# SUSTAINABILITY IN THE TRANSPORTATION AND INDUSTRIAL SECTORS AND A LOOK AT KYMERA INTERNATIONAL'S COMMITMENT TO ENVIRONMENTAL, SOCIAL, AND GOVERNANCE (ESG)

**Barton White***

*Vehicles today are powered either by an internal combustion engine, an electric motor, or a combination of the two. What happens in the future is being written today by global pressure to reduce greenhouse-gas emissions. The auto industry is the "low hanging fruit" because emissions from cars are well documented and there are alternative technologies available to replace gasoline engines. The goal is clear, if you reduce greenhouse gases, preservation of the planet (i.e., natural resources) is possible, which goes well beyond cars on the road and is being addressed throughout the manufacturing, commercial, and private sectors through alternative fuels and renewable energy. It is certainly not possible to review all the technologies available to reduce greenhouse gases, but I will review the common (and in my view the most promising) ones as well as how Kymera International, a leading specialty material company, is approaching sustainability from several different angles.*

Car manufacturers and the Environmental Protection Agency ("EPA") are all-in on battery electric vehicles ("EVs" or "BEVs"). Over the past two years, all major auto manufacturers have effectively come out in one form or another with their commitment to the EV space. In April 2023, the Biden administration proposed its toughest regulatory limits on automobile pollution, in that, by 2032, two thirds of new vehicles sold in the U.S. will have to be fully electric.[1] This is quite a statement/mandate considering that while the sales of EVs have increased dramatically, it is estimated that in Q-1 2023 EV share of new car sales was only at 7% (and this was a record high).[2] In 2021 General Motors announced its plans to phase-out and aim to sell only EVs by 2035.[3] I am sure they chose their words carefully. "Phase-out" and "aim" can be interpreted as best efforts and not a guarantee. After all, how could they guarantee this bold strategic move when there are so many factors that will come into play over the next decade.

So, what exactly must happen for the Biden Administration's 2032 directive to be realized? A lot! The idea makes sense, the reality is quite different. But before we delve into the issues around making the EV mandate a reality let's take a quick trip down memory lane and how we got to the EV phenomenon.

In the late 1970s emission control was garnering some attention, but it wasn't exactly a newsworthy topic. However, the U.S. Clean Air Act of 1970 pushed manufacturers to change from leaded to unleaded fuel and add an

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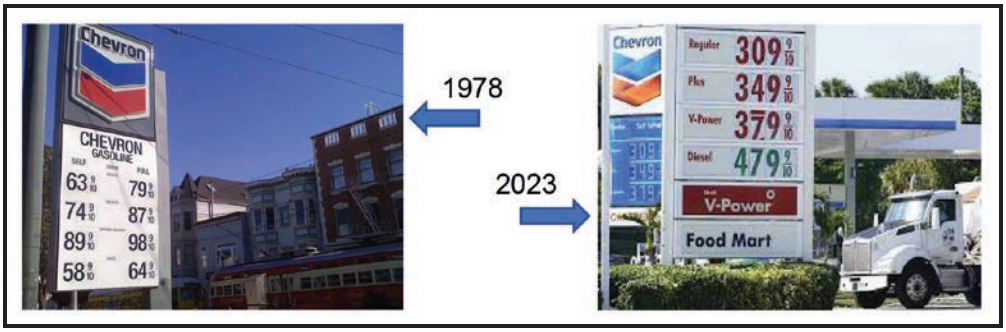



***Figure 1.*** *Comparison of fuel prices—2023 vs. 1978*

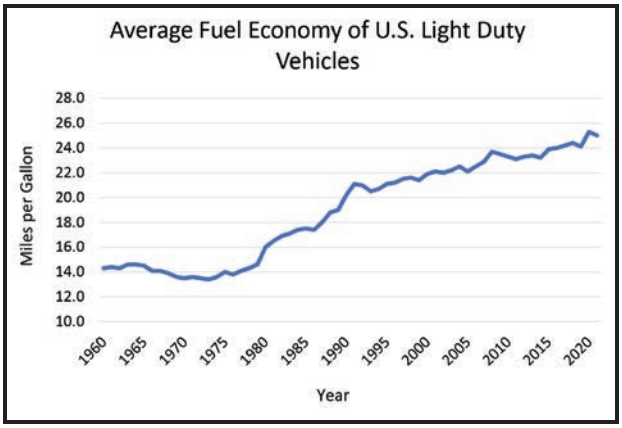



***Figure 2.*** *Average fuel economy of U.S. light-duty vehicles. Source: U.S. Energy Information Administration and the Bureau of Transportation Statistics*

emission control exhaust device known as the catalytic converter. The price of fuel in the late 1970s was ~$0.65/gallon, which in purchasing power translates to ~$3.10/gallon today, meaning that the price of gas has not really changed much in the past 40-plus years (Figure 1).

Considering that the fuel economy in cars has improved considerably (Figure 2), the cost to operate a car has gone down and the emissions from each vehicle have decreased. The problem is that in the 1970s there were approximately 125 million cars on the road in the U.S., whereas today the number is approaching 300 million. More cars on the road, more tailpipe emissions.

The 1973 fuel crisis in the U.S. accelerated the development of the compact and subcompact car and was instrumental in many owners changing to foreign cars as the U.S. auto manufacturers were still focused on larger vehicles, and their smaller versions were priced significantly higher than, for example, their Japanese counterparts. While compact and subcompact cars have grown in popularity in the last several decades, many Americans are still drawn to larger vehicles. The introduction of the sport utility vehicle ("SUV") in the 1990s took the U.S. by storm. This significant change in the consumer buying pattern towards SUVs did not help to improve fuel consumption and resultant emissions issues continued.

With more cars on the road, even if they are more efficient, the amount of $CO_2$ emitted to the atmosphere is growing. Whether or not you think that humans are contributing to climate change, my hope would be that most Americans believe that reducing greenhouse gases ("GHG") is a good thing. This does not mean we have to switch to EVs as there are plenty of other alternatives we will discuss later; but air pollution from cars is real. According to the EPA 65% of global greenhouse gases are related to $CO_2$ emissions. When you break down the $CO_2$ emissions by sector (Figure 3), transportation leads the way. In 2021 the EPA estimated that in the U.S. 6,340 million metric tons of $CO_2$ equivalent was emitted to the atmosphere and transportation accounted for 28% of this, or almost 1,800 million metric tons. Now, transportation is not only cars, as it also includes trucks, trains, ships, and airplanes. The largest source of transportation related $CO_2$ emissions is from vehicles on the road (cars and trucks).[4]

It is easy to understand why regulators have targeted the auto sector; not only because it is a large contributor to greenhouse gas emissions, but more importantly,

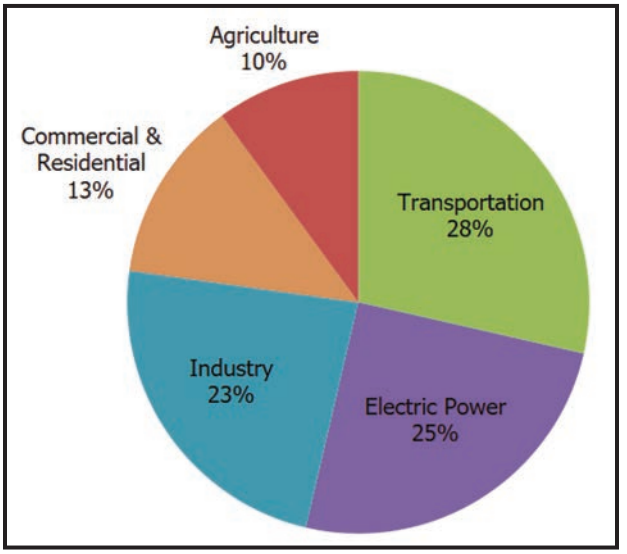



***Figure 3.*** *Percentage of U.S. greenhouse gas emissions by economic sector in 2021. Source: EPA*

there is an addressable solution. While airplanes cannot go electric, cleaner fuels are being used today and research is ongoing to reduce greenhouse gas emissions from air travel further (discussed later).

Now back to the issue at hand and what is challenging the EV world meeting the 2032 mandate. In my view there are two key elements to achieving zero tailpipe emissions successfully; namely the battery and the infrastructure to support charging.

### *Batteries*

We are probably most familiar with the lithium-ion battery that contains (among other materials), lithium, cobalt, graphite, and nickel. To meet the EV demand in the next decade, it is estimated that almost 400 new mines will have to be developed.[5] Considering the time (minimum five years) and the cost, this is no small feat. Because of their high energy density relative to weight, lithium-ion batteries can be smaller than competing technologies. There are serious concerns that there are simply not enough resources on the planet for certain materials to sustain the continuous demand that the battery requires, or the cost to extract them is prohibitive. There are other issues such as where and how the materials are mined.

More than 70% of the world's cobalt is mined in the Democratic Republic of the Congo ("DRC"), a country riddled with violence, corruption, and child labor (largely found in artisanal and small-scale mining)–Figure 4.[6] Human rights groups have been trying for years to improve the conditions in the DRC, but with limited success. In November 2021 a report came out that widespread worker exploitation, violence, and employee rights abuse was prevalent at five of the largest cobalt mines in the DRC.[7] Demand for cobalt is expected to increase by over 100% by 2030 and so a long-term dependance on the DRC is inevitable.[8] Automakers, including Tesla are working to reduce and perhaps eliminate cobalt in their batteries, but this is no easy task.

According to U.S. Geological Survey, there are an estimated one million tons of cobalt resources in the U.S. (the largest being in Minnesota). However, it is not currently economically viable to extract the metal. Additionally, there are more than 120 million tons of cobalt resources identified on the ocean floor.[9] To put this in perspective, in 2022 a total of 190,000 metric tons of cobalt was mined globally. The mining in the U.S. could be done with strict adherence to environmental, social, governance ("ESG") guidelines and lessen the dependence on foreign sources. It would also help control raw material prices, which would drive down EV costs.

In addition to the challenges surrounding the mining resources required as well as the cobalt troubles, the price of lithium is a major area of concern. Prior to 2017 the price of lithium (battery grade lithium carbonate) was relatively stable at around $6,000/mt. From 2017 to today the price has gone as high as ~$85,000/mt (2022) and to a low of ~$25,000/mt (2023).[10] This extreme volatility is concerning and begs the question; will we be held hostage to the price of lithium in the future as we are to the price of oil today? The price of lithium is not the only potential headwind facing the metal as, according to a Columbia University report in January 2023, mining of lithium can have negative effects on the environment, including using large quantities of water (extracting one tonne of lithium requires approximately 500,000 litres of water), creating mineral waste and other related pollution and health concerns (Figure 5).[11] Of course, researchers are working hard to find alternative battery formulations to lessen the dependance on lithium, including those based on sodium and fluoride-based ion technology. However, China is leading this race (by far) and so even if successful, it will further increase the U.S. dependance on China.

Disposal of batteries is currently an environmental nightmare that includes the release of toxic fumes and heavy-metal soil contamination. There is a tremendous amount of work being done on recycling batteries,

***Figure 4.*** *Child labor in the DRC. Source: CBS News*

***Figure 5.*** *Brine pools and processing areas at SQM lithium mine in Chile. Source: mining.com*

which would lessen the dependance on mining (ever so slightly) but could prove to be a huge opportunity from a business, environmental, and cost perspective. The two main ways to recycle metals are through pyrometallurgy (burn off non-metallics) and hydrometallurgy (using chemical methods after the batteries have been shredded). These processes are not particularly efficient, cost effective, or clean, which is why so many start-ups are investing in new technologies, because if they are successful there is a huge potential payday down the road.

While the auto industry has already publicized their intention of (largely) switching to electric vehicles, EVs pose social and environmental problems. As described earlier, there are real concerns surrounding raw material availability, ESG concerns in the DRC, and in the mining of lithium.

Zero tailpipe emissions will improve the environment but moving from gasoline-powered vehicles to fully electric is not as clean as most realize. Mining of the metals for the battery production emits roughly the same amount of greenhouse gases compared with oil drilling, and the production of electricity itself can be a contributor to GHG, especially if said production is manufactured using fossil fuels. Accounting for the mining and refining of the metals as well as the contribution from electricity, the amount of $CO_2$ emitted from production of EVs is higher than for a conventional gas-powered vehicle.[12] However, when you combine production and operation of the vehicle, EVs are still by far the winner when it comes to reducing $CO_2$ emissions.

### *Infrastructure*

We all have experienced driving down the highway and looking at the fuel gauge and saying, "I can make it to the next exit". While a few years ago a long trip with an EV seemed impossible, today, there are approximately 140,000 public charging stations in the U.S. and in 2022 that number increased more than in the last three years combined.[13] As a comparison there are more than 145,000 petrol fueling stations across the U.S.[14] Does not seem so bad right? Well, it comes down to charging time and the type of outlets equipped at the stations. For me, time is the key point.

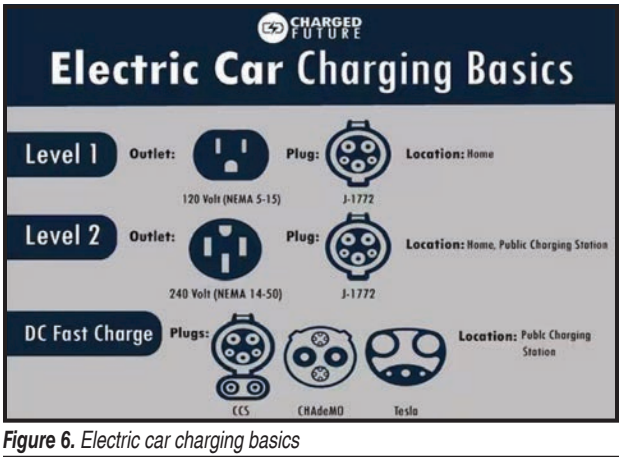



***Figure 6.*** *Electric car charging basics*

There are three types of charging outlets (Figure 6): Level 1 outlets will take the longest to charge (40-50 hours) and so I would guess that most people would prefer a Level 2 (similar to a dryer outlet) installed at their home where charging to 80% capacity can be done in 5–10 hours. Level 3 chargers are based on DC (direct current) and cannot be installed at your home. These Level 3 rapid chargers can accomplish your needs in under one hour. Unfortunately, out of the approximate 140,000 charging stations, it is estimated that there are less than 21,000 level 3 chargers in the U.S. (10,000 of them added in 2022).[15] So, having all these Level 2 chargers available today just off the interstate, does not make a whole lot of sense. Even with Level 3 it will take 30 minutes–one hour to charge your car; imagine waiting in line at a gas station for that long! And of course, charging it is not that simple. As a battery charges and gets closer to full capacity, charging slows down to prevent battery damage. This is why it is recommended to only charge to 80%, which means the distance you can travel is reduced by at least 20%, because you would not want to get close to zero charge. Also, we all know from our experience with rechargeable tools, that over time, as the battery ages, charging times will increase. Other factors affecting charge time are outside temperature, the type of battery and the age of the car. To put this all into perspective it is estimated that by 2030 over two million Level 2 chargers and close to 200,000 Level 3 chargers will be required.[16] The Biden Administration has committed to using federal funds to pay for the installation of 500,000 chargers at an estimated cost of $7.5 billion.[17]

Over the next several years charging and battery technology will improve and there likely won't be as many Level 2-types installed, but until we really see improvements in battery and charging technology, I am not quite ready to take the plunge into full-electric.

### *Is EV really the answer? Toyota does not think so!*

Toyota, the largest car company in the world, has taken a super interesting strategy on EVs. They are quoted as saying, "some people will not purchase an EV until every gas-powered car on planet earth has been confiscated or crushed".[18] Instead, they say they will enjoy making profits while investigating all solutions around carbon neutrality, while other large car companies lose money and invest heavily in the EV space. While developed countries will largely adopt EVs in the next decade, underdeveloped countries will take significantly longer,

creating a huge market opportunity for Toyota.

Most countries/regions have set mandates around banning or phasing out internal combustion engine ("ICE") automobiles by 2030. However, while the two largest global markets for cars, China and the U.S. have committed to increasing the amount of EVs on the road, they are not mandating the complete removal of ICE powered vehicles.

Toyota believes that hybrids, hydrogen-fueled cars and improved ICE cars are the way to go, but they are keeping all of their options open.

### *What else can we do?*

In most industries first mover status is often the winner and there is no doubt that electric vehicles have a huge head start over competing technologies. ICE supporters will note, however, that significant improvements to the combustion engine (including eFuels, discussed later) are ongoing with (for example) Toyota and Mazda producing engines with thermal efficiencies—a measure of the percentage of burned fuel an engine can convert to propulsion—in the 41% to 42% range. As CSP Daily News reports, this compares with a more typical high of 20% and a low in the 30% range. Other technologies/methods such as turbocharging, weight reduction, improved aerodynamics, and cylinder deactivation (the engine shuts off fuel to a portion of its cylinders when they are not needed) can significantly improve fuel efficiency.[19] And so it may just not be the time to give up on the internal combustion engine, and a combination of ICE and EV may be the best compromise.

Hybrids and Plug-in Hybrids

The U.S. Department of Energy quotes the following data (Figure 7) when it comes to $CO_2$ emissions.[20]

The fully electric vehicle assumes that all types of methods are used to produce electricity, and that as we move to more renewable energy sources such as wind and solar that this number will drop. However, the same could be said for hybrids ("HEV") and plug-in hybrids ("PHEV"). Table I is my interpretation of the pros/cons of all the powered vehicle options, and you can draw your own conclusions. Keep in mind that technology is changing so rapidly that this table will likely be outdated in the next twelve to twenty-four months.

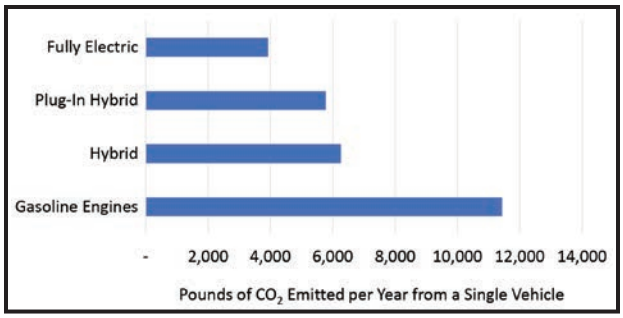



*Figure 7. $CO_2$ emitted by vehicle power source*

**TABLE I. PROS AND CONS OF VARIOUS POWERED VEHICLE OPTIONS**

| | Proven Technology | Infrastructure Supported | Reduces GHG | Purchase Price | Operating Cost / Maintenance |
|---|---|---|---|---|---|
| ICE | ● | ● | ○ | ● | ○ |
| BEV | ◐ | ◔ | ● | ○ | ● |
| HEV | ● | ● | ◐ | ◕ | ◐ |
| PHEV | ◕ | ● | ◕ | ◐ | ◐ |

● best option ○ worst option

HEVs are powered by an internal combustion engine in combination with an electric motor that uses energy stored in batteries. In HEVs, the battery is charged by the internal combustion engine or through regenerative braking. PHEVs use a battery to power an electric motor and the battery is charged through a plug-in (as in a BEV) or through regenerative braking. The PHEV can run full-electric (even at high speeds) for short distances, whereas HEVs are supplemented with gasoline on the highway.

So, while I am not ready to commit to a BEV, if I needed a new car I would certainly lean toward the PHEV because I would not have to worry about finding charging stations on long trips and my daily commute to work (albeit one-way) would be fully electric. In addition, PHEVs offer a big improvement over current ICE vehicles, cutting the $CO_2$ emissions in half. EVs do offer an additional 15% reduction in $CO_2$ over PHEVs, but with continued research into cleaner fuels the gap can be closed and the spend on infrastructure to support would be significantly reduced.

### *Hydrogen*

Hydrogen is certainly an option for cars but like EVs, it faces infrastructure challenges that are akin to its electricity-powered counterpart. Fuel-cell electric vehicles ("FCEV"), powered by hydrogen are gaining momentum because consumers are able to fill up their cars with hydrogen in three to five minutes (similar to fueling with gasoline), compared with a BEV that needs significantly more time to charge. The two biggest challenges are infrastructure and cost. California is currently the only state that has a reasonable amount of $H_2$ filling stations. According to the Department of Energy, California accounts for 56/57 publicly accessible hydrogen fueling stations (Hawaii has one). The Toyota Mirai (Figure 8) is a vehicle on the market today and averages ~73 miles per kg.[21] The capacity of the tank is 5 kg, and so you can drive ~375 miles on a single tank that costs

~$80, meaning the operating cost is ~$0.21/mile, compared with gasoline that is ~$0.13/mile (average in most states, whereas it is ~$0.17/mile in California).

What methods are used to produce hydrogen and how exactly does an FCEV work? Hydrogen can be generated from many sources including using fossil fuels such as natural gas (the largest source of hydrogen today is produced by steam-methane reforming to separate hydrogen atoms from carbon atoms)[22] but can also be manufactured using several other methods such as water, solar, and wind. In the case of water, an electrolysis process uses an electric current to split out hydrogen from water. The electrolysis process is powered by electricity from renewable sources, nuclear energy, and fossil fuels. While fossil fuels are the source most often used to create electricity, this is no different to the EV that uses electricity to charge a vehicle, meaning that both the FCEV and BEV do emit net greenhouse gases.

A fuel cell is essentially electrolysis in reverse and uses a series of membranes (approximately 300 in a car called a "stack" and are individually known as a polymer or proton electrolyte membrane ("PEM"))—Figure 9. At the anode side a platinum catalyst is used to split hydrogen into protons and electrons. The PEM only allows protons to pass through the membrane and the electrons are forced through a circuit to generate electricity and power the motor. The protons pass through the membrane to the cathode (a platinum catalyst is also used) and are combined with the electrons (after passing through the circuit) and oxygen from air to produce water (and heat) that is emitted through the tailpipe. Platinum works reasonably well on the anode side for the hydrogen oxidation reaction to split the protons and electrons, but on the cathode side where an oxidation reduction reaction takes place, it requires several more layers of platinum to be effective.[23]

Technology advancements made by companies such as Mott Corporation, have developed porous transport layers using thin titanium sheets (~250 µm) that offer better mass transport on the anode side of the fuel cell.[24] In combination with a platinum coating (to prevent the formation of an oxide coating and stabilize the electrochemical performance), titanium is proving to be a valuable asset to hydrogen fuel cell technology. While tape casting is a common method of producing the sheets, the powder metallurgy process has been shown to provide excellent results. Withstanding the mechanical stresses in a PEM is critical and Mott believes that their materials, which are sintered powders, overcome these issues.

It is going to take more research and improvements to the efficiency of the hydrogen fuel cell (the PEM and catalysts) and significant investment in infrastructure before it really poses a challenge to the BEV. While hydrogen may have a longer way to go for the auto industry, industrial use provides some other interesting alternatives. Per the earlier discussion, in 2021, Industry accounted for approximately 23% of total greenhouse gas emission in the U.S. and as such is garnering a lot of attention.

Similar to many companies in the powder metallurgy sector, Kymera International ("Kymera"), (www.kymera international.com) uses hydrogen in its plants, particularly in those plants that reduce copper oxide to copper, creating a porous-like structure that is ideal for certain applications in the automotive industry. The availability of the gas has been an issue due to increased demand; energy prices (inflation) and hydrogen plant issues in certain parts of the U.S., which at times has led to the curtailment of hydrogen supply. The global hydrogen market is expected to grow by more than 250% by 2040 (7.1% CAGR from 2023 to 2040) driven by increased demand from the transportation and power generation sectors.[25] Despite global plans to expand hydrogen production, certainly in the near term, supply issues will

***Figure 8.*** *2023 Toyota Mirai (hydrogen powers an electric motor)*

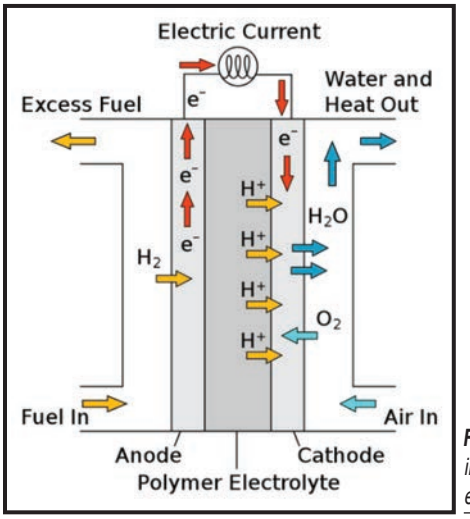



***Figure 9.*** *Fuel cell image courtesy of energyeducation.ca*

remain a concern. This is why "green" hydrogen is going to be critical to avoid disruptions to the powder metallurgy and greater industrial markets.

Kymera is committed to the environment and as part of its focus to reduce its greenhouse gas emissions, energy has been one of the areas the company has targeted. However, continuity of supply also plays a role in its decision to go "green". Companies such as Plug Power have developed what they are calling a "Green Hydrogen Ecosystem" and are manufacturing a wide array of systems to power industry.[26] In 2024 Kymera will install an electrolyzer system at one of its plants, and already has installed a similar system at another one of its U.S. sites. In addition to changing the form/process of hydrogen that industry is currently using today, there are opportunities to replace fuel and electric vehicles with hydrogen powered ones, such as forklifts. Turnkey hydrogen fuel cell forklifts are available in the market, they are "green", do not rely on electricity and can be refueled in under five minutes—Figure 10.[27] If you are currently using propane powered forklifts, you may want to consider hydrogen. While the upfront costs are higher, the operating costs (maintenance, fuel) of a hydrogen forklift can be as much as 60% lower than its propane counterpart.[28]

While electric vehicles and electricity in industrial settings may be the preferred method of power, climate related natural disasters such as hurricanes, earthquakes, freezing rain, fires and floods are increasing and have caused major disruptions that have led to power failures/downed electrical grids that take days and even weeks to restore. According to climatecentral.org, between 2000 and 2021 83% of reported power outages in the U.S. were weather related and major power outages (affecting 50,000 people or more) increased by 78% in the same period.[29] Therefore, as electricity becomes less reliable, hydrogen may prove to be a valuable alternative.

### *Alternative Fuels*

In addition to electricity, hydrogen, propane, and natural gas, other forms of cleaner fuels exist today including biodiesel and ethanol, and companies such as Shell and Exxon are working hard to produce even cleaner fuels. We should not think that large oil and gas companies are simply just sitting back and waiting for electric vehicles to take over. Per a Shell USA media release, they have developed, "a blend of second-generation ethanol derived from sugarcane waste and other biofuels, to create a fuel comprised 100% of feedstocks categorized as "renewable" under the applicable regulatory frameworks".[30] Shell (as Royal Dutch Shell) formed a joint venture with Cosan SA in 2010 and Raízen was born. In November 2022, Shell, through a long-term agreement, agreed to purchase 3.25 billion litres of sugar-cane cellulosic ethanol from Raízen.[31] Production from the second-generation ethanol is expected to be online in 2025. This fuel type is expected to produce 60-80% less greenhouse gas emissions compared with traditional fossil-fuel gasoline. However, as with EVs (i.e., electricity production), biofuels do emit greenhouse gases when they are extracted, and particularly, $N_2O$ when the sugarcane straw is removed from the soil. There are programs to recycle some of the straw, but the other issue surrounds the source(s). Sugarcane is largely cultivated in Brazil due to favorable climate conditions, which again makes the U.S. rely on a foreign country, albeit an ally, but nonetheless one that has had its issues with corruption. To promote their new fuel, Shell has teamed up with INDYCAR to help decarbonize the sport of racing and I assume to gain fuel brand identity and proof of efficacy of the new fuel. The fuel is expected to be launched at a racetrack near you in 2023. Most (if not all) oil and gas companies are working on fuel alternatives and ExxonMobil is no different. In conjunction with Porsche, ExxonMobil is testing their new eFuels; synthetic fuels made from hydrogen, and they believe that eFuels could reduce greenhouse gas emissions up to 85% compared with fossil-fuel gasoline.[32] Porsche is also working with other companies such as Siemens Energy, and in December 2022 they announced that their Chilean pilot plant in Punta Arenas was officially opened. According to Porsche, the pilot plant will produce 34,000 gallons of eFuel, that will first be targeted to race cars. Then, consumers will be able to test drive Porsche vehicles using eFuels at their global Porsche Experience Centers. Next phases will include a 14.5 million gallon plant (next three to five years) and then a 145 million gallon plant two years later (toward the end of the decade).[33] The eFuel production is complex and involves using water (split into oxygen and green hydrogen using wind energy as the power source), combining it with carbon dioxide (filtered from the atmosphere) to form a synthetic methanol and then converting it to an eFuel. Methanol


***Figure 10.*** *Turnkey hydrogen fuel-cell forklifts*

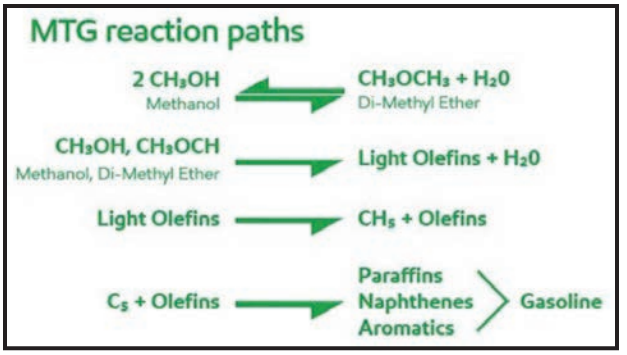



***Figure 11.*** *Methanol to gasoline production path*

to gasoline ("MTG") is done in a fluid bed reactor, where methanol (and a small amount of water) goes through a series of heat exchangers and then to a fluid bed reactor where it is converted to hydrocarbons and water and eventually gasoline (Figure 11).[34] Porsche believes that this fuel can be a direct substitute for current fossil-fuel gasoline and that consumers will not have to make modifications to their engines. A final thought on the source of energy/type of vehicle: it is the consumers that will choose which vehicles they will purchase and not solely based on a mandate from the government. There will not be a ban on internal combustion engines and so this is why car manufacturers such as Toyota and Porsche are investing heavily in non-EV technology. If eFuels can be produced at the low greenhouse gas emission levels that some are predicting, and/or if hydrogen's infrastructure problems and cost can be overcome, then in 2035 and beyond, electric vehicles may end up being just one of many options, especially if the time to charge an EV does get below five minutes.

### *Aviation*

I will state the obvious and say that we will not be flying in commercial electric planes any time soon. However, we are much closer to electric flying taxis than you may think. A joint venture formed between Boeing and Kitty Hawk Corp., Wisk Aero ("Wisk"), unveiled its all-electric, autonomous four seat eVTOL (electric vertical takeoff and landing) in late 2022 (Figure 12). It will have a cruising altitude of ~3,000 feet above ground, a range of 90-miles, a cruising speed of ~130 mph and will seat four.[35] Wisk is targeting a cost of $3/mile per passenger. To put this in perspective, a flight from New York City to JFK airport will take seven minutes at a cost of $60—not bad![36]

While Wisk expects to launch their eVTOL in the next five years, their competitor, Joby Aviation ("Joby") announced it plans to launch an air taxi service in 2025. Joby claims a range of 150 miles at a cruising speed of 200 mph.[37] While their estimated ride costs are similar to Boeing's expectations, Joby's CEO, JoeBen Bevirt expects costs eventually to be the same as a yellow cab in New York (but hopefully easier to flag down).[38]

In terms of commercial aviation, as you can imagine, a lot of work is being done on sustainable fuels. The U.S. Department of Energy is supporting advances of biomass and waste resources to create fuels using materials such as corn, algae, cooking oil, wood mill waste, and municipal solid waste.[39] While this is a tremendous accomplishment in greenhouse gas reduction, the price of these alternative fuels is at least three times more expensive compared with the kerosene-type fuels used today.[40] This will of course increase the consumer cost to fly which is unlikely to be acceptable.

Known as SAF (Sustainable Aviation Fuel), these alternative fuels can reduce carbon emissions by 80% on average. The aviation industry has set a much longer and less aspirational position on greenhouse gases and has targeted a 50% reduction by 2050.[41] These fuels can be used today and are a direct replacement for the current fossil-fuel materials, but the prices are just not competitive. Jet fuel accounts for 25-30% of an airline's operating cost[42] and per Figure 13, while the price of airline tickets has dropped (especially when you consider the time value of money) as competition has increased and budget airlines emerged; over time the trend of fuel-to-ticket price has been fairly consistent. There-

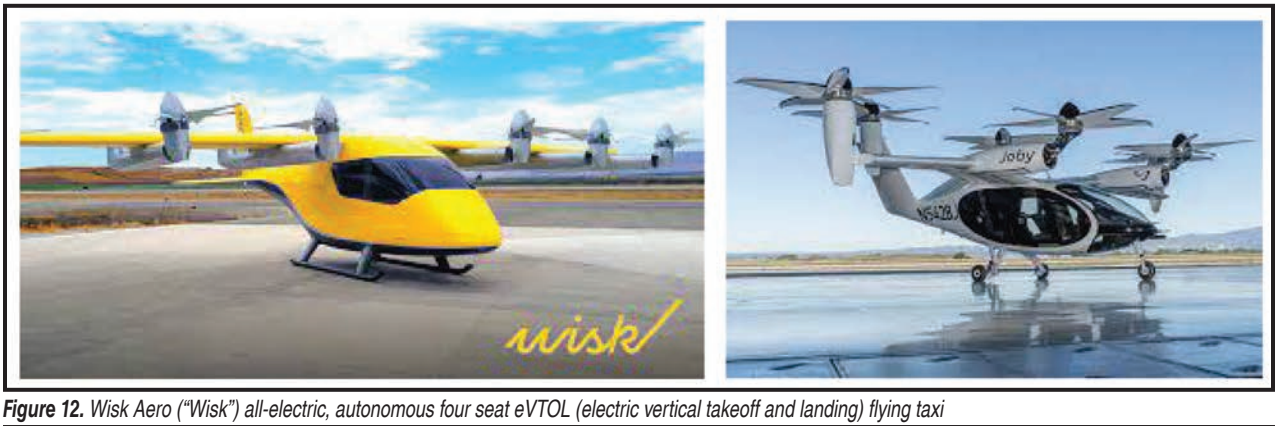



***Figure 12.*** *Wisk Aero ("Wisk") all-electric, autonomous four seat eVTOL (electric vertical takeoff and landing) flying taxi*

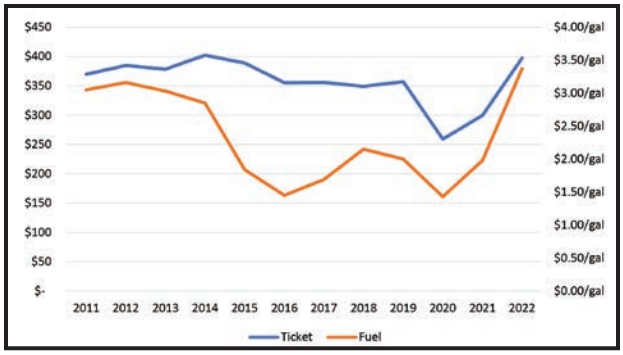



***Figure 13.*** *Average airline ticket price in relation to average jet fuel price. Data from the U.S. Bureau of Transportation and Statistics*[43]

fore, if the price of fuel tripled, we would expect a significant increase in airline ticket prices.

The commitment to reducing the carbon footprint in the aviation industry is clear, but because it is on a longer time horizon compared with automobiles, the industry has time on its hands to develop alternative fuels further and work with other technologies such as eFuels and hydrogen fuel cells.

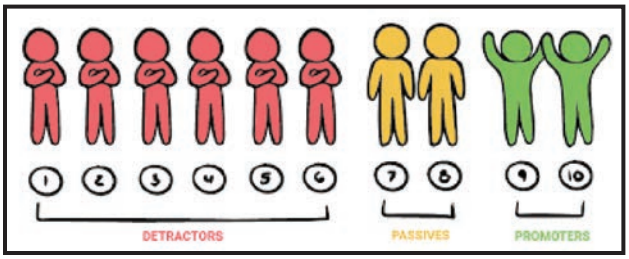
### *Sustainability & Kymera International's Environmental, Social, and Governance (ESG) Focus: The 3P's*

Sustainability has certainly become an integral part of everyday life. Although today it largely centers around the environment and the preservation and ongoing support of natural resources, it is not the only component of sustainability. Greenhouse gases are the focus of the world because of the impact they are having on the environment and the long-term sustainability of the planet. However, social and economic concepts are also important. ESG is not just a fad or a collection of buzzwords but should be a meaningful part of the economy. While ESG is now a widely used acronym, in its more basic form, we are talking about the "3P's", people, (the) planet, and profits. Skeptics will say that ESG is just a money pit and adds no value to an organization, but I think it is the complete opposite. Not only because it is the smart thing to do, but it's also the right thing as well.

Three years ago, Kymera embarked on a strategic growth path through organic and inorganic initiatives that included new product development, LEAN manufacturing, and mergers and acquisitions. While the results we were looking for were certainly tied to financial outcomes, we also realized that to achieve these goals we needed to address the "S" in ESG simultaneously. Our strategy is based on principles called Objectives and Key Results ("OKRs"), where a single objective is created, and three to four (max.) measurable key results are set on a longer-term basis (e.g., five years out). These OKRs are supported by annual and quarterly ones that are aligned and where people are held accountable throughout the organization. The objective is concise and to the point and defines what is to be achieved. The key results should support the objective and be measurable. The biggest mistake people make when creating OKRs is their key results are not measurable but are rather activities. For example, an activity (also can be looked at as a KPI) is, "enhance the image or brand of Kymera", whereas the key result would be "enhance the image or brand of Kymera", as measured by, "an increase in sales of $500,000". The key result should be aspirational and set at a level where there is not a clear path on how to attain the goal. Success is defined by achieving 80% of the goal; if you get above 100% you probably did not set the key result high enough. With all that in mind, Kymera set its corporate 2025 OKRs in 2020 (and most recently updated them to 2027). We set four KRs and two of them were ESG focused. One was geared towards reducing our greenhouse gas emissions (discussed later) and the other was employee satisfaction.


While there are a lot of ways to measure employee satisfaction, Kymera chose to use eNPS (employer net promoter score). Questions are sent out to employees, and they are asked to answer each on a scale of 0-10. eNPS score is based on identifying "Promoters" (a score of 9–10), "Passives" (a score of 7–8) and "Detractors" (a score of 0–6). The eNPS score is measured as % Promoters minus % Detractors (Passive responses are not used in the calculation) The scale is set at -100 to +100 and any positive result means you have more Promoters than Detractors in your organization and is considered a good result. Kymera's OKR target for 2025 was set at +35, which would put us at the top of the manufacturing sector in employee satisfaction.

When Kymera first did its survey in 2020/2021, we scored -6. This obviously meant we had a lot of work to do. We reviewed the data and the comments and set out to improve our score. Our latest survey's results were outstanding, and we achieved a score of +26 which exceeded all our expectations. You will see in the follow-



ing paragraphs some of the reasons why our score improved dramatically in the past two-plus years through the employee programs we implemented and the continued focus on transparency and communication.

Kymera is owned by Palladium Equity Partners ("Palladium"), a private equity firm out of New York. The most important metric that Kymera, Palladium, and its Board of Directors focus on is safety. It is the first item of business at every board meeting, weekly update, and any new employee introduction. Kymera will never sacrifice safety for profits. Palladium is minority owned and has a strong belief that people, regardless of how they look, what they believe in, how they identify, or the position they hold in the organization should be welcomed, treated fairly, and given the opportunity to succeed.

Private equity firms buy and sell companies, and of course Palladium is no different. When a company is sold, executives and senior managers often receive a portion of the proceeds to ensure alignment and retention at the top level. However, Palladium believes that every person in the organization contributes to the success of the company and as such all should be rewarded. On the surface this may appear that it would have a dilutive effect on Palladium's (and their investors') returns. The reality is that by incentivizing everyone throughout the organization, they will work together to ensure product is manufactured to the highest quality, orders are shipped on time, new products are developed and launched, employees are retained, and customers are offered novel materials that will help them grow and be more competitive.

The result is that all stakeholders (employees, customers, investors, and the community) will benefit from Kymera employee alignment across the organization. Kymera's long-term incentive plan ("LTIP") ensures that 100% of the personnel base benefits from a sale as all employees are given the equivalent of phantom shares free of charge. In addition to a LTIP, Kymera also shares annual profits with its employees through a short-term incentive plan. This is an example of: *P is for People and Profits!*

In addition to doing the right/smart thing for its employees, Kymera has global community programs, a Diversity Council, and a Women's Resource Group (Inspired Women of Kymera (iWOK)). To engage all employees in the greenhouse-gas reduction effort and bring alignment to the team, Kymera implemented a cross-functional challenge to drive employee engagement worldwide and develop a pipeline of improvement projects. Kymera's employees delivered, and in the last two years identified actionable projects and suggestions resulting in more than 3,000 mt of GHG reduction. This is an example of: *P is for People and (the) Planet!*

As part its commitment to the environment, Kymera


implemented an aggressive decarbonization plan with a goal of reducing its operating greenhouse gas emissions by one-third (approximately 10,000 mt) by 2025, which would be in line with the targets implied for Kymera by the Paris Agreement.[44] Kymera's decarbonization program began in 2020 when we performed a greenhouse-gas inventory and designed a series of objectives and key results to achieve our 2025 reduction target. Kymera's commitment to achieving our GHG reduction target is evident and our early actions, including converting three of Kymera's production facilities to 100% renewably-sourced electricity is just one example of our decarbonization efforts. Those facilities alone have reduced Kymera's GHG emissions by greater than 5,000 mt annually. As discussed earlier, Kymera has one green hydrogen unit installed and will be adding an electrolyzer to another plant in 2024. This is an example of: *P is for People and (the) Planet!*

In addition to our efforts to reduce GHG emissions, in 2022 Kymera embarked on an ESG accreditation journey and chose EcoVadis, a globally recognized business sustainability rating provider. I look at sustainability rating companies in a similar manner to quality accreditation and to ISO's 9000 series released in the late 1980's. EcoVadis' rating system is based on awarding medals to companies who meet minimum scores on themes related to environmental, ethics, labor and human rights, and sustainable procurement.[45] The score/medal is a benchmark against other companies and as more companies look to adopt this rating system and enhance their sustainability efforts, the criteria to reach a given medal status will likely increase. Like ISO once you obtain a medal you must maintain the standards at that level. If not, you can be downgraded or lose your accreditation. We have seen companies advertise their accreditation on an individual plant basis which may be somewhat misleading in a multi-plant

business. When Kymera made the decision to push toward a sustainability accreditation, we decided to include all our global plants including those in the U.S., Australia, Austria, Bahrain, China, Germany, and Slovenia. We plan on not only maintaining this status in 2023 but include the acquisitions we made during 2022 and 2023 (at time of submission). Our 2027 goal is to be among the top 1% of all EcoVadis rated companies, which based on the current rating system today would equate to a Platinum Medal.

***Governance***

When people think about ESG, I believe they mainly associate it with the environment. I demonstrated above that the "S" in ESG is critical to a company's success, but quite often the "G" is overlooked. Governance in a company is of paramount importance. In its simplest form, corporate governance is the system in which companies are directed and controlled.[46] Strong corporate governance will give all stakeholders of the organization comfort that they are investing in, working for, purchasing from and associating with a company that has accountability, transparency, and operates within the laws that they are governed by and that there is oversight from (as an example) a Board of Directors. Kymera's board is made up of a diverse group of external and internal (to Palladium) senior professionals with a wide array of experience in different industries.

Kymera has implemented several programs/initiatives to enhance its corporate governance, some of which are listed below:

- **Financial & Risk Management**
  - o External financial and lender audits
- **Compliance & Reporting—Policies/Procedures**
  - o Ongoing cybersecurity training and protection as well as overall IT strategy to minimize opportunities for systems to be compromised.
  - o Robust set of policies governing ethical and transparent business practices including:
    - ▪ Code of Business Conduct
    - ▪ Employee Reporting Policy
    - ▪ Compliance Helpline
    - ▪ Non-Retaliation Policy
    - ▪ Compliance Policy
  - o Compliance training
  - o Helpline/reporting
  - o Procurement policies including:
    - ▪ Responsible Sourcing
    - ▪ Supplier Code of Conduct
    - ▪ Conflict Minerals
    - ▪ Supplier surveys
- **Board Structure and Composition**
  - o Mix of internal and outside Directors
  - o Diverse board composition
  - o Board committees:
    - ▪ Audit
    - ▪ Compensation
    - ▪ Stakeholder engagement
  - o Minimum quarterly meetings
  - o Board member involvement in strategic teams
    - ▪ M&A
    - ▪ OKRs
    - ▪ Diversity

## SUMMARY

Sustainability (as it relates to ESG) is a term used to describe the preservation of natural resources. As EV technology has advanced in the past few years, regulators and industry players alike have come out publicly to support and commit to the reduction of greenhouse gases. Mandates have been put in place to accelerate the adoption of electric vehicles, but it is clear there are other options that would require far less infrastructure expenditure.

In reviewing EV options, my view is that plug-in hybrids would be the best option because we would not have to spend billions in the U.S. on infrastructure. Since this solution does not achieve zero tailpipe emissions, PHEV, in combination with eFuels seems to be an excellent alternative. In addition, until there is a clear line of sight to significant battery improvements that meaningfully increase driving range, and/or charging times are reduced to under five minutes, the average consumer is unlikely to accept only having EV options. The other significant challenge for EVs is the dependance on electricity and how increased power failures threaten the availability of power. This becomes a safety concern, especially as hurricanes, floods and fires continue to be on the rise. We can use advanced hydrogen fuel-cell technology to power the electric motor and while this too requires infrastructure, there is not the same constraint due to time-to-fill.

Sustainability goes well beyond the environment and the "S" and "G" from ESG certainly need to be considered. Kymera International has embraced ESG and made it an integral part of its business which has resulted in significant improvements to employee satisfaction that benefits all stakeholders.

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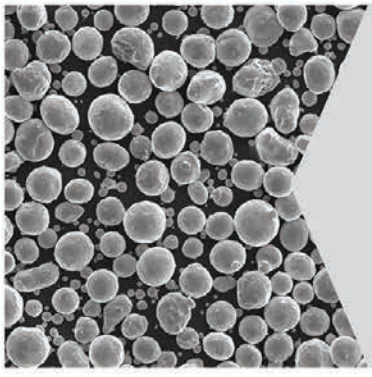

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