electrolyser players, including a major global industrial company.

The margin for green hydrogen is big. We're already starting to see progress with a number of targets; for example, as part of the recently announced EU hydrogen strategy, Germany alone has committed to invest €7 billion in hydrogen-related businesses and research, and we

think the estimated addressable PEM market is in the range of 2-4 billion per annum in 2030. Given the strong overlap of fuel cells and our core science capabilities, we know we have the ability to succeed. We are well-positioned to bring new solutions to the hydrogen space and look forward to playing an important role in this energy transition. Back to Robert.

Conclusion

Robert MacLeod

CEO

Thank you, Eugene. Thank you, Jo. So to conclude. As legislation tightens and concern over climate change gains momentum, we believe that hydrogen will play a significant role in enabling the energy transition. And with such a key role to play across multiple sectors, investments in hydrogen-based technologies and associated infrastructure is accelerating. We already have an established and profitable fuel cell hydrogen production business today, and with our leading technology, we're uniquely positioned to benefit from what is very significant growth opportunity in a fast-growing market. Our opportunity in hydrogen is not an accident. It's founded on decades of experience and underpinned by our science expertise across the Group. We're proud of our role in enabling the transition to a global low-carbon economy. For us, the opportunities are broad but more importantly, it helps us to deliver our vision for a cleaner, healthier world.

So that's finished what we were going to present for the day, so now it's over to you for questions, so I'll hand over to the moderator first, and then we'll welcome your questions.

Q&A

Operator: Ladies and gentlemen, if you wish to ask a question, please press star and one on your keypad and wait for your name to be announced. If you wish to cancel your request, please press the hash key. Once again, to ask a question, please press star one on your telephone. Your first question comes from the line of Thomas Wrigglesworth from Citi.

Thomas Wrigglesworth (Citi): Hi, good morning, thanks very much for the presentation. I'll limit myself to two questions. However, I've got a lot of learning to do clearly. First question is around the alternative technologies. I think other companies have started looking at non-PGM-based exchange membranes. Could you maybe help explain, you know, why – you know, do they have any viability, you know, what is – what might change the landscape in that regards?

And then secondly, when it comes to – could you unpack a little bit of your addressable market from 2-4 billion in 2030? You've given some assumptions but, you know, what percentage of cost of, say, a fuel cell for 100KWs vehicle is – would be the PEM membrane? And similarly, an electrolysis of, let's say, 10 MW, what's the cost of the PEM membrane in a 10 MW electrolysis system, would be very helpful. Thank you.

Robert MacLeod: Thanks Tom and good morning. So let's go – Eugene with the first one and then the second one, I'll try and sort of, carve that out a bit to give you a bit of colour.

But, Eugene, the alternative technologies non-PGM related electrolysis –

Eugene McKenna: Yeah.

Robert MacLeod: – for green hydrogen.

Eugene McKenna: Thanks, Tom. So there are alternative technologies being discussed at the moment. They're at much earlier stages of development of technology readiness. In particular, there is a technology called AEM, exchange membranes. They work – at a simple level they work in a similar way to PEM electrolysis, but there's no requirement for platinum group metals. And so it is entirely possible as we go decades into the future that AEM technology may catch up with PEM electrolysis. I would say, however, that being expert at PEM electrolysis, we have positioned the company very well for moving through into AEM technology as that develops in the future.

Robert MacLeod: Okay, thanks Eugene. And on the addressable market, I think, Tom, you were asking a little bit about car, trucks, and also about green hydrogen. And if I just look at green hydrogen first, because that's I think still on the slide – maybe it is not on the slide anymore. So the £2-4 billion of addressable market is very much linked to the assumption that we made previously around the growth in the hydrogen market, which we showed on slide – I'll get the number in front of me in a second – on slide 19, which is the sort of terawatt-hours required for green – for hydrogen. And we had assumed, as have the Hydrogen Council and BP, a pretty much equal split between green and blue. So you can debate that, but that is the assumption that we used.

And then in coming up with the £2-4 billion market, we ranged that between, well, how much does PEM – what's the PEM share compared to the other types of technology, as Eugene referred to, the alkaline water technology? So at the lower end of PEM share as it says on the slide, assuming 30% share, then you end up with a £2 billion market opportunity, and as a 60% share you end up with a £4 billion market opportunity. So that's how we try to frame it on that. And you are talking around about any A-value ex metal conversationally, about $50 per kilowatt.

Now, on the fuel cell side, Jo, do you want to give a bit of colour on the fuel cell side on the kilowatt side, probably focussing on trucks, I guess?

Jo Godden: Yeah. Yeah, sure. So for 2030 for trucks, we see that penetration starts to happen with 5% of vehicles with a fuel cell platform. And the dollar – kind of the dollar per kilowatt there in trucks, in 2030, the cost downs are getting towards $25 per kilowatt, and this translates into an – the MEA of the fuel cell stack is about 30% of that stack, and you're getting towards £3,000, around that level, for the MEA component. And then the CCM, as we've put there on the slide 16, is around £2,500.

Robert MacLeod: Okay, Tom, does that give you enough?

Thomas Wrigglesworth: Thank you, yeah.

Robert MacLeod: Albeit there are no assumptions, of course, but, you know, that is what we expect the market size roughly to be. So thanks Tom.

Thomas Wrigglesworth: Most appreciated.

Operator: Your next question comes from the line of Alex Stewart from Barclays, please ask your question.

Alex Stewart (Barclays): Hello. Good morning, can you hear me?

Robert MacLeod: Yes, we can. Morning, Alex.

Alex Stewart: Hi there. Thank you very much for the presentation and all the information about the industry size. That's really interesting and helpful. You talked a lot about the addressable market and revenue opportunities. You haven't talked a huge amount about profitability or relative profitability and returns. Can you give us some sense of which of the various opportunities you talked about today is the most attractive in terms of the return on capital you can make and whether they all would satisfy at scale your 20% aspiration for the Group return on invested capital?

And then secondly, hopefully a simple question, your fuel cell component business today, which I appreciate is a small part of the Group, do you have any sense of what sort of share of the market you have? Do you think you are a minority player? Do you think you have a sort of decent portion of the new orders that come through or the new business that comes through? Any sense of that would be really useful. Thank you.

Robert MacLeod: Of course. Actually, to both of those – well, I'm going to ask Jo to answer the one on the fuel cell share. But on the return on capital and margins, look, I think both – all of these businesses, absolutely, we believe we can meet our target aspirations for a greater than 20% return on capital. The exact projection of margins and profit growth will obviously depend on how the market evolves. But they're relatively low capital-intense opportunities, particularly on the fuel cell side, because they're relatively low capital intensity, as Jo explained. And on the hydrogen side, particularly on the blue hydrogen side, we already have developed the technology and the process technology. And the catalyst that will go into those plants come off our existing lines that we already have of production capacities that we already have today.

So from a return on capital point of view, they should be attractive. I'm not going to give the relative attractiveness between the different opportunities, but they all are sufficiently attractive. Jo, do you want to talk a little bit about share?

Jo Godden: Sure. Sure. Look, as you know, we have a well-established profitable business in fuel cells today. And we have built our reputation over the last years really in emerging markets of non-road, and we have a 25% share in the material handling market. And now, we are really building significant momentum in automotive and that, you know, has grown to 25% of our business, and that's primarily been in China, which is very much the early adopters of MEA's that we are supplying onto buses and commercial vehicles, logistics vehicles in China. So that is where we are positioning, and we are securing more business in that sense all the time, which is why we have invested in our manufacturing facility in China. But it is an emerging market, and it is quite fragmented with different components in different parts of the value chain.

Robert MacLeod: I think, Alex, it's hard to give an absolute number for sharing.

Jo Godden: Yeah.

Robert MacLeod: I mean, we can give a number for share for the forklift truck market because that's more established. I think it's quite hard, particularly in China, to be clear about the exact share that we have, but it does feel like we have a meaningful share. So,

you know, what is meaningful? North of 20%, probably. But it's really hard to be precise about it.

Alex Stewart: That is really helpful, thank you. Perhaps if I could just answer that or ask it another way, do you feel like there is a lot of competition for the parts in the fuel cell, the MEA that you are manufacturing, or would this be a pretty consolidated market?

Robert MacLeod: Jo, do you have a view on that?

Jo Godden: Yeah. Well, there are not that many players in MEA at this time. And actually, we are really well-positioned as we're in lots of points in the value chain, as you saw in the slides. We're in the PGM; we're in the catalyst, we are able to coat and supply the membrane as well as through to the MEA. So that's a real opportunity to be working and collaborating as the market develops with our customers and tailor the performance of our products to their fuel cell systems.

Robert MacLeod: Thanks, Alex.

Alex Stewart: Thank you.

Robert MacLeod: Thanks for the question.

Operator: Your next question comes from the line of Adam Collins from Liberum. Please ask your question.

Adam Collins (Liberum): Yes, good morning. Thanks again, it's been very interesting. I have three questions, please, at this stage. Firstly, on the blue hydrogen opportunity, thanks for the details on the average value per project. I think you said £50-60 million for licenses and £5 million for catalyst refill values. Could you perhaps give us your sense on what the value opportunity then might be for HyNet if it scales to phase five? You suggest it's a very big project, but just to give us a sense for what it might mean on what looks like it's going to be one of your first and biggest opportunities.

On the MEA side then for PEM electrolysis, I know that's kind of quite long-term but would you be able to say whether the value per kilowatt in electrolysis is similar to fuel cell? Essentially, is it the same value proposition? I have heard it said that the value proposition is slightly less in electrolysis despite the fact the sort of technology play is the same.

And then finally, on PEM fuel cell, could you discuss what the likely role of captives is going to be in this equation. To what extent do you think that the OEMs themselves will be producing part of the value chain?

Robert MacLeod: Adam, nice to speak to you again. Thank you very much for your question, and I think you get the prize for being able to make it very easy for me to share the questions out. Three questions and I'll take one, Eugene takes one, and Jo takes one. So a prize for that. But we will start off Eugene with HyNet, maybe you can give an answer there.

Eugene McKenna: Yeah. I mean, I am quite comfortable with giving numbers for general plans. So then first, the HyNet phase one is about half the size of the plant that we give in the example size of £50-60 million for, and the refill size. And it is kind of public information how big plant has gone. Clearly, there will be commercial discussions about the exact size of that opportunity between us and HyNet. So that's that.

Robert MacLeod: Yeah, I think we cannot really give too much on that. So, I will answer –

Adam Collins: Okay, may I just ask just for a clarification? We know how big that project is in terms of production volume, but we don't know – when you talk about a typical project and the cell values, what is a typical project then in terms of blue hydrogen volume?

Eugene McKenna: So, HyNet's about 80,000 tonnes a year. The typical projects we've scaled to is about twice that size – 160,000 a year – which we think will be heading towards a typical working scale plant whenever this gets off at scale.

Adam Collins: Yeah. So your numbers are based on 160?

Robert MacLeod: So if you look at the – if you – when you do get the slides, Adam, if you look at slide 24, which is where we have the data, there is a little sub – superscript 1. And under superscript 1, you get based on an average plant size of 160 kilotonnes. So those are what our numbers are based on.

Adam Collins: Okay, that's helped.

Robert MacLeod: Okay. Now, on the – so the second question about the sort of relative values per kilowatt, I think we see, or we have based the numbers at least on slightly more value per kilowatt on the electrolysis MEA versus the vehicle MEA. And that is principally because the – it's a slightly thicker and more, you know, durable – it needs to be a more durable MEA in some respects, so therefore the membrane will be thicker and the coat – probably the catalyst layers will be a bit thicker, too. And as a result, the absolute value per MEA might be greater. So, we are talking about, you know, something like $50 per kilowatt for a green hydrogen MEA in 2025, going down to, say, $40 per kilowatt. And Jo's already said that we would expect $25 per kilowatt in 2030 for a truck. So those are the rough sort of numbers.

Adam Collins: Great.

Robert MacLeod: And that's how we have based – sorry, that's how we based our – the numbers that we presented to you. Now, so we are not warranting that those are going to be the absolute right numbers, but that sort of pathway that we expect to be going under.

And Jo, your question on the likely role of captives in the fuel cell market.

Jo Godden: Thank you. The early adopter OEMs that have been leading on fuel cell vehicles have certainly been doing a lot of their deep research, their learning and developing of the fuel cell system in-house, and that's been at the time when the supply chain is just becoming established. So it's always difficult to say what will happen over time in an emerging market, but we are certainly in a great position to start to work with those – well, we are working with those OEMs for business as the market starts to scale.

So, for example, if we're able to supply something that has better performance, improved durability, high quality for a competitive cost, then that's something they would really want to evaluate as they scale their business and require a broader supplier base. So what we're doing now is working with them, proving this to them, and it's the reason why OEMs and tier one customers want to work with JM, because they recognise the need for continual improvements and believe that we are well-positioned to do this. So there's lots of opportunity to colaborate and supply some or indeed all of our components.

Adam Collins: May I ask a quick follow-up?

Robert MacLeod: Of course, yeah, yeah.

Adam Collins: Is there a strategic or technical value in the fact that you do both the electrode and the membrane as opposed to just doing CCMs?

Jo Godden: Yes, there is. And as we're deeper experts really in these aspects from the catalyst, the ability to coat the membrane, placing those modules where we exactly want them. So this – we can really optimise those key elements that really give the durability and performance, as I mentioned in the presentation. So that structure of membrane together with how we coat the catalyst layers, and it all interacts really determines the performance. And that's where our capabilities really are and delivers that competitive advantage.

Robert MacLeod: And we absolutely think we have strategic advantage of the CCM, the catalyst-coated membrane. When you then go on to the MEA, which is where you're putting a seal in the gas diffusion layer, that's more about – what's the word I'm looking for? It's more about assembly, which is not where our competitive advantage lies. So whilst there might be more value in supplying an MEA, the real competitive advantage we believe is in the catalyst-coated membrane.

Adam Collins: Thank you very much.

Robert MacLeod: Okay. Thanks, Adam, for your questions. So, next please?

Operator: Your next question comes from the lines of Charlie Webb from Morgan Stanley. Please ask your question.

Robert MacLeod: Hello, Charlie.

Charlie Webb (Morgan Stanley): Morning. Morning everyone. Thank you very much for the presentation, some – definitely some insight in there – a few from me. Just first off, on blue hydrogen, just wanting to be clear. Is this all about new opportunities, as in there isn't really a retro opportunity for grey hydrogen where you already serve kind of traditional catalysts? Do you see is there any way you can upgrade or scale, or is this very much for new blue hydrogen plants? Just to clarify that.

Then just on green, kind of, circling back to, kind of – obviously, this is nascent, you guys kind of mentioned it, the technologies continue to evolve. How do you ensure – I mean, is this an area where you need to have partnerships with some of those other leading electrolyser producers, I guess, Hydrogenics, ITM? Is that where you need to form some sort of technology development partnership to ensure that your technology has a good chance? I mean, how do you kind of ensure that? Because it does feel like there is a lot of different paths being taken right now in terms of moving towards green hydrogen and how to scale it up. You know, just how you are thinking about kind of developing your product offering?

And then lastly, kind of tying it together, just thinking about the capital cost, the CapEx. I mean, you clearly see great opportunities across all three of these, kind of, production and on the fuel cell side. You know, how much CapEx do you need to put to work to continue to support the growth? Is there – is that kind of captured in what you're already planning today or are there changes here where you need to invest more to make sure you're positioned for this growth?

Robert MacLeod: Charlie, thank you for the questions. So start off Eugene on blue hydrogen, the new versus retro.

Eugene McKenna: Yeah. So the – these are new applications for hydrogen that we're interested in where it's being used as an energy vector at really high volumes, which is quite difficult to how grey hydrogen is being used. So there are benefits of doing this at large scale where your close to carbon capture and storage. A lot of grey hydrogen is small, inland close to end-markets. So, we think the hydrogen infrastructure will evolve in a different way over the next 20 years. And indeed, the grey hydrogen market is already transforming where traditional small plants are being replaced by larger, more efficient plants that then distribute their hydrogen down a pipeline network rather than building them like that.

So, I think that grey hydrogen will be replaced, but it won't be as simple as simply replacing an existing grey hydrogen plant with a new blue hydrogen plant.

Charlie Webb: And then, sorry, just a quick follow-up on that. Does that mean that when you think about these large hydrogen opportunities, therefore you are kind of more steered towards I guess opportunities methanol, ammonia, which traditionally I guess have been the larger world-scale-type hydrogen plants or is it, as you say, these – more the energy vectors? Just trying to get a sense, is it more industrial use or do you think it's more energy use?

Eugene McKenna: Well, it's the production of hydrogen at scale – at very, very large scale – either for distribution into – for example in HyNet hydrogen will go into the gas distribution network for domestic use. It'll also go into large industrial uses. It'll also go into transport. There are advantages in producing the hydrogen at very large scales. Typically, that 160,000 tonnes a year size would be a good world-scale to think about to get the efficiencies of scale there. But it'll go into all of those applications which are very different to where grey hydrogen is used today.

Charlie Webb: Okay, thank you.

Robert MacLeod: Okay. So on the green hydrogen, you're absolutely right, Charlie, it is nascent, and we are working with a number of the sort of – the suppliers of electrolysis at the moment. And how we exactly move this forward, I don't think we'll be doing it all ourselves. We will be working in, sort of, development partnerships and stuff like that. But exactly how this moves forward, we will navigate our way through. But, absolutely, I suspect it will be, you know, very much like the way we work in our existing businesses, which are, you know, working in partnership with customers because this is a technology solution and people will want their different – they'll want to work with us on the technology to develop it together.

And lastly, on CAPEX for all three. Well, I have mentioned that it is relatively low capital intensity in these areas. The – and in particular in hydrogen, we have the capacity at the moment for the catalyst production. And once you have developed the technology you don't need to put – you know, the licensing, you do not need to invest that, so that is not – and it's very, very capital-light business because it is a technology and people engineering business.

On the fuel cell side, the doubling of the capacity that we've just– we are close to finishing, we'll finish by the end of this year, cost us about £15 million, I think it was, Jo, to double our capacity from where it was before. And so, I think the ability to scale up; we can do that.

We did that project within less than a year. And so, therefore, the ability to scale up rapidly and at relatively low capital cost is there for us.

Charlie Webb: That's good. Thank you very much.

Robert MacLeod: You are welcome, Charlie. Thank you. Next please.

Operator: Your next question comes from the line of Sebastian Bray from Berenberg Bank. Please ask your question.

Sebastian Bray (Berenberg Bank): Good morning and thank you for taking my questions. My first one would be on the cost structure for blue hydrogen. Robert, you mentioned earlier a figure of about $40 per kilowatt for electrolysis. If I take your market share assumptions and accessible market sizes is it fair to say we're talking about roughly a figure of half of that on a per-unit hydrogen or per kilowatt basis for blue, so roughly $20?

And as a second question on that, is there any precedent for licences being quite as big or as valuable as the £50-60 million? I do have a third question on green electrolysis, but I'll pause there.

Robert MacLeod: So, Sebastian, thank you for your questions. I think – I'm not sure if I got your first question, could you repeat it again, please, because I think there were puzzled faces in this room?

Sebastian Bray: For a unit, let us say that if it is, all things being equal, Johnson Matthey providing the catalyst of the technology to make one kilogram of annual capacity of blue hydrogen worth roughly half of what it would get for the equivalent amount of green hydrogen capacity in an electrolyser?

Robert MacLeod: Crikey. I don't – can we come back to you on that one? I think we've looked at it in a slightly different way because we've – and I don't know if I have all the details per kilowatt.

Eugene McKenna: So, I guess I would say there's a slightly different way in which the revenue flows because there are upfront lump-sum payments to us in blue hydrogen at the start, followed by refill once every three to four years as things progress forward, which is a slightly different way things go in green hydrogen. However, it'll just be a straight – if you want a straight translation over the kilotonnes per year of hydrogen production will have a translation directly across into kilowatts and we can get that to you immediately after.

Robert MacLeod: Yeah. I think the translation we've used is roughly 40 kilowatts per kilogram of hydrogen. So – and that's a sort of, well used, sort of, rough range of value. So I guess I'd have to get my calculator out and work about 160 kilotonnes of it into terawatt-hours gigawatts and then compare that with the value for the green hydrogen. But, hopefully, your calculator will be better than mine, Sebastian.

Sebastian Bray: It's – I just was wondering perhaps in principle from revenue or profitability terms or maybe both would you prefer one unit of green or one unit of blue hydrogen?

Robert MacLeod: I do not think I look at it like that. I look at the opportunity, and I think the opportunities are good in both. The return on capital should be good for both. And I think with the offering that JM has, I think we could be competitive, and both of them could be attractive for us. I mean, if you think about JM and the way we operate, we operate in

niches. Our strategy is very much to operate in niches which require a technology solution. And the technology solution required for green hydrogen is around an MEA that works with thrifting the PGM content on that – in that system which allows us to capture value. And the same thing is true in blue hydrogen around the technology in the catalyst. If you can make a better catalyst, you can attract more value. And in both of them, I think they're potentially attractive markets.

Now, on the licensing question, Eugene, £50-60 million per plant, do you want to answer that one? It was around – have we seen something of that scale before and in that –

Eugene McKenna: So yes, we've seen plants of this scale for methanol. So, no blue hydrogen plants exist at the moment. So the plants using this scale of technology, our scale of technology, do exist where the final application is methanol. So, we are quite confident of the scale.

Robert MacLeod: So, I hope I answered your questions, Sebastian. Because as Eugene said, we don't have a – there are – at least no hydrogen plants at this scale don't exist at the moment.

Sebastian Bray: Understood. This is helpful. Thank you. My last question was on the electrolysis area. What exactly is it that Johnson Matthey can sell to the electrolyser providers that they themselves are not doing at the moment? And if you were to say, let's say, on a five-year view, is it likely that there will be any commercial sales to this area by 2025? Not as a matter of guidance, but just what is your gut feeling saying?

Robert MacLeod: So, I think the opportunity in green hydrogen is here and coming very rapidly. And it's incredible how it's evolved in the last 12-18 months and probably even arguably even six months. And there are a relatively small number of players here in the PEM market. What they'll be looking for is an MEA, so the membrane electrode assembly, exactly like they'll be looking for truck manufacturers and the auto manufacturers are looking for in – for their fuel cell stack.

So what we would be looking to offer is either the catalyst-coated membrane or, if some people wanted it, go further down to the MEA. But we think where we have competitive advantage would be the catalyst-coated membrane. And we are talking to, at the moment not all, but certainly some of the existing main players. And obviously, what we think we can offer is – and while they'll be attracted to is, is our deep PGM chemistry expertise and the fact that we've got proven track record in fuel cells because actually, the fuel cell for a truck is not that different from a fuel cell for a green hydrogen car.

Sebastian Bray: That's understood. Thank you for taking my questions.

Robert MacLeod: You are welcome, Sebastian. Do we have another question? We do. Next please.

Operator: Your next question comes from the line of Andrew Scott from UBS. Please ask your question.

Andrew Scott (UBS): Yeah, thanks.

Robert MacLeod: Morning, Andrew.

Andrew Scott: Yeah. Morning, Robert, and thank you for the presentation, and also to Jo and Eugene. I had a couple of questions. And first of all, I just want to check the methodology in the numbers. So very, very useful getting that overall view of your addressable markets in each of the three segments. Just checking that that is a revenue as is normal with JM. So it is ex substrate ex PGM content. So it's the revenue number that then you apply a margin to. So I just wanted to check that, first of all.

Robert MacLeod: Well, that's very easy, just yes.

Andrew Scott: Okay, perfect. And, sorry, just while we're on that margin application, I sort of got a sense from what you were saying through the presentation that the margin might be a bit above the average of the Group. I just wanted to check that that's right?

Robert MacLeod: So, I guess the question is – so in the medium-term or let's say longer term –

Andrew Scott: Yeah, longer-term.

Robert MacLeod: – the answer to that – then the answer to that absolutely should be yes. But, clearly, in the scale-up phase –

Andrew Scott: Sure.

Robert MacLeod: – it will be. But there is no reason why it should not be higher than the current average margins, yes.

Andrew Scott: Yeah, great. Thank you. Second question was entirely different; it was around the slide on autos and trucks. I'm just trying to work out the trade-off between your existing HDD franchise and the opportunity in fuel cells. I just want to check this maths with you, basically. Are we looking at a similar margin on the CCM business to HDD and therefore I just apply the multiple difference on the revenue line to get to my EBIT? So, in other words, about I think I am right in saying about three times the opportunity in trucks. I wanted to check that maths, please.

Robert MacLeod: So, I think you are absolutely right. At the moment we sell – I mean, it all depends on the size of the truck, of course. This number is based on, you know, the £2,500 is based on a sort of, 160-type kilowatt truck, so that's a mid-size truck rather than a large one. But if you look at our existing clean air business you are – you know, the catalyst content is about £1,000 – dollars. And this is going up to £2,500-3,000 per vehicle. So yes, a tripling. Exactly the margin structure, as you know, in clean air you've got obviously quite a significant substrate cost that we then coat. And so, I would hope that the margin in fuel cells should be better than the margins in clean air when you get to scale.

Andrew Scott: Yeah, sure. Perfect, thank you. And, sorry, I'm going to steal another one if I can. Just really a question around the development so far of electrolysers. It seems to be the common view, consensus thinking, that PEM is just the better model for the green hydrogen market because of some of the comments that you mentioned actually, which was obviously the variability of the grid and also the footprint. And yet the last two major contracts, the NEL contract with Nikola, the Saudi JV with Air Products and NEOM, they both use alkaline technology. I wondered if you can reconcile that, please.

Robert MacLeod: Well, the good news is I have got Eugene, who hopefully can.

Eugene McKenna: And so there is a great demand to move forward with decarbonisation and to produce green hydrogen, and the alkaline technology is currently the most advanced. So if you want to get a project on the go now, you can play to the strengths of alkaline. So you can do it at scale, work footprint is not a problem; you can connect it to a source of electricity which does not suffer from variability. You know, for example, hydroelectric, for example, where you get a standard flow of electricity or just connecting to the grid. So these will not be the mass deployments of green electricity, but you can find examples which will play to the strengths of alkaline. And given that it's more advanced than PEM at the moment, that's a natural choice for a demonstration plant at the moment to get you going.

Andrew Scott: Okay. So you are saying it is a scaling thing and a CAPEX per kilowatt thing at the moment.

Eugene McKenna: And technology readiness.

Andrew Scott: Yeah, and technology readiness. Okay, brilliant. I appreciate your thoughts, everybody. Thanks a lot.

Robert MacLeod: Thanks, Andrew. So next, do we have another question?

Operator: Yes, your next question comes from the line of Lucy Hancock from Bernstein. Please ask your question.

Robert MacLeod: Hi, Lucy.

Lucy Hancock (Bernstein): Hi. Hello everyone, and thank you for the presentation – very insightful, very useful. A lot of the questions I had have already been asked, but there are a couple of clarifying points that are still, sort of, outstanding from my side. So it's clear then from the MEA versus the CCM you think that the MEA is not exactly where your capabilities are; it's a less valuable part of the value chain—but just going forward then, because obviously the £33 million who will be MEA and CCM, are we to assume that the MEA is a much smaller part of that revenue, the £33 million? And then, therefore, going forward, you know, you've shared this estimate of £1 billion for just CCM. Is there an incremental revenue opportunity for MEA that's missing there or is it quite – is it much smaller given that you have not included it? That was the first question.

And the second question was around stationary – stationary use and stationary applications – around 50% of the revenue at the moment from the slide that you have shared, and we have not talked about that. Is that to assume then you don't see significant growth opportunities on that one?

And I will just sneak in a last third one on green hydrogen. Just is it possible, I again realise it is a nascent technology, are you able to share any of the equivalent, I guess, economics that you have for blue hydrogen, which is around the upfront CapEx the refill size and particularly the replacement cycle? So if you said three to four years for blue hydrogen does that, sort of, apply to green as well? Thank you.

Robert MacLeod: Oh, those were different questions. I guess, hopefully, as you say, we answered the rest of them well. But yes, Jo, do you want to answer the first two? The first one I think on MEA versus CCM and then on stationary?

Jo Godden: Yeah. Both it – just could you just say exactly that question in the first part again just so I get it precise to answer you, please?

Lucy Hancock: Sure. So £33 million if I understand is CCM and MEA that you saw through, and then you see that CCM is the higher value and, sort of, where it does have the most value. And you have given a number – a market size estimate of £1 billion, which is just CCM. Is there then an incremental market opportunity for MEA that we're missing?

Jo Godden: Well, in the current £33 million much of that we are going through to the MEA at the moment, just because most of those customers require that as they're developing really. And – but we've projected the CCM value going forward. That's where our core capabilities play but, we do add value to the MEA also, because we've got skills and technology in how we apply the seals, which is also complex, but it's more than assembly than the real smart and the chemistry that goes into the – and the talent that goes into producing the CCM. So there is more incremental value on that £1 billion. And the – in an MEA, about 80-85% of it is CCM in value.

So going on to the second point around stationery, stationery was a market that certainly was emerging, so we have had a longer history there with the catalysts and products that we have sold into that market. But we don't see the trajectory of growth in stationary. We also have our customer base there and look for opportunities, but the real growth as you see from the vehicle figures that will start to adopt fuel cell technology, particularly in trucks, is where the really exciting place to play is for us, and it plays to our strengths, and we're well connected to that market.

Robert MacLeod: Okay. Thank you, Jo. And, Eugene, do you want to answer the question about equipment size?

Eugene McKenna: Yeah. I mean, we've – in green hydrogen, we've looked at the model of supplying MEAs, and charging for the MEAs, and we see those – a typical value for when we would expect those to be changed out would be about once every five years and that will be for either green performance but also there is going to be such quick technology development here, and after five years the new MEAs that are available are going to be so much better that people will have to change them out to get more performance out of the equipment.

Robert MacLeod: Does that answer your question, Lucy?

Lucy Hancock: Yes, that is really helpful. Thank you. Thank you very much, all.

Robert MacLeod: Thanks very much, Lucy. Do we have any more questions?

Operator: Yes, your next question comes from the line of Chetan Udeshi from JP Morgan. Please ask your question.

Chetan Udeshi (JP Morgan): Yeah. Hi, thanks, a couple of questions. Firstly –

Robert MacLeod: Hi, Chetan.

Chetan Udeshi: Hi. Hi. Just based on my understanding it seems in clean air catalyst market, you know, outside of Toyota, maybe everybody else uses, you know, merchant products from JM, Umicore, BASF etc. Is that going to be the same you think in the fuel cells market? We hear JM talk a lot about their own proprietary fuel cell technology which they are now going to license to Nikola. So do you think the sort of, captive involvement could be

similar or higher than what we see in the clean air catalyst market? That's the first question. And the second question on the PEM electrolyser market. I acknowledge that it's a small market, but I am curious why is it not involved in with any of the existing whatever small-scale projects that might be going ongoing on the PEM electrolyser side? Is it just a maybe lack of – you know, maybe you guys did not focus on that market in the recent years and just because now it's getting bigger that is increasing in focus? And if you can – are the comparators for PEM-CCM similar to what you have in the future as well? Thank you.

Robert MacLeod: Okay. Thanks, Chetan. Jo, what would you say about the captive market and how that's going to evolve?

Jo Godden: Yeah. Well, as we talked a little bit earlier around the captive market and the early adopters, and it is still an emerging market, and they will – those OEMs developing early generation fuel cell systems, and as you talked about the clean air catalyst, similar players in that market also are in fuel cell catalysts. Indeed, we have leading fuel cell catalysts, but we are able to optimise the catalyst – the anode and cathode layers, the membranes to get to the CCM, we're also completely in control of that performance and the costs along that supply chain because we are – we're putting those materials together. So, we're very well placed to support the roadmap where R&D is targeted to get along the path to cost down. We talked about the thrifting and the efficiency in automation, and these all come together to be more competitive. So it will – there will be elements where some stays captive. But as this market really scales the best technology working in collaboration in the way that we do with OEMs and tier ones will be – we'll have a really good place, and this is where our capabilities are in this.

Robert MacLeod: And I think if you look at the fuel cell market – not the fuel cell market – sorry, the clean air market, I guess two years ago, a lot of people did their initial research in-house. But then as the market developed, they went out to the market as it scaled.

Jo Godden: Yeah.

Robert MacLeod: And I think we expect a similar thing to happen here. Eugene, do you want to answer about why not now? Why aren't we there for existing customers?

Eugene McKenna: Yeah. So, I think it is probably fair to say that there is not current supply chain for CCMs for green hydrogen and for electrolysis. The interest has absolutely exploded at the moment, and there is a commitment to put a lot of capacity down on the ground in the next five years and then in the next ten years. But that supply chain has not yet developed. Lots of people, the OEMs – some OEMs are making CCMs artisanally themselves at the moment. It's absolutely not their – something they are actually interested in doing because they are in the business because they are good at other parts of the electrolyser. So, I think this is a market that is forming right now. And I think we're very well-positioned right now. I think the time is right. I do not think we're late. I think the time is right for us to increase our efforts in this area right now.

Robert MacLeod: Thanks, Eugene. Thanks, Chetan. Next.

Operator: Your next question comes from the line of Maggie Schooley from Stifel. Please ask your question.

Maggie: Morning everybody, I have three quick questions as well if I may? The first, can you give us an understanding of the PGM loading of a PEM fuel cell stack for an FCEV versus, for instance, what you would have in a typical catalytic converter with an LDV or HDD? That would be the first, to have an understanding of how that plays into PGM Services.

And the second question was within CCM coating is obviously the key. Can you give us a little – some indication of are you using high-speed ink printing or plasma technology to better understand how you can produce this at scale?

And then the last question, apologies, is when we talk about the flow sheet for low-carbon hydrogen and the capital costs does that include the air separator unit as well or is that outside of that 40% reduction in capital cost? Thank you.

Robert MacLeod: Okay. Maggie, those were good questions. That's a euphemism for Robert can't answer them, so if I take your details. Jo, PGM loadings of an MEA versus or CCM versus, say, a catalyst?

Jo Godden: Yeah. Well, they're in the region of four, five, six times depending. It depends on the type of vehicle to an emission control catalyst.

Maggie: Okay.

Robert MacLeod: So that's an aggregate for the vehicle, not on a single MEA. Because there are how many MEAs per on a sort of, 80-kilowatt car? It's –

Jo Godden: 300 or so MEAs.

Robert MacLeod: Yeah, exactly.

Maggie: So, 300 per vehicle. Okay.

Jo Godden: Yeah.

Robert MacLeod: And the second question was about how do we coat a CCM – without telling our competitors how we coat?

Jo Godden: Yeah. Well, we have learned a lot over the last 20 years to be really good at coating – and longer really because we coat our substrate. It's core to our technology in Johnson Matthey and part of our core science. And I mentioned that we've got a very clear R&D roadmap of how we are continuing to develop our manufacturing technology and to get to the most efficient processes to be able to deliver on the target costs and total cost parity of ownership parity for this market to really establish itself in the future.

Robert MacLeod: Okay. Thanks, Jo. And, Eugene, the flow sheet for the low-carbon hydrogen, the extra units.

Eugene McKenna: It's 40% cheaper for the total capital cost of the units required to produce the hydrogen. The major saving is in carbon capture and storage where because the carbon dioxide is produced at high pressure, you need a much lower carbon capture storage unit to capture the carbon. So that's where the real big hit comes in capital costs.

Maggie: Okay. Thank you so much. I appreciate the answers.

Robert MacLeod: Not at all, Maggie. Thank you for the questions. Next – do we have another question?

Operator: Yes, your next question comes from the line of Sanjay Jha from Panmure Gordon. Please ask your question.

Sanjay Jha (Panmure Gordon): Thank you. Thank you for taking my question. Most of my questions have been answered. I just have a couple of questions if I may? I wondered if some of the bus and truck manufacturers are experimenting with solid oxide fuel cells probably more as a range extender with batteries. Do you have any sort of thoughts how is that as a technology and whether you see that as a threat to your PEM-based technology? And, secondly, on the – on PEM, I wanted to check is the purity of hydrogen really key? I mean, what I'm just trying to see – is green hydrogen – is that key where – is that an important way to produce high-purity hydrogen because I understand PEM needs kind of much purer hydrogen.

Robert MacLeod: Hold on. So, thank you, Sanjay. Jo solid oxide versus PEM fuel cells?

Jo Godden: Yeah. Well, certainly, you're right that the range extenders on buses and trucks in China were a way of demonstrating fuel cell technology. But this really doesn't have the durability in the automotive application to be a long-term solution. That is where we are really starting to see the PEM technology take root in automotive. It gets us to the high kilowatt-hours of power, it gets us to long hours of cycle time on a fuel cell system, and we're getting to those levels where you get a million miles out of a truck. So it wouldn't – it's not a suitable technology long-term for the fuel cell automated market.

Robert MacLeod: Okay. Thank you, Jo. And on PEM and the purity of hydrogen.

Eugene McKenna: So, PEM does produce – has the capability to produce hydrogen at much higher purity levels. And also, another advantage is it can produce it the pressure, which can be very useful if you are trying to store the hydrogen as well, unlike alkaline water. And how important that purity is depends on how you're getting it to its end application. So, for example, at HyNet the gas going into the grid are being mixed with all sorts of other things. So typically, hydrogen is brought to the purity required for the end application by purification just before that application. And so, for example, there will be plants built where the application is right beside the production of hydrogen when the purity may be very useful indeed. However, if it goes into pipelines, then that final purification step is where things will be adjusted to the needs of the end application.

Robert MacLeod: Does that answer your question, Sanjay?

Sanjay Jha: Okay.

Robert MacLeod: Good. Okay. I think we've got three more questions. And – next?

Operator: Yes, your next question comes from the line of Ranulf Orr from Redburn. Please ask your question.

Ranulf Orr (Redburn): Hi. Morning all or just afternoon, just one question left for me. And I'm just wondering about, you know, potential benefits in adjacent businesses in ENR, and I'm thinking about the use of ammonia as a sort of transport medium for hydrogen. And I think you have a license business there. And so I guess the question is, do you see any uplift or benefit to your ammonia licence business from a hydrogen economy as well? Thanks.

Robert MacLeod: Good. Eugene, you can probably answer that one.

Eugene McKenna: So, we are also global leaders in ammonia. There's lots of synergy between the technology that we are developing for blue hydrogen and our ammonia and methanol businesses. It is one of the reasons why we think we'd be good at blue hydrogen and why we think we are a good owner for blue hydrogen. No specific link into our existing ammonia technology from blue hydrogen, but we are very interested in the fact that ammonia could be a carrier for hydrogen-based energy.

Robert MacLeod: And I think when we talk about the opportunities for the rest of the Group, for green hydrogen as well as fuel cells, etc, I mean, we talk about a catalyst-coated membrane where you have to make the catalyst first, and that is part of our – so to make the catalyst, you need the PGMs. And to make the PGMs, if you have got recycled PGMs then you can go to your customer and say not only are we giving you a product which has zero emissions at the tailpipe but also, or in – or if you are generating hydrogen through electrolysis – but also the embedded carbon through the PGMs that are going into the manufacturing process are very low. So that integrated capability that JM offers, not only around the technology associated with PGM catalysis and what we know there, but the recycling and all the other ancillary benefits of being part of the integrated JM Group is why we think that JM is not only well placed to play this area, but I would go further and say uniquely placed. So, I think there are lots of opportunities for the broader Group that this – these opportunities derive.

So thank you for your – did you have another one or is that –

Ranulf Orr: No, no. I was just going to say thanks for the answer.

Robert MacLeod: You are very welcome. Next?

Operator: Your next question comes from Nicola Tang from BNP Paribas.

Nicola Tang (Exane BNP Paribas): Hi everyone. And actually, Robert, thank you, you just touched on my question a little bit just then. And I wanted to talk a little bit more about this closed-loop offering that you mentioned a bit because I'm thinking that could be, you know, one area of your competitive advantage versus any new entrants as you adjust to the flagging. I was wondering if this is something that comes up in your discussions today with either existing customers or potential customers and at what point – or at what point should we start thinking about closed-loop in fuel cells, so thinking actually about recycling fuel cells? Thanks.

Robert MacLeod: Jo, do you want to talk about what actually the customers are saying to us at the moment?

Jo Godden: Yeah. Well, certainly, the customers – or the big – the major truck OEMs are obviously very, very interested in a sustainable supply chain and where the raw materials are coming from. So the fact that we've got these capabilities and we're developing even further in recycling and being able to provide a secondary metal rather than a primary, because, as I think I mentioned in – earlier in the presentation, there's a significantly lower carbon footprint associated with secondary PGMs. So it is definitely – you are right, this is definitely a differentiating, and we've got the skills within the organisation to really optimise that.

Robert MacLeod: So, I think what we're seeing at the moment – if I contrast this with battery materials, where maybe a couple of years ago, when we were talking to customers

about battery materials, were they really talking about the embedded carbon within the battery materials? Not really. They were talking about cobalt and where cobalt came from, i.e., the artisanal mines in the DRC. But now, they really are talking about the whole embedded carbon within the whole supply chain and really driving that down. And that's particularly true with the Western OEMs, the European and the American OEMs, less so for the Chinese OEMs. So, certainly, we would expect that trend to absolutely happen in this space as well. And we would – we absolutely believe having that closed-loop offering, and the ability to offer low-carbon – low embedded carbon PGM on to a – into the generation of a fuel cell and/or a MEA to go into green hydrogen production will be a competitive advantage and something that we should be able to extract some value for.

Nicola Tang: Great, thank you.

Robert MacLeod: Thanks, Nicola. Next?

Operator: The final question comes from the line of Jean-Baptiste Rolland from Bank of America. Please ask your question.

Robert MacLeod: Jean-Baptiste, you get a prize for being patient.

Jean-Baptiste Rolland (Bank of America): Hi. Hi, Robert. Thank you very much for taking my question, a lot have been – has been answered already. And I know – I appreciate the focus today is really on hydrogen, but I would like to know if you could elaborate a little bit further maybe on where you see in the transportation sector your technology for fuel cell articulating with battery materials. Because given your current investment in ELNO I guess there are probably some synergies that you can extract between the two products for the power train and any vision that you have around where this power train is going would be really helpful if you could share it. Thank you.

Robert MacLeod: So, I think they are very complementary, the capabilities and having both skills. But to be clear, I don't actually think that the customers are going to come to you because you can do both. I think you have to have the best battery capability and technology. So the cathode material needs to give the right level of energy density at the right level of cost at the right level of longevity and performance. The same is absolutely true on the fuel cell technology and the MEAs or cathode coated membranes going into that. Because by us – I do not think being necessarily, you know, the one-stop-shop being able to supply battery materials and fuel cells are necessarily going to help. But understanding the customer's demand; understanding what their particular requirements are will allow a degree of complementarity that will help, but you still need to have the best technology. And being the best average is not good enough. Because you might be – you've got to have in each application the best and that's what the customers buy. But there is a complementarity to it.

Having said that, as we talked about, we do expect that in fuel cells, the first push will be in heavy-duty applications, so trucks and buses – long-distance buses. Whereas, obviously, as you know, the first push for battery materials and the battery market is battery electric vehicles which is a different application.

Jean-Baptiste Rolland: Okay, makes sense. Thanks very much.

Robert MacLeod: Very good. Are there any more questions that have been added at all?

Operator: We have no further questions. I'll now hand the conference back to Robert for closing remarks.

Robert MacLeod: Well, look, thank you very, very much, indeed, for joining today. I hope you found today helpful and you got a bit more insight on, firstly, the hydrogen market itself, but also, JM's position in the market and why we are so excited about the opportunity, which has evolved very rapidly over the last few years. For those of you who have followed JM for a long time, you would know that we have been in the hydrogen market for many, many, many years; not just in the hydrogen production side that Eugene talked about, but also in the fuel cell business. And we've had optimism and encouragement about the fuel cell market for many years. But it does feel very much like its time is coming now. And in many ways, the fact that we are starting to see penetration into China now, and lots and lots of interest in Europe and America is really exciting. So, I think we're very well placed and we're very excited about the opportunity and excited to share it with you.

And so with that, thank you very much for listening. I'm sure we'll see you all again over the coming months, and we'll happily give more answers to your questions, as I'm sure you'll have them over the next coming months. And please feel free to call Martin or Louise or Jane in the IR team if you've got any further questions.

So thank you very much for listening and see you again soon.

Operator: That does conclude our conference for today. Thank you for participating. You may all disconnect.

[END OF TRANSCRIPT]