# Hydrogen Starting to Find its Footing in the Energy Transition

Initiating Coverage on Plug Power (PLUG) and Nikola Motors (NKLA)

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**Please Read: Important disclosures and analyst's certification appear in appendix**

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# Energy Transition: Hydrogen Outlook

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## Hydrogen Is Starting to Find Its Footing in the Energy Transition. We Initiate on Plug Power Inc. and Nikola Corporation with Buy Ratings.

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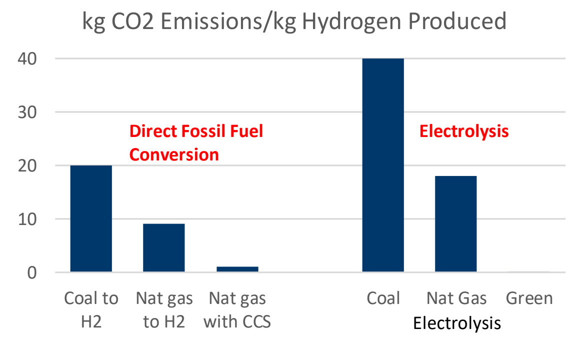
**WHAT YOU SHOULD KNOW:** Hydrogen has been around for decades (the fuel that powered us to the moon), but the recent momentum around hydrogen and specifically green hydrogen (produced from renewables) is a culmination of multiple factors including 1) increasing availability and improving efficiency of wind and solar, 2) the Paris Agreement signed in 2015 which has many countries and companies pledging net-zero emissions by 2050, 3) the rise of ESG and impact investing, 4) an increased focus on carbon offsets and taxes, 5) increased capital flows into the sector from investors and banks as they look to green their portfolios, and 6) efficiency gains in hydrogen production from improving technology and economies of scale. And while these factors and others are paving the way for hydrogen to be part of the ongoing Energy Transition, by 2030 only ~1% of the world's energy supply is expected to be hydrogen which is why there is so much debate about whether hydrogen is on the cusp of a mega-cycle or will simply be relegated to niche applications. We see the potential for both paths with government policies across Asia, Europe, and the Americas most likely having an impact on the outcome. Bottom line: at a minimum, we expect increasing demand for hydrogen through 2050 as countries and companies figure out how hydrogen fits into their industrial and transportation energy mix.

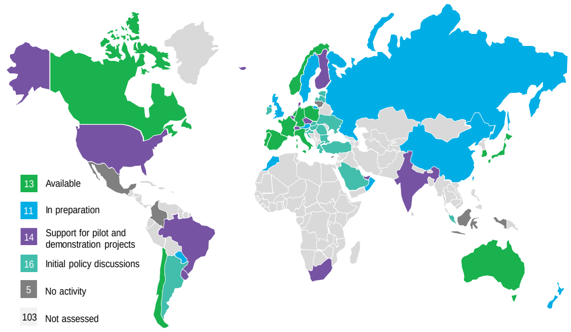
- **An Opportunity for Energy Independence.** Despite the higher financial costs of hydrogen-powered economies, with most countries importing their energy needs (think fossil fuels) hydrogen offers a potential path toward energy independence. This could be one of the many reasons some countries are bigger proponents of green hydrogen than others as producing hydrogen locally and creating jobs along the way sounds much more attractive than continuing to send money overseas for their energy needs. Under that lens, maybe hydrogen is not so expensive.
- **Why Hydrogen, Why Now.** Hydrogen can be produced from renewable energy, does not produce greenhouse gases, is an excellent carrier of energy, and can be shipped by pipelines or in tanks. And while batteries are gaining the most traction as containers of energy, hydrogen can help decarbonize industries where batteries fall short due to their lower energy density and higher weight.
- **Path of Least Resistance.** Industrial applications like steel, refining, and chemicals where green hydrogen can be produced and consumed on-site (avoids transportation costs) look poised to be early adopters of green hydrogen. Additionally, hydrogen for industrial use is already gaining traction in some nations' zero-emissions policies. Hydrogen's transportation future looks more uncertain given the tug of war with batteries. We expect hydrogen to be used in niche applications.
- **Lowering the Cost Curve.** Green hydrogen is currently non-competitive with other energy at $3-5/kg. The two biggest cost components are the renewable energy to produce hydrogen and the cost of the electrolyzer. However, efficiency gains are expected to drop the cost of green hydrogen below $2k/kg by 2030 and below $1/kg by 2050 which on an energy equivalent basis compares favorably to a gallon of diesel (~$3 in the US and ~$6 in Europe). Looking at natural gas, the $1/kg is equivalent to ~$7.40/MMBtu which is above the $3 price in the US and $6 in Europe (before transport and storage costs) but below the $9 landed price in Asia.
- **Initiations.** In conjunction with this report, we initiate coverage on Plug Power (PLUG, Buy, $40 PT) a hydrogen fuel cell company, and Nikola Corp. (NKLA, Buy, $18 PT) an up-start hydrogen fuel cell and battery electric OEM for Class 8 trucks.

## Focus Charts

Exhibits 1 & 2: Conventional hydrogen production is a major greenhouse gas emitter responsible for over 800M tonnes of CO2 per year. However, with the use of carbon capture, or using electrolysis combined with renewable sources of electricity, would result in carbon-neutral hydrogen production. Hydrogen strategy is available in much of Europe, Canada, Chile, Japan, South Korea, and Australia, with other major populations working on a strategy or supporting initial pilot projects.

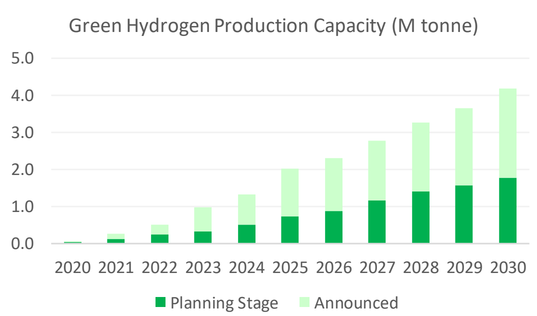



Source: Bloomberg NEF, BTIG Research

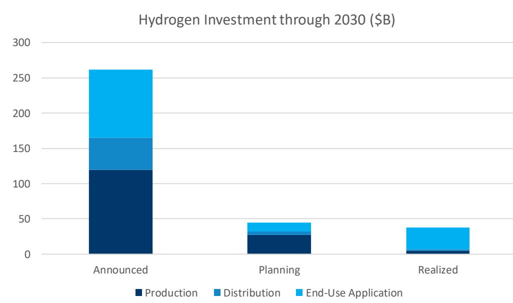



Source: Bloomberg NEF, BTIG Research

Exhibits 3 & 4: According to the Hydrogen Council, there are 4Mtpa of green hydrogen projects in the pipeline through 2030. Over $300B in hydrogen investment through 2030 has been announced, of which about $80B are for projects that have at least reached the planning stage.

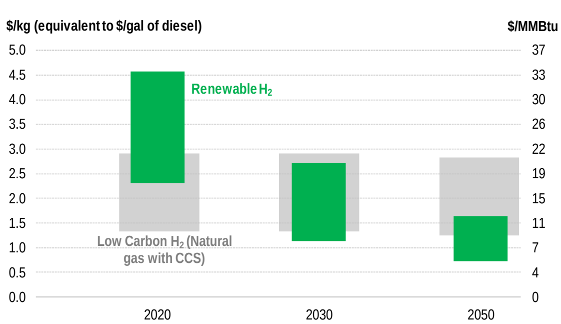



Source: Hydrogen Council, BTIG Research




Source: Hydrogen Council, BTIG Research

Exhibit 5 & 6: We expect a substantial drop in the cost of renewable hydrogen over the next 10 years which is driven largely by the availability of low-cost renewable solar and wind.

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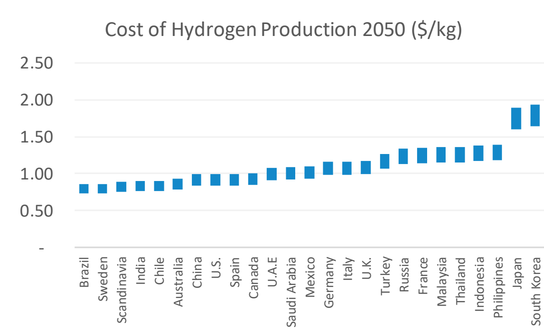
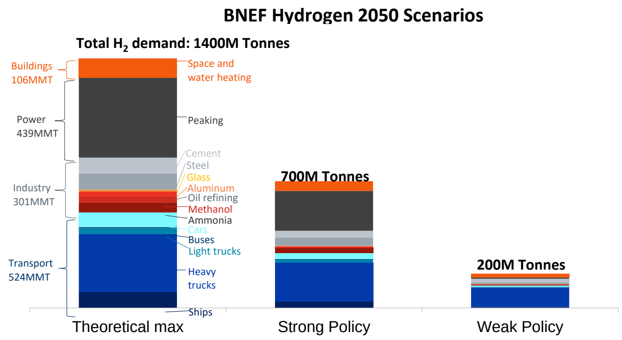
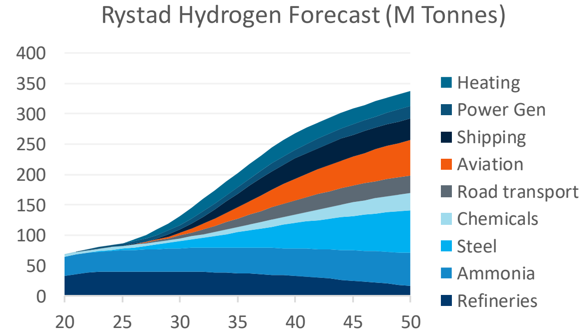



Source: BNEF, BTIG Research

Exhibits 7 & 8: Bloomberg New Energy Finance (BNEF) estimates hydrogen demand of 200M-700M tonnes/year by 2050 depending on policy scenarios. While Rystad forecasts hydrogen demand of about 330 MT by 2050 (5x current levels).

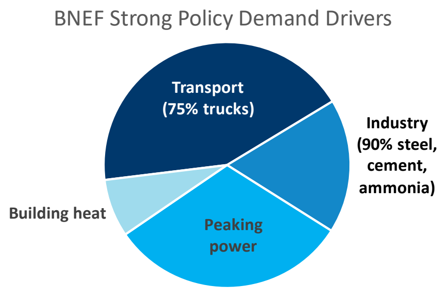



Source: BNEF, BTIG Research

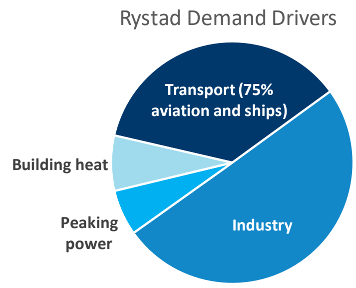



Source: Rystad Energy, BTIG Research

Exhibits 9 & 10: BNEF and Rystad forecast transportation is likely to represent 40% of H2 demand in 2050, but BNEF sees this mostly coming from trucking while Rystad has it coming from aviation and shipping. According to Rystad the biggest driver of demand is industry, at about 50% of the total with building heat and peak power each accounting for less than 10%, while according to BNEF industry is only 20% of demand while peak power is 30%.




Source: BNEF, BTIG Research




Source: Rystad Energy, BTIG Research

## I. Executive Summary: Hydrogen Powering Hard-to-Decarbonize Sectors

- **Need for a carbon-free energy-dense storage molecule:** While electrification on the back of wind and solar is leading the charge towards a lower carbon energy world, we expect hydrogen and other energy sources (think nuclear and fossil fuels) to have a seat at the table in the ongoing energy transition. Key to hydrogen's position is that it fills a need for a clean molecule that (i) can be created through sustainable and inexpensive solar and wind power and (ii) does not produce greenhouse gases (by-product of combustion of hydrogen is water). Also, hydrogen is an excellent carrier of energy that has high energy density per weight (not per volume) and has a tendency to combine with other elements and release energy in the process. Hydrogen also burns non-toxic and releases no greenhouse gases into the atmosphere. It can be transported via pipeline as a gas, or liquified and shipped. While batteries have been gaining the most traction as containers of energy for EVs and energy storage for power, hydrogen can help decarbonize industries where batteries fall short (think industrial applications) due to their lower energy density and higher weight, long recharge times versus molecule fuels, and the need for electric infrastructure to recharge them. And did we mention hydrogen can be blended with natural gas up to 20% to help decarbonize natural gas-powered energy.

- **Hydrogen economics should start to look more compelling in 2030…** Green hydrogen is expensive currently at $3-5/kg, with the two biggest cost components of green hydrogen being (i) the cost of power and (ii) the cost of building and running an electrolyzer. Current renewable hydrogen costs of $3-5/kg are based on a cost of power of $40/MW at the low end. What has hydrogen bulls excited is that renewable costs are expected to drop by 2030 to around $30/MW and then to about $25/MW by 2050 which should help pave the way for cheaper green hydrogen. Energy is the most expensive cost in manufacturing green hydrogen. Looking at electrolyzer costs, recent quotes in Europe have been as high $1,000/KW but can be built for as low as $500/KW (think absorption costs) while in China costs are estimated as low as $200/KW and may dip below $100/KW by 2050. Summing it all up, this translates into the cost of green hydrogen declining to $1.50/kg by 2030 and dipping below $1/kg by 2050. To put this in perspective, 1kg of hydrogen carries the equivalent energy content of a gallon of diesel which carries a price of about $3 in the US and $6 in Europe, making hydrogen potentially a viable substitute for heavy-duty trucking. Turning to natural gas the comparison looks a bit more challenging with $1/kg of hydrogen equivalent to $7.40/MMBtu of natural gas, which currently has a price of $3 in the US, $6 in Europe, and $9 in Asia. We note the $1.50/kg does not include any transportation or storage costs while the $9 price in Asia is a fully delivered cost which includes the price of Henry Hub plus liquefaction plus logistics (pipelines and shipping).

- **…with much-needed policy support being implemented:** Not surprisingly, the cost of hydrogen is currently too high to be an economically viable fuel substitute for most industries and is in need of major policy support to help drive scale and improve economics (not unlike what happened in wind, solar and electric vehicles over the last two decades). However, the reductions in the cost of renewable energy are already happening outside of hydrogen, but the lower cost of electrolysis requires economies of scale and the buildout of the electrolyzer supply chain which will need policy support. And even if hydrogen production costs eventually approach $1/kg, whether it is a tax or a credit on carbon it will be required to make green hydrogen competitive in most industries. Currently, there are 75 countries (half of global GDP) that have announced zero net carbon ambitions, including 30 countries with roadmaps to bring hydrogen into their energy mix. However, only a few of these countries have concrete hydrogen production and hydrogen electrolyzer targets, which includes Chile which is looking to have 25GW of capacity by 2030 (largely on the back of private investment), and the EU which is looking to have 40GW by 2030 using a more balanced mix of public and private capital. In addition, the EU has imposed a cost on carbon, and similar systems are slowly being rolled out across the globe, with China rolling out its carbon trading system this year which covers 30% of its emissions.

- **Pickup in electrolyzer investment to boost hydrogen supply:** The first step to increasing the use of hydrogen as a carbon-neutral fuel is to put in place the necessary supply chain which includes building out electrolyzer capacity. There are currently over 20GW of electrolyzers planned to be added over the next 10 years, with the majority of announcements in Australia and Europe. There are also about 30 blue hydrogen projects, where hydrogen would be produced from natural gas and the CO2 stored away, which is carbon neutral and currently less expensive than green hydrogen. When we look at investment dollars, announcements to date total over $300B in hydrogen investment through 2030 across the value chain. However, there is a lot of work to be done, as the current pipeline of green and blue hydrogen projects equates to just 7Mtpa of hydrogen production which is just 10% of the currently produced gray hydrogen (70Mtpa), and just 1% of the 700Mtpa forecasted by BNEF by 2050 in a strong policy scenario. It is worth noting that some pilot projects are moving forward with blue hydrogen even though the companies are targeting long-term commercial projects to use green hydrogen. We view that as affirmation that these companies are committed to moving forward their hydrogen strategies so they can hit the ground running as green hydrogen production ramps higher.
- **Demand potential over 10x current levels:** Current annual hydrogen demand is roughly 70M tonnes largely from refining and fertilizer. We believe green hydrogen is well-positioned to gain adoption in hard to decarbonize industries (think steel and cement), which represent 30% of global CO2 emissions. Big picture estimates put the theoretical maximum demand for hydrogen in 2050 at around 1,400M tonnes, not surprisingly with a wide range of realistic 2050 outcomes. According to BNEF in a weak policy scenario, hydrogen demand could be as low as 200M tonnes (3x current levels), while in a strong policy scenario demand could be as high as 700M tonnes (10x current levels), with 40% coming from transportation (largely trucks), 30% from power generation, 20% from industry, and 10% from water and home heating. Meanwhile, Rystad's 2050 forecast is about 330MT (5x current levels) and assumes industry represents 50% of demand, with transport driving about 40% of the demand-driven largely by shipping and aviation.
- **Industrial Applications should be a key winner for hydrogen:** We view the near-term path of least resistance for hydrogen in heavy industries like steel, refining, chemicals, and other industrial applications. One of the gating factors for hydrogen as a transportation fuel in the medium term will be the lack of hydrogen infrastructure (think the combination of production, liquefaction, transportation, storage, and delivery), while for industrial applications hydrogen can be produced on-site (think cutting out the middle man) by plugging the electrolyzer to a power source (think wind, solar or hydro-electric for green hydrogen and even fossil fuels in the near term to start the transition). Additionally, many of these industries either already use hydrogen (blue/gray) or could use hydrogen in place of other fossil fuels. Because in many applications hydrogen would be a chemical input rather than a power input, batteries cannot compete. In addition, industrial use of hydrogen has been emphasized in some national policies which should lead to earlier adoption in these countries at least in some niche applications. Long-term we see steel, refining, ammonia production, and cement as some of the biggest users of hydrogen by 2050.
- **Transportation is the battleground:** With battery electric looking already to have won the passenger car and small commercial vehicle market, we see the biggest potential opportunity for hydrogen in on-the-road transportation in long-haul trucking, where some noticeable advantages over batteries exist. However, batteries have a significant advantage in that electric charging infrastructure is well ahead of hydrogen with 300-400k stations worldwide versus about 1,000 for hydrogen. Meanwhile, we see an even stronger argument for hydrogen (most likely a derivative) as fuel for deep-sea shipping and aviation, where batteries are just too big/heavy (we note hydrogen for deep-sea shipping and aviation is still in its very early stages of development). Not surprisingly, heavy-duty transportation is set to be a battle ground for hydrogen and batteries with BNEF's forecast and Rystad's forecast both assuming that transportation could account for over 1/3 of hydrogen demand by 2050, yet BNEF's forecast sees 75% of that demand driven by long-haul trucking, while Rystad believes that batteries will dominate the trucking market and hydrogen would largely be relevant in shipping and aviation.

## II. Themes to Drive the Hydrogen Market in 2021 and Beyond

- **Hydrogen Hubs…** Not unlike what the Middle East and North America are to the oil industry, expectations are for major hydrogen hubs or corridors to form around renewable energy sources for the large-scale production of green hydrogen. Countries like Australia and regions like the Middle East are being targeted as potential production hubs given their proximity to Asia and Europe and their favorable climate which should make them low-cost renewable energy producers. However, one of the drawbacks of production hubs is around the transportation and the potential energy efficiency loss during the liquefaction and regasification process of hydrogen.

- **…Or Hydrogen Production at the Source.** One of the greatest potential benefits of hydrogen we see is the ability to produce it locally. Now countries will need to invest in renewable energy to power the electrolyzers and have access to the water to produce the hydrogen, but why rely on another region or country if the pieces are in place to move towards being energy self-sufficient even at a higher cost. Unlike fossil fuels, hydrogen (which is just another means of storing energy) can be produced anywhere. Not surprisingly, countries like Australia and major shipbuilding nations in Asia (Japan and Korea) are already working aggressively on lowering seaborne transportation costs (they have industries to protect).

- **Hydrogen Blending.** Fortress Transportation and Infrastructure (FTAI, Buy, $35PT) announced plans earlier this year to start blending hydrogen into its natural gas power plant to lower the carbon emissions at its facility. Hydrogen can be blended to up to 20% with natural gas. We expect others to follow.

- **Next-Generation Fuel Cells.** Step changes in technology have the ability to change the cost of hydrogen and advances in High Temperatures (HT) Proton Exchange Membranes (PEMs) technology continue to increase the efficiency gap versus Low Temperature (LT) PEMs. These efficiency gains could in turn accelerate the adoption of hydrogen as a fuel as the total cost moves towards competing fuel sources.

- **Tracking Policy Support.** Not unlike wind, solar, farming, and oil and gas (all of which still receive government support in the US and around the world), hydrogen will continue to need policy support to become more economically competitive. We note policy support and the funding that comes with it, will likely remain a major gating risk factor over the next few years for green hydrogen. However, with the governments' targeting carbon net-zero over the next 3-4 decades and more countries adopting hydrogen strategies the pieces look to be falling into place for the development of hydrogen hubs around the world. The IEA's recent report on addressing zero emissions by 2050 is expected to be a major talking point at the United Nations Climate Change Framework Convention in Glasgow in November.

- **Working Together.** The demand for Energy Storage Systems (ESS) is set to increase rapidly as power companies look to offset the intermittency from wind and solar but also for energy security. And while size and weight are typically not issues for ESS which lend themselves nicely to electric batteries, the increasing need for backup power could also provide opportunities for hydrogen.

- **Transportation and Storage.** Hydrogen is notoriously difficult to store and transport since it provides about 1/3 of the power as natural gas for the same volume (think lower volumetric energy density). Therefore, hydrogen is typically made more energy-dense before it is transported (think compressed, liquefied, or chemically combined). Most likely the store method will depend on the distance traveled. We expect derivatives (think ammonia) to be the long-haul seaborne winner owing to its stability (and the fact there are already some seaborne ammonia tanks on the water).

- **Tracking Carbon Prices.** Earlier this week the European Carbon Contract (MOA) closed at ~$65/tonne which was up roughly 65% YTD. With some companies and countries already calling for a carbon levy of $100-200/tonne, strong policy support at least in Europe may not be that far behind.

## III. Hydrogen 101 – Back to School

- **Where hydrogen is found:** Hydrogen is the simplest and most abundant element in the universe, but on our planet, it rarely exists on its own. Less than 0.0001% of the earth's atmosphere is hydrogen, and the majority of accessible hydrogen on earth is locked within water molecules. Over 70% of the earth's surface is covered in water, but only 3% of that is fresh water (what is needed to run through an electrolyzer) and only 0.5% is accessible fresh water.

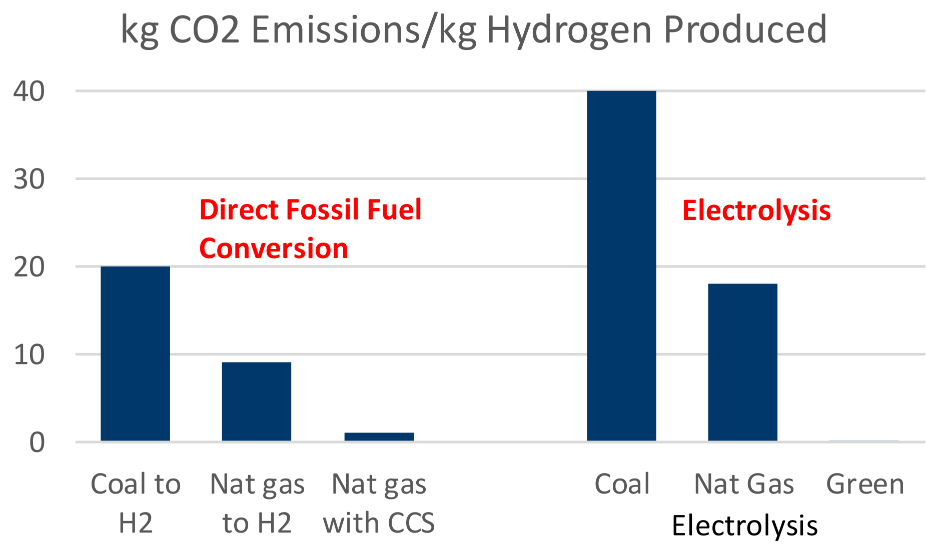
- **Molecule properties:** The properties of hydrogen make it an excellent carrier of energy. It has a tendency to combine with other elements and release energy in the process. When burned it is non-toxic and releases no carbon pollutants. In fact, the byproduct of burning hydrogen is water. It is also a very light gas, containing the highest amount of energy per unit of water vs. any other molecule on earth (not counting nuclear fuel). One drawback as a fuel is it has a very low volumetric density, making it more challenging to store and transport. It can be compressed into a liquid, but its boiling point is -253C (compared to -162C for natural gas), which is just 20C above absolute zero (the lowest possible temperature for matter).

- **Challenges:** While hydrogen is very energy-dense by mass, it has very low volumetric density, which makes it challenging to store and transport. To put it in perspective, hydrogen's volumetric energy density is ~30% that of natural gas (a cubic foot of hydrogen has 30% the energy content compared to a cubic foot of natural gas). This means that storing hydrogen requires 3x more space than an equivalent amount of natural gas. One positive is that hydrogen moves 3x faster than natural gas through a pipeline which can help offset the 3x higher volume that needs to be piped. Hydrogen is also highly reactive, which makes it very useful in chemical manufacturing, but also poses challenges as it can react with other materials. Additionally, hydrogen's small molecular size makes it easy for it to escape through the smallest of cracks.

- **How much is a kg of hydrogen?** Prices and figures around hydrogen are typically referenced in kilograms (kg). A kg of hydrogen has the equivalent energy content of 1 gallon of diesel or 0.13MMbtu of natural gas. This equates to about 40kwh at perfect efficiency, although current fuel cell technology is lower (we note the fuel cell industry is focused on improving efficiency, and increased capital flowing into the sector should help drive increased fuel cell efficiency longer term). One battle ground developing for hydrogen fuel cells is against lithium-ion batteries in the transportation sector and while batteries look to have already won the passenger vehicle market, segments of the heavy-duty commercial vehicle market look to be up for grabs.

- **The colors of hydrogen:** While burning hydrogen does not emit any carbon emissions, the production of hydrogen does release emissions if the hydrogen is produced using fossil fuels. Historically, most hydrogen has been produced through a chemical reaction using methane or coal; with this method, hydrogen is referred to as gray hydrogen. Producing 1kg of hydrogen from methane releases about 9kg of $CO_2$ into the atmosphere, while producing hydrogen from coal releases 20kg. Producing hydrogen from methane is referred to as grey hydrogen; however, with carbon capture and storage (CCS) technologies gaining momentum (not just for gray hydrogen but for fossil fuels), the effects of $CO_2$ can be mitigated with existing CCS technology which is referred to as blue hydrogen. Not surprisingly, what has some countries, companies, and ESG investors most excited about as they look to meet their carbon-zero targets over the next few decades is the prospect of green hydrogen which is produced by using a process of water electrolysis, with the power coming from renewable energy (think wind, solar, hydro-electric). We note that electrolysis using power produced from fossil fuels creates even more $CO_2$ emissions than producing it through a chemical reaction from coal or natural gas.

Exhibit 11: Conventional hydrogen production is a major greenhouse gas emitter responsible for over 800M tonnes of CO2 per year. However, the use of carbon capture, or using electrolysis combined with renewable sources of electricity, would result in carbon-neutral hydrogen production.




Source: Bloomberg NEF, BTIG Research

- **Hydrogen history:** Hydrogen has been used as a source of fuel as early as the 1800s, powering the first internal combustion engines. It was also used in the 1960s to put the first man on the moon. Hydrogen was also considered as an alternative fuel during the 1970s oil crisis, as well as in the past two decades as a means to reduce climate change and meet net-zero carbon initiatives. However, it failed to gain traction in previous decades as oil and gas proved more plentiful than many experts expected and hydrogen economics were substantially less attractive than fossil fuels. However, declines in renewable power generation cost over the last decade, combined with more political and corporate will to reduce GHG emissions, pave the way for increased green hydrogen demand in the coming decades.

- **Hydrogen today:** the majority of hydrogen production comes from fossil fuels (largely natural gas), with ~70M Metric tons of pure hydrogen produced in 2020, resulting in over 800M tonnes of CO2 gas or about 2.3% of the 35B tonnes of CO2 produced each year globally. Not surprisingly, given the challenges of transporting hydrogen, the majority of hydrogen is produced in captive plants at the point of use. It is predominantly used as a feedstock to produce ammonia and methanol as well as to reduce impurities in oil refining. However, longer-term green hydrogen (produced from renewable energy and water) is likely to see increasing demand growth as a complement to battery power in decarbonizing the world. The formation of the Hydrogen Council (group of companies advocating the use of hydrogen as a clean fuel alternative) coupled with net-zero carbon initiatives by governments worldwide and potential incentives, has put green hydrogen on the map as a key potential contributor towards decarbonization.

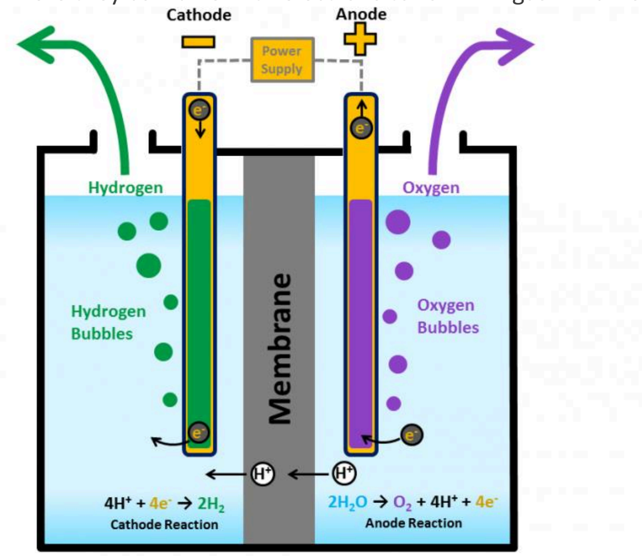
- **Why this time is different:** The two major input costs for hydrogen production are (i) the cost of renewable energy, (ii) and the cost of an electrolyzer. Today, the cost of renewable energy has reached parity with conventional fossil fuels but is still poised to head lower. Additionally, as renewable power generation is dictated by the weather, we expect green hydrogen to serve as another vehicle to store energy just like batteries. And while investment in green hydrogen is still largely in its infancy there already have been some cost reductions. More importantly with countries around the world announcing plans for hydrogen hubs, and more global banks targeting green financing, and over 200 companies already members of the Hydrogen Council we expect more capital to flow into the sector which should provide the critical mass to position green hydrogen as part of the global energy transition.

## IV. Hydrogen Supply – Fossil Fuels and Water

- **Fast-changing landscape:** The majority of hydrogen supply today is produced by converting fossil fuels (primarily natural gas) into hydrogen through a chemical process. Through this process, the world produces about 70M tonnes of pure hydrogen. However, the future of hydrogen looks very different, as hydrogen shifts from it being an input for ammonia production and oil refining and producing a lot of CO2 emissions, to becoming an agent of decarbonization for a number of key industries. This pivot requires green hydrogen which is produced from electrolysis (an electric current passing through water and splitting water molecules into hydrogen and oxygen molecules). To be considered green hydrogen, the electricity needs to come from renewable power. Aside from electrolysis, the traditional method of converting natural gas into hydrogen can be combined with CCS to reduce greenhouse gas emissions.

- **How an electrolyzer works:** Electrolyzers use electricity to break water molecules into hydrogen and oxygen molecules. Similar to a battery, an electrolyzer contains a cathode (positively charged), and anode (negatively charged) which are separated by an electrolyte membrane. When electricity is applied to the water molecule, the water is broken up and part of the molecule then travels through an electrolyte barrier, the result of which forms hydrogen (H2) molecules at the cathode. We note there are multiple types of electrolyzers including 1) PEM (Proton Exchange Membrane or Polymer Electrolyte Membrane), 2) alkaline and 3) solid oxide.

Exhibit 12: Illustration of how a PEM electrolyzer works, with electricity reacting with water at the anode, breaking water molecules into Oxygen (O2) and hydrogen ions (H+). The hydrogen ions travel across a membrane to the cathode where they combine with electrons to form H2 gas which is then captured.



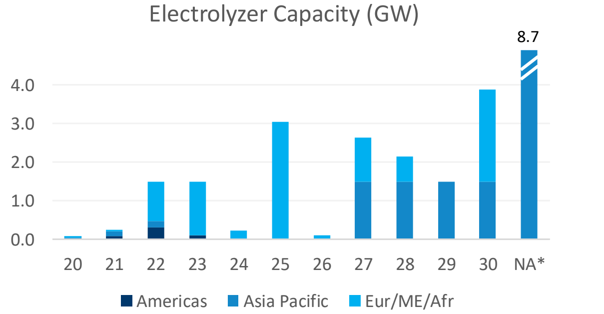

Source: Energy.gov, BTIG Research

- **Alkaline and PEM electrolyzers:** Today there are two predominant electrolyzer technologies: Alkaline and PEM. In a PEM electrolyzer, water reacts with an electric current at the anode. This is the negative side of the circuit which means electrons are pulled away from the water molecule across an external circuit from the anode to the cathode. This forms oxygen and positively charged hydrogen ions at the anode. These positively charged hydrogen ions move to the cathode across a solid polymer electrolyte, linking up with the electrons to form H2 gas. In an alkaline electrolyzer, the reaction with electricity occurs at the cathode, where a current adds electrons to the water molecule. This separates the water molecule into H2 and negatively charged 2OH ions. The negatively charged ions pass to the anode through a liquid alkaline electrolyte comprised of potassium or sodium hydroxide. This leaves the H2 to be collected at the cathode.

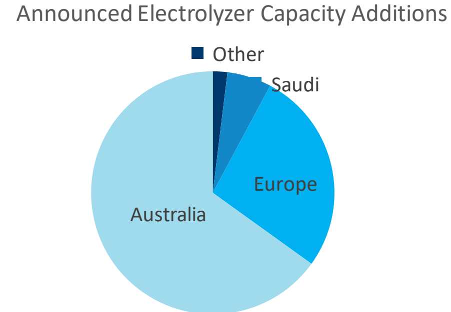
- **Solid oxide electrolyzers:** These use a solid ceramic electrolyte. Similar to an Alkaline electrolyzer, the reaction occurs at the cathode where an external circuit adds electrons to the water molecule forming H2 and negatively charged oxygen ions at high temperatures. These oxygen ions then pass through the ceramic membrane, which then reacts at the anode forming oxygen gas as well as generate electrons for the circuit. These electrolyzers require substantially more heat (700-800C) compared to PEM or alkaline electrolyzers operating closer to 100C. These electrolyzers could potentially be a lot more efficient, as they would use heat from available sources to reduce the amount of electricity required.

- **Electrolyzer capacity additions:** There are currently over 20GW of electrolyzer capacity planned to be added over the next 10 years. We estimate about 17GW of known projects in the planning stages scheduled to be delivered before 2030, with another 9GW of projects without a known start date, some of which we estimate would be completed this decade. Over half of these projects are in Australia with most of the remaining projects in Europe or Saudi Arabia.

Exhibits 13 & 14: There are over 20GW of electrolyzer capacity projects in the pipeline over the next decade, with the majority in Australia and Europe.

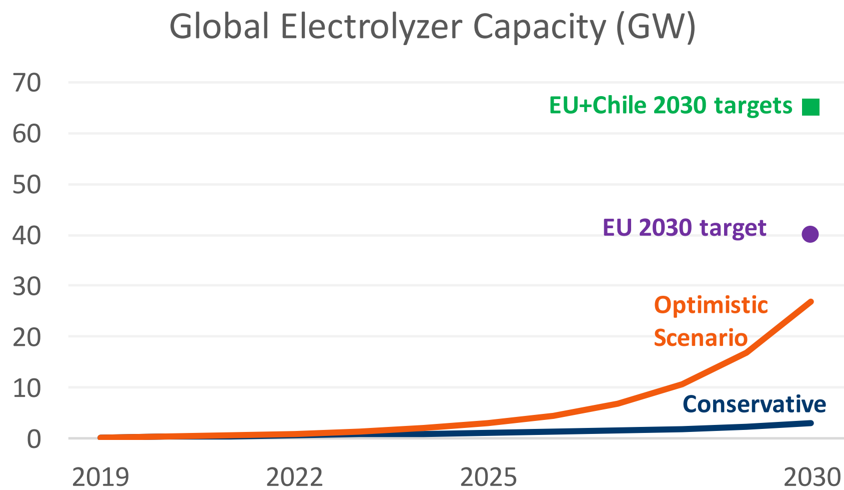



Source: Bloomberg NEF, BTIG Research; *projects without planned start date labeled as NA




Source: Bloomberg NEF, BTIG Research

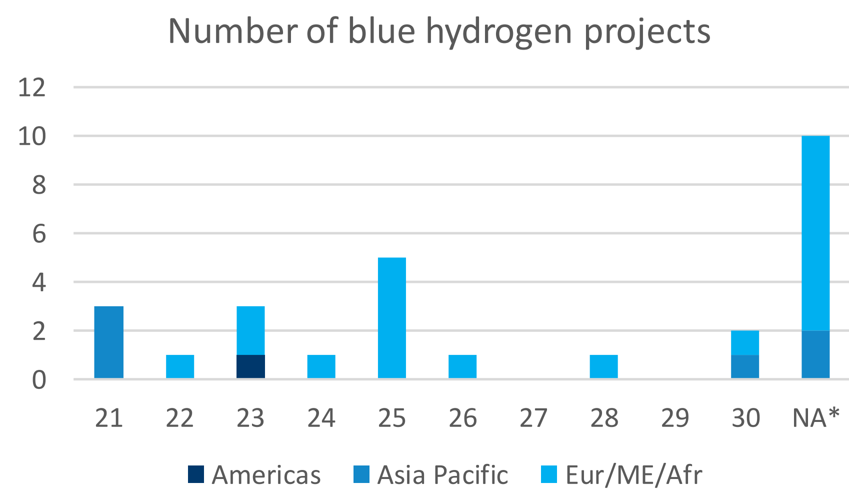
Exhibit 15: In an optimistic scenario, we see close to 30GW of global electrolyzer capacity built out by 2030, while a conservative scenario only sees 3GW come to fruition. Both are substantially below the targets put out by the EU and Chile of 40GW and 25GW respectively, which would require substantial governments support.




Source: BNEF, BTIG Research

- **Low carbon blue hydrogen projects:** Blue hydrogen projects, that make use of CCS (carbon, capture, and storage) are also gaining traction. The lion's share of these projects would use natural gas as a feedstock to create hydrogen through steam methane reforming. The economics of blue hydrogen are currently a lot more attractive compared to green hydrogen (see Hydrogen Economics section for details), while carbon storage capacity is plentiful, with over 14,000 Gt of global capacity, which equates to hundreds of years of storage if all CO2 emissions were sequestered. There are about 30 blue hydrogen projects that have been announced so far, but details around size and scope remain scarce. Several blue ammonia projects have also been announced, and just last year we saw the world's first shipment of blue ammonia from Saudi Arabia to Japan (we note ammonia has been transported on tank barges in the US for decades).

Exhibit 16: There are close to 30 blue hydrogen projects with CCS, although their capacity is currently unknown.



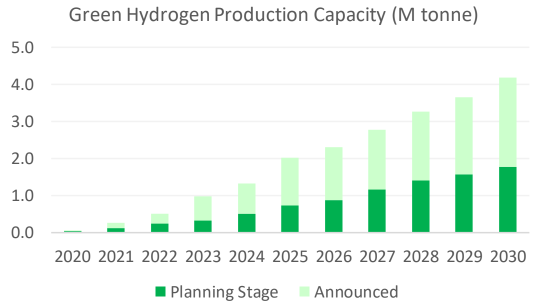

Source: BNEF, BTIG Research

- **Electrolyzer manufacturing capacity:** Shipments of electrolyzers have increased from 135MW in 2018 to 200MW in 2020, a nearly 50% increase, but still a very small amount. The current capacity to manufacture electrolyzers is 3-5GW/year, with over 2/3 in the hands of 5 companies. This is sufficient to meet current construction projects, but in order to meet larger long-term targets, global electrolyzer capacity needs to increase exponentially.

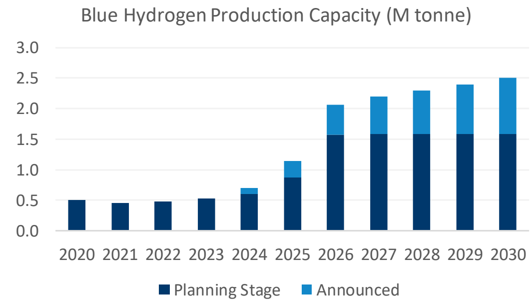
- **How much green hydrogen can electrolyzers produce:** Currently it requires ~50kWh of electricity to produce 1kg of hydrogen at 100% efficiency. This implies that at 100% efficiency a 1GW electrolyzer would produce around 175M kg of hydrogen per year. But because sun and wind (think power) are intermittent and at variable intensity levels, we expect an efficiency factor of 30-50%, implying that 1GW of renewable electrolyzer capacity will generate 50-90M kg of hydrogen per year. Or 20GW of electrolyzer capacity translates into 1-2B kg of hydrogen per year or 1-2M tonnes. This pales in comparison to the 70M tonnes of blue/gray hydrogen being produced per annum for industrial use (there is a lot of work to do).

- **Total hydrogen capacity through 2030:** While we estimate the announced green hydrogen electrolyzer projects through 2030 could produce up to 2M tonnes of hydrogen at most, the Hydrogen Council (see next bullet point) estimates that announced green hydrogen projects could potentially bring green hydrogen production to 4M tonnes/annum by 2030. However, to date just under 2M tonnes of those have either been FIDed or are in the planning stage, with the rest considered more preliminary. In addition, there are another 2.5M tonnes of low carbon blue hydrogen projects, of which about 1.5M have either been FIDed or are in the planning stages. The total project pipeline of nearly 7Mtpa has tripled since 2019 (the pace is picking up).

Exhibits 17 & 18: According to the Hydrogen Council, there are 4Mtpa of green hydrogen and 2.5Mtpa of blue hydrogen projects in the pipeline through 2030, with just over 3Mtpa considered to be mature.




Source: Hydrogen Council, BTIG Research

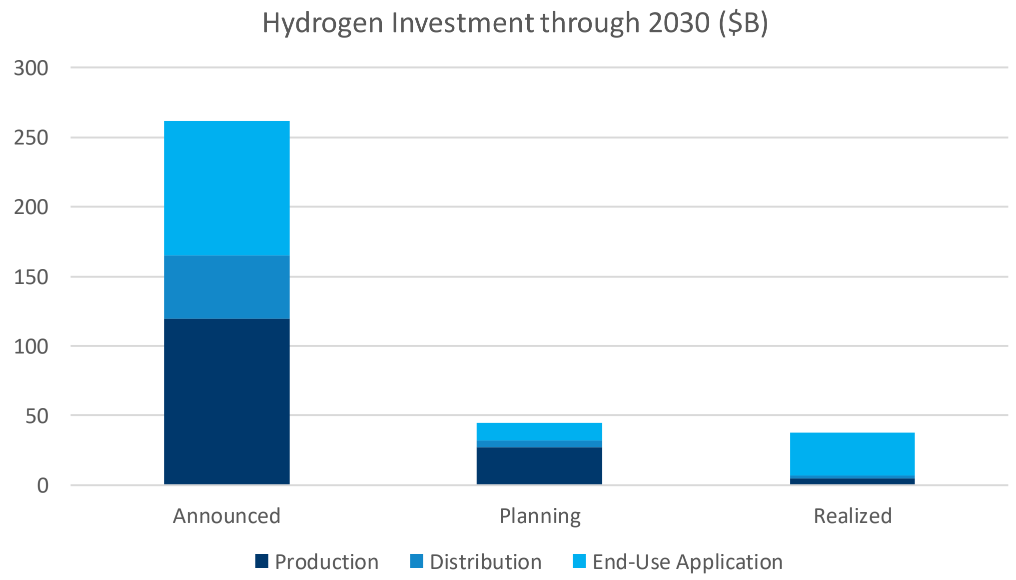



Source: Hydrogen Council, BTIG Research

- **Hydrogen Council**: The Hydrogen Council is a CEO-led initiative created in 2017 with a long-term vision for hydrogen as a clean energy fuel. In just the last year the Hydrogen Council has grown from 60 members to over 100 members. Members included large and small oil and gas companies, automobile companies, major industrial companies, and companies solely focused on hydrogen. The members of the Hydrogen Council plan to increase their hydrogen investment six-fold through 2025 and 16-fold through 2030.

- **Announced investment:** So far over 200 projects have been announced across the hydrogen value chain, coming to over $300B in investment through 2030, or about 1.4% of global energy funding. Over $80B are for projects that have at least reached the planning stage, and of these about $40B have been FIDed. The value chain of investments includes hydrogen production (green or low carbon blue hydrogen), hydrogen distribution, and end-use applications. Most of the FIDed investments are currently for the end-use application, related to fuel cells and hydrogen vehicle platforms. However, more than half the projects in the planning stages and preliminary stages focus on production.

Exhibit 19: Over $300B in hydrogen investment through 2030 has been announced, of which about $80B are for projects that have at least reached the planning stage.




Source: Hydrogen Council, BTIG Research

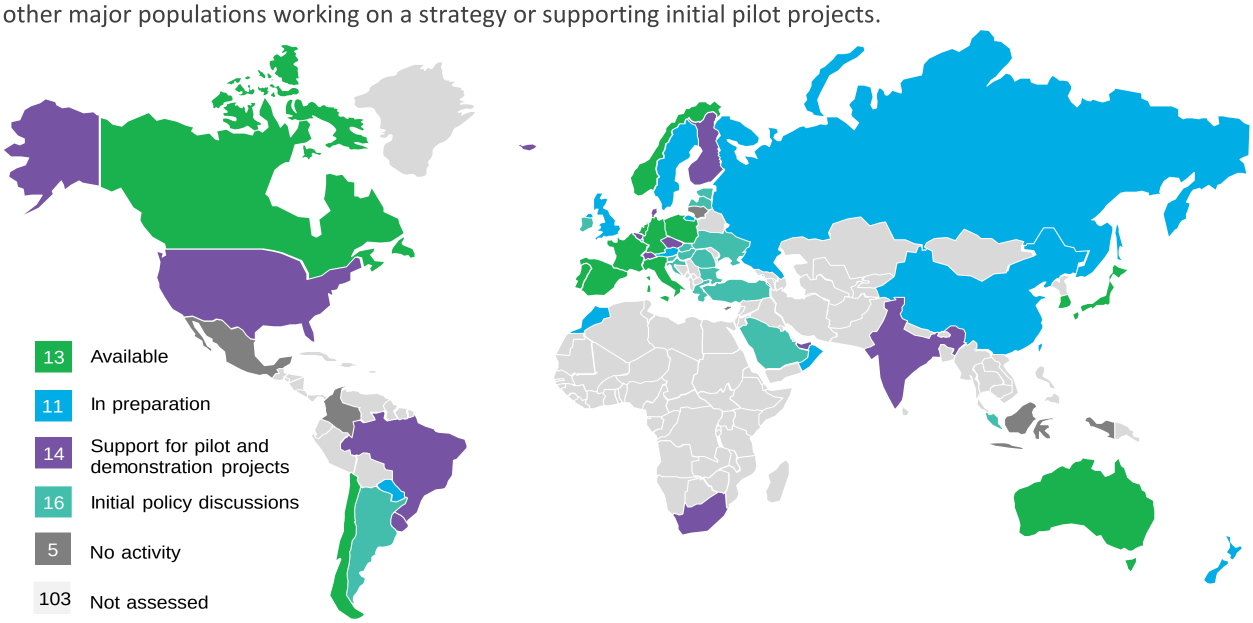
## V. Hydrogen Policy Needed - Not Unlike Solar, Wind, and Oil and Gas

- **Leading the Hydrogen Charge.** Not surprisingly the lion's share of the countries focused on building hydrogen power are based in Europe. This makes sense for two reasons with the first being their commitment to Paris Accord where countries choose their path to achieve carbon neutrality with most countries committing to becoming carbon neutral by 2050. And while wind and solar are expected to provide increasing percentages of Europe's power, other sources of energy will be needed to achieve carbon neutrality by 2050. Interestingly, whether it's batteries (largely expected to be from renewables going forward), coal, oil, or hydrogen each is really just a different form of energy storage (think power on demand). Hence despite the current high cost of hydrogen (costs are expected to come down), hydrogen's ability as a power source (we note not as efficient as other power sources) and its ability to be transported point to hydrogen being part of the greener global power market of the future.

- **Need for policy:** Green hydrogen is still in its early innings (really Spring Training) and not unlike electric vehicles over a decade ago or wind and solar a few decades ago. Additionally, hydrogen energy is more expensive than other traditional energy molecules, because, unlike fossil fuels that need to be extracted from the ground, hydrogen energy is manufactured and requires both energy (cost of renewable energy) as well as electrolysis (cost of production). Therefore, similar to EVs roughly a decade ago, hydrogen will require subsidies 1) to encourage investment, 2) drive down the cost of electrolysis, and 3) build critical mass. It is estimated that we may need $150B in cumulative subsidies through 2030 to help push projects forward. In addition to initial subsidies, taxes on carbon, like the ones already instituted in some countries in Europe, are likely needed to make green hydrogen a viable replacement fuel in many industries.

- **Current hydrogen policy:** Currently ~75 countries (roughly half of global GDP) have announced net-zero carbon ambitions. This includes 30 countries that have published roadmaps to bring hydrogen into their energy mix, with 13 countries already having clear-cut hydrogen strategies at the start of 2021 and another 11 countries working on hydrogen strategies with an expectation that these countries publish their roadmaps over the next 1-2 years. We note more than a few countries and companies have committed to net-zero much in terms of tangible plans in achieving these announced goals.

Exhibit 20: Hydrogen strategy is available in much of Europe, Canada, Chile, Japan, South Korea, and Australia, with other major populations working on a strategy or supporting initial pilot projects.



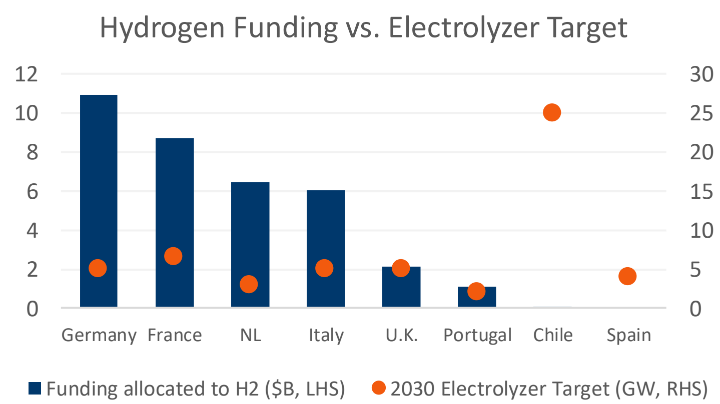

Source: Bloomberg NEF, BTIG Research

- **European Union Policy Rollout:** The EU rolled out its hydrogen strategy in mid-2020, which requires all member states to draft a hydrogen plan and calls for decarbonization through hydrogen in 3 phases. Phase 1 requires the decarbonization of existing hydrogen production by 2024 by installing at least 6GW of hydrogen electrolyzers and producing up to 1M tonnes of renewable hydrogen. Phase 2 calls for the deployment of 40GW of electrolyzers by 2030, producing up to 10M tonnes of renewable hydrogen, allowing expanded use into industries like steelmaking, trucks, rail, and ships. Phase 3 calls for expanded use of hydrogen into sectors that cannot be otherwise decarbonized, by 2050. Countries including France, Germany, Spain, and Portugal have all announced hydrogen consumption targets in their national strategies, while quotas for aviation and shipping fuel are also in advanced discussions.

- **Chile:** In 2020, Chile announced its hydrogen strategy, identifying hydrogen as a way to decarbonize its economy and as a major new industry that will transform the country's dependence on mining and exporting non-renewable resources (the plan is to shift to exporting hydrogen). Chile's targets include building 5GW of electrolyzer capacity by 2025 and 25GW of electrolyzer capacity by 2030. The initial stage will focus on replacing grey hydrogen with using locally produced green hydrogen, followed by using hydrogen to decarbonize local heavy-duty trucking and blending it into the natural gas grid. Chile also has ambitions to start exporting green ammonia by 2030 and exporting green hydrogen next decade.

- **The UK:** announced its Green Stimulus plan in late 2020 that targets 5GW of installed low carbon hydrogen capacity by 2030. The UK looks to be taking a more measured approach in focusing more on the transition to hydrogen than on the color of the hydrogen. We like that strategy as from an economic cost and volume perspective we have concerns around the rollout of green hydrogen. While using a combination of green hydrogen (electrolysis) and blue hydrogen (steam methane with CCS) should help hydrogen demand to grow and give time for green hydrogen to mature into a more established market.

Exhibit 21: Some of the biggest countries in Europe have committed the most hydrogen funding, while Chile has the most aggressive electrolyzer target, with limited committed government funding.




Source: Bloomberg NEF, BTIG Research

- **Australia** is pushing its hydrogen agenda aggressively as it looks to leverage its growing solar and wind power generation network. As a major commodity exporter of coal, Australia has a lot at stake as steam coal demand is projected to drop over the next few decades. Hence the pivot to hydrogen makes sense and it is worth noting, Australia is more focused on creating a regional hydrogen network with Australia producing hydrogen and exporting it (Europe is largely targeting local consumption). Australia has two advantages as it looks to export hydrogen: 1) vast amounts of land which will produce solar and wind to power electrolyzers, and 2) an abundant water supply stranded in Northern Australia (currently being used to produce traditional commodities). And while Australia has not committed to hard and fast carbon emissions dates (the Australian government has noted talk is cheap) it has given major project status to the Asian Renewable Energy Hub (AREH) which plans to use 23GW of renewable energy to produce green hydrogen with the first production in 2027.

- **US playing catchup:** While many countries were moving forward with their hydrogen agendas over the last few years, the US did not. And while state-level incentives like California's Low Carbon Fuel Standard (LCFS) have carbon credits trading at ~$200/t, lack of a long-term coordinated hydrogen agenda at the federal level probably sees the US lag China and Europe in the drive for green hydrogen. Additionally, unlike some nations aggressively pushing hydrogen agendas, the US is one of the largest oil producers in the world which is probably why the 2020 stimulus bill earmarked more money for CCS than hydrogen. Yes, the current administration has pledged the US would cut emissions by at least 50% by 2030 and create a net-zero emissions economy by 2050, but currently, the US has no hydrogen strategy.

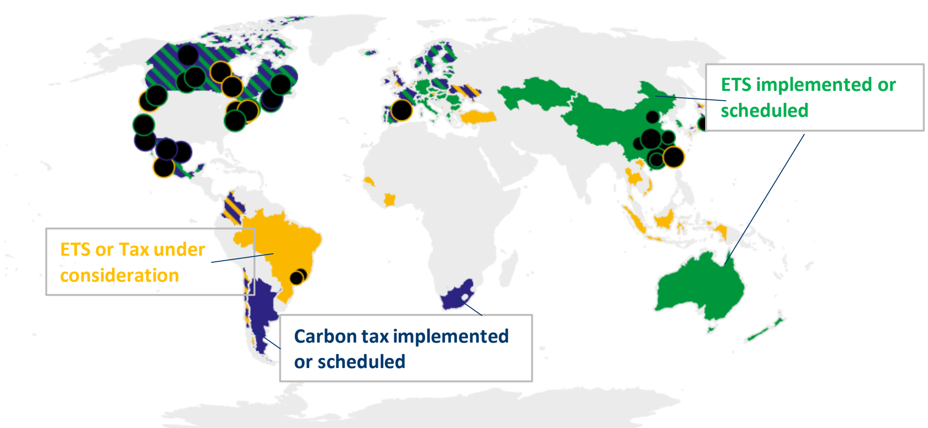
- **China targeting fuel cells:** China is the largest GHG emitter in the world, a title they are expected to maintain for at least the next few decades. And while China has pledged net zero emissions by 2060, there are multiple red flags on their ability to achieve this target (not unlike with many other countries and companies). Now as part of their push for reduced GHG emissions, the government plans to have 10,000 hydrogen fuel cell vehicles on the road by 2025 along with 80 hydrogen filling stations and it is targeting to have over 1 million fuel cell vehicles (both commercial and passenger) on the road by 2030.

- **More Funding is Needed.** The Hydrogen Council estimates that governments worldwide have committed over $70B in public funding for hydrogen (we note this figure most likely represents pledges without concrete timelines). Looking at Europe it allows investors in hydrogen to apply for EU funding with some countries (France and Germany) separately committed to the substantial funding of hydrogen projects. In Chile, the government has only announced $50M in funding but is hoping to attract private money through incentives. Australia plans to invest A$18B (US$13B) into low carbon technology including hydrogen in the coming decade with a goal of achieving a 5:1 private to public investment ratio. The AREH is expected to cost $36B and is a key project in Australia's push to become a hydrogen hub. UK's 2020 green stimulus package offers £500M for hydrogen through 2030.

- **Carbon pricing** should help shift the societal costs of GHG emissions to CO2 producers and incentivize less CO2 emissions. There are two mechanisms by which this can be achieved. (i) An ETS (emissions trading system), caps the total of GHG emissions and allocates credits to different industries; the credits can then be traded and establish a market price for carbon. (ii) A carbon tax system on the other hand directly imposes a tax on CO2 emissions. The key difference is that an ETS has a predetermined reduction in CO2 emissions, but not a predetermined price, while a carbon tax system has a predetermined CO2 price, but not a clear CO2 reduction outcome. We have seen an ETS type system implemented in the EU since 2005, while other countries like Argentina or South Africa have a carbon tax system. Most recently, in 1Q21, China implemented a national ETS system for CO2, which initially covers 30% of China's total emissions.

Exhibit 22: Map of ETS or carbon pricing system (or both) implemented.

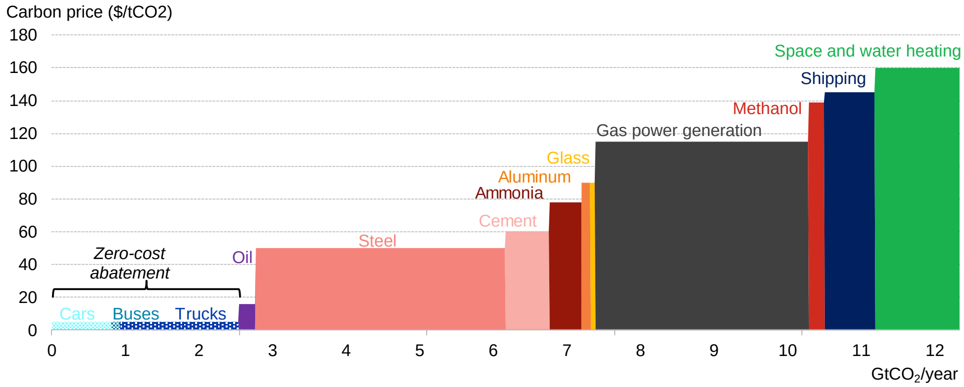
Map of National and Regional Carbon Pricing Initiatives




Source: World Bank, BTIG Research

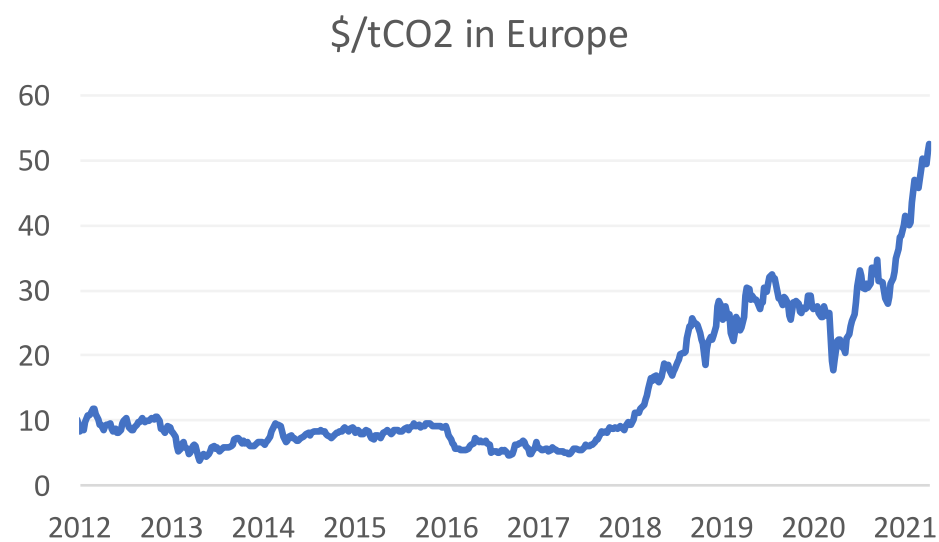
- **Carbon pricing makes hydrogen economic across more industries:** We estimate that even if we can lower the production cost of hydrogen to just $1/kg, we would still need a CO2 price of $100/t to incentivize industries like Steel, Cement, and Aluminum to convert to hydrogen if the decision was solely a financial decision. Currently, gray hydrogen production emits almost 1GtCO2 per annum, while industries that green hydrogen could help decarbonize emit another 12GtCO2, which is 1/3 of total global CO2 emissions. We estimate that a carbon price of $150/t could make it economic to convert most of these industries (gas power generation, shipping, and water heating) to hydrogen. While most carbon pricing mechanisms today have a CO2 price of under $20/t, the recent surge in C02 pricing in Europe (carbon is up over 60% YTD) with carbon in mid-May at $65/tonne could be a sign of things to come.

Exhibit 23: We estimate that a carbon price of at least $150/t will most likely be required to help incentivize some industries to switch to Hydrogen by 2050 if the decision is solely a financial decision.




Source: World Bank, BTIG Research

Exhibit 24: The price of CO2 traded in Europe has recently risen north of $60/t.




Source: Bloomberg, BTIG Research

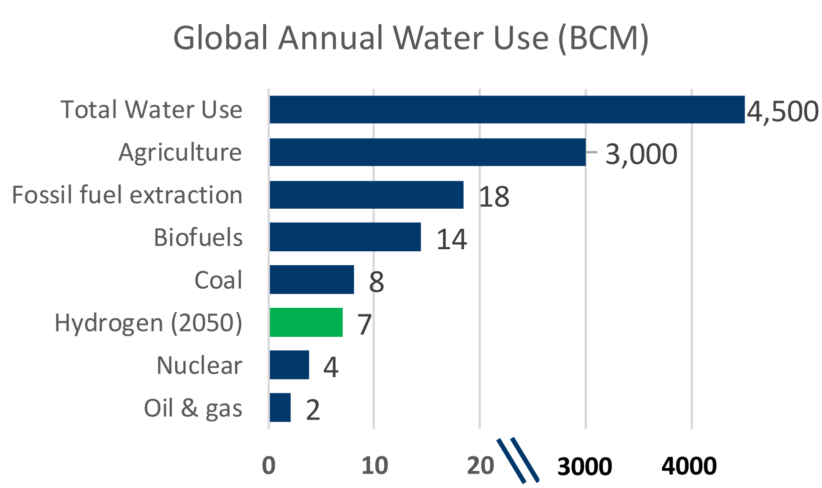
## VI. Water Wars – Probably Not So Much

- **Availability of water is scarce…** While over 70% of the earth's surface is covered with water, only 3% of it is fresh water and just 0.5% of it is accessible fresh water, as a large portion of the fresh water is trapped within the polar caps (unfortunately less by the day). This 0.5% of the earth's surface equates to about 1M square miles. While this may seem like a large area, like most commodities, water is not distributed evenly and hence many people have poor access to drinking water. It is estimated that around 50% of the world's population lives in areas with water scarcity on a continual basis (at least once a month per year).

- **…but surprisingly (at least to us) hydrogen requires a lot less water than some other industries.** Currently, the world uses just over 4,500 Bcm of water per year (over a quadrillion gallons). However about 2/3 of it or ~3,000Bcm is consumed by agriculture, while industrial uses account for ~20% (1,000 Bcm) and domestic uses about 10% (500Bcm). Industrial uses are broad-based with water use estimates for fossil fuel extraction and processing at about 18Bcm of water with biofuel irrigation and processing about 14Bcm (combined just ~3% of industrial water use). Meanwhile, hydrogen, which consumes 10L (~2.5gallons) of water/kg of hydrogen during electrolysis, would in an optimistic scenario require just 7Bcm of water in 2050, slightly lower than 8Bcm used by coal today. This equates to just about 0.2% of global water consumption in 2050 for hydrogen, while the net effect could actually end up water neutral, as hydrogen would replace other fuels that require water to produce. Our bigger concern may be putting electrolyzers in water-scarce regions, such as the Middle East to harness the region's abundant solar resource. Desalination is always an option but that adds to the total cost and requires energy.

- **Salt water?** There is no scarcity of salt water, in fact, there is arguably too much of it. Unfortunately, the electrolysis process to create hydrogen currently requires fresh water for the electrolyzer to function properly. Although future technology may unlock a way to convert ocean water into hydrogen directly, this is not the case today. However, desalination of ocean water is an option in regions like the Middle East that have a scarcity of fresh water. And just like most technologies, the cost of desalination has decreased substantially over time. In the 1960s desalination started to be scaled up, with costs declining from $30/1000 gallons to as low as $3.5/1000 gallons today. Since we need ~2.5gallons of water to produce 1kg of hydrogen, the cost of desalination would add less than $0.01/kg. Desalination would require a significant amount of energy, but that could come from renewable energy just like hydrolysis. Another potential concern around desalination is what to do with the salt brine leftover, which is typically dumped back into the ocean and could disrupt the natural habitat.

Exhibit 25: While hydrogen electrolysis is water-intensive, the amount of water required for electrolysis in our 2050 optimistic scenario is relatively low compared to other energy and non-energy uses of water.




Source: Hydrogen Council, BTIG Research

- **Hydrogen Truck Water Economics in Perspective:** A FCEV truck traveling 100,000 miles/year requires about ~37 KG of hydrogen per day (~7.5 Miles/Kg), so 2.5 gallons of water per kg of hydrogen points to just over 90 gallons of water/day. Putting that into perspective an average American uses 80-100 gallons/day directly, but that can be more than 10x indirectly (a hamburger takes over 660 gallons to grow). Meanwhile, the average golf course uses ~310,000 gallons per day. And while we love our golf, the simple math points to the water consumption of a golf course being able to power 2,700 hydrogen trucks annually.

- **Just Because It is a Topical Concern.** With the Colorado River water rights being called into question once again (water levels are at ~41% of the average rate) we thought it worthwhile to at least consider the call on freshwater to supply the Class 8 truck market with hydrogen. And while one or even 10 stations does not make a dent in the US water supply, transitioning the roughly 2.8M Class 8 trucks in the US to hydrogen (if that is even possible it would be a 2-4 decade process), could push water demand for the Class 8 truck market to ~110B gallons annually. That is equivalent to the usage of ~3,000,000 Americans or the water demand of ~1,000 golf courses. And while water is cheap in the USA at roughly $4-6 per 1,000 gallons, in a place like Belgium water costs can be as high as ~$25 per 1,000 gallons while in Germany it is ~$10 per 1,000 gallons. Like most of the hurdles around hydrogen, government policies that actually address these issues in a sustainable way will most likely be required.

Exhibit 26: While freshwater costs have the potential to change over time (think increasing demand and climate change) increases in water costs should have a limited impact on the price of hydrogen.

| | | Cost per Kg of Hydrogen<br>Price of Water per 1,000 Gallons | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | $3 | $5 | $7 | $10 | $15 | $20 | $25 |
| Utilization | 20% | 3.73 | 3.73 | 3.74 | 3.75 | 3.76 | 3.78 | 3.79 |
| | 40% | 2.94 | 2.95 | 2.95 | 2.96 | 2.98 | 2.99 | 3.00 |
| | 60% | 2.68 | 2.68 | 2.69 | 2.70 | 2.71 | 2.73 | 2.74 |
| | 80% | 2.55 | 2.55 | 2.56 | 2.57 | 2.58 | 2.60 | 2.61 |
| | 100% | 2.47 | 2.47 | 2.48 | 2.49 | 2.50 | 2.52 | 2.53 |

Source: Company Data, BTIG Research

## VII. Hydrogen Economics – Costs Are Set to Come Down

- **Cost components of green hydrogen:** Primary cost components of green hydrogen are the cost of renewable energy and the cost to build and run an electrolyzer. In addition, if it is not used at the production site the cost of transportation and storage needs to be considered. Currently, hydrogen costs $3-5/kg to produce, but that is expected to dip to $1.50-2.50 by 2030. Storage of hydrogen using the most economic methods costs $0.20-$0.50/kg, while transportation would likely cost $0.10-$0.50/kg by pipeline, but north of $2/kg by ship, and as high as $1/kg by truck. Therefore, the cost of hydrogen can more than double when shipped. In this section, we dive deep into the makeup of each cost component and provide additional details around the numbers.

- **The cost of hydrogen production:** Today renewable hydrogen costs between $3-$5/kg to produce compared to low carbon hydrogen with carbon capture, costing $1.50-$3.00/kg to produce. Renewable hydrogen is expected to decline to $1.50-2.50 by 2030 and $0.70-$1.60 by 2050.

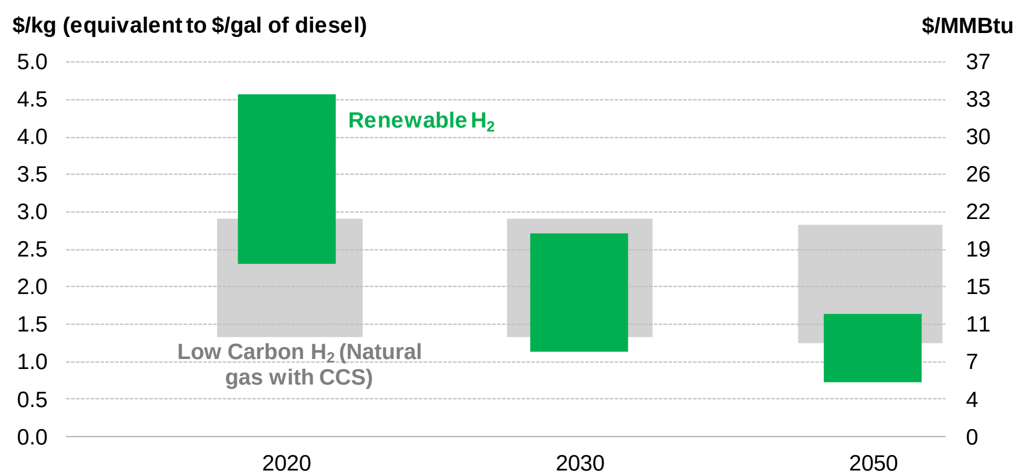
    - *Comparing to diesel:* 1kg of hydrogen has an energy content of ~135k BTU similar to a gallon of diesel. Today a gallon of diesel costs about $3 in the US and $6 in Europe compared to hydrogen at $3-$5 to produce (does not account for H2 transport or storage costs or any margin).

    - *Comparing to natural gas:* $1/kg of hydrogen equates to $7.40/MMBTU versus the current cost of natural gas in the US at ~$3/MMBTU, in Europe at ~$6/MMBTU, and in Asia at ~$9/MMBTU. We believe the higher cost of hydrocarbons in Europe versus the US is one of the key drivers behind Europe's push to accelerate hydrogen adoption. The cost of renewable hydrogen today implies $20-30/MMBTU, but by 2030 is expected to drop to $10-20/MMBTU and in 2050 $5-10/MMBTU. It is important to note this assumes no price on carbon (tax or credits).

    - Bottom line: the cost of hydrogen is currently too high (part of why the transition has been slow to start), but should become more competitive next decade (2030+).

- **LCOH model:** We have put together a model calculating the Levelized Cost of Hydrogen (LCOH) -based on key underlying assumptions, which allows us to tweak assumptions such as the cost of energy, electrolyzer capex, and other key factors and see the impact on the cost of hydrogen production.

Exhibit 27: We expect a substantial drop in the cost of renewable hydrogen over the next 10 years.

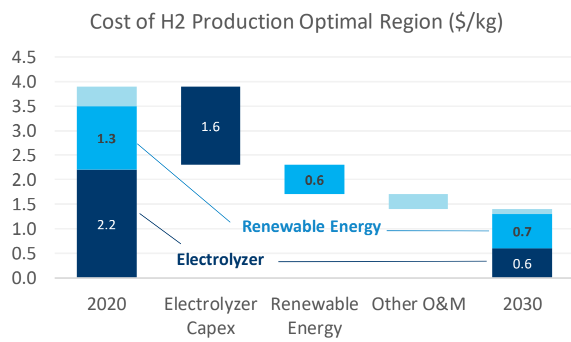



Source: BNEF, BTIG Research

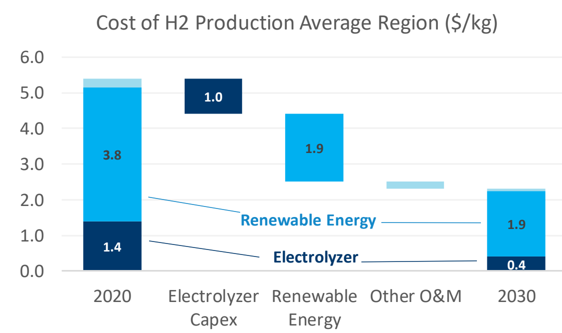
- **Hunting for cost declines:** The decline in the cost of hydrogen will be driven by declines in the cost of renewable power and electrolyzer costs. In the past 10 years, the cost of wind and solar has declined from over $100/MWh to under $40/MWh in certain regions. We expect that the cost will decline further to below $30/MWh by 2030 and potentially (think 2050) to around $20/MWh in regions with the most abundant wind and solar resources. Meanwhile, capex to build electrolyzers is around $500-1000/KW, but that cost is estimated to be as low as $200/KW for large-scale electrolyzers made in China. We expect Western-built electrolyzer prices to converge towards Chinese equipment over the next decade, with Chinese-built electrolyzers expected to drop below ~$150/KW by 2030 and $100/KW by 2050.

- **Not All Hydrogen Markets Created Equally.** According to the Hydrogen Council, hydrogen production in optimal regions is around $4/kg (higher than BNEF estimates, which is evidence of the diverging camps around costs). About $2.2/kg comes from the cost of the electrolyzer and over $1.3/kg comes from the cost of renewable energy. Over the next 10 years, the total cost of hydrogen in optimal regions could dip below $1.5/kg, with the majority of the drop coming from a 70% drop in electrolyzer capex reducing the cost by $1.6, and a 50% drop in renewable energy costs dropping the cost of hydrogen by $0.6/kg. However, we note the numbers are quite different in regions that do not enjoy the lower-cost renewable energy. According to the Hydrogen Council, hydrogen tends to cost over $5/kg in these higher-cost renewable power regions (think less sun and wind), with nearly $4/kg of cost from renewable energy and $1.4/kg from electrolyzer capex. The average region may see the cost of hydrogen production approach $2/kg, with the majority of the cost decline coming from cheaper renewable energy.

Exhibits 28 & 29: The potential exists for decreases in hydrogen production costs driven by lower electrolyzer and energy costs. Below we show the high end of the cost curve in 2020 and a cost decline bridge through 2030.



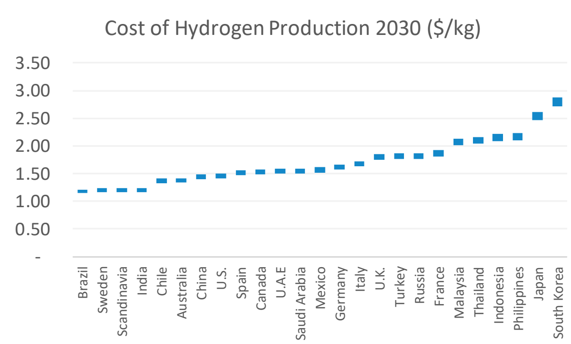

Source: Hydrogen Council, BTIG Research



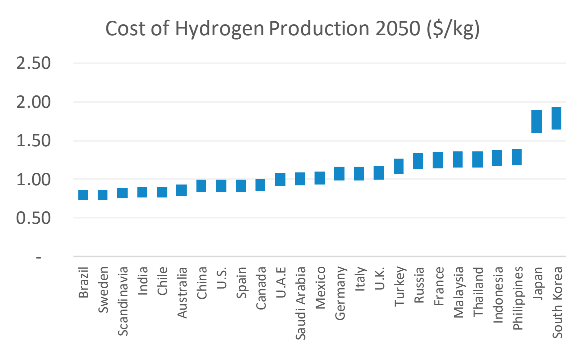

Source: Hydrogen Council, BTIG Research

- **Geographic cost differences:** There are significant differences in the cost of green hydrogen production by geography, as regions with abundant renewable resources have the advantage. These countries include Brazil, India, Chile, Australia, China, and the US, as well as Scandinavian countries.

Exhibits 30 & 31: Hydrogen costs are driven largely by the availability of low-cost renewable solar and wind.



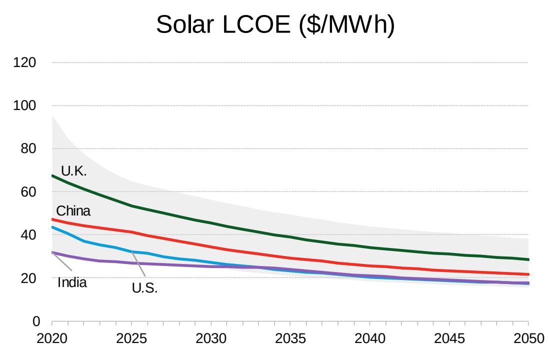

Source: Bloomberg NEF, BTIG Research



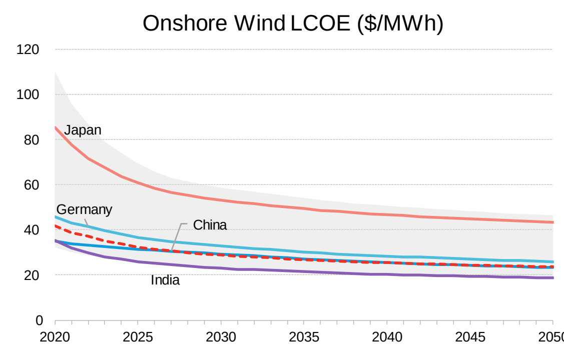

Source: Bloomberg NEF, BTIG Research

- **Cost of renewable power:** Solar and onshore wind costs have declined substantially over the last decade from costing over $100/MWh less than a decade ago to sub-$40/MWh in certain regions (cheaper than burning fossil fuels). India and the US are examples of low-cost producers of both wind and solar (helps to have diverse geographies). Not surprisingly, while the UK is an example of a low-cost wind producer, the cost of solar in the UK is high. However, further cost declines around renewables are still needed to make hydrogen economic. Cost declines from massive deployment of renewable power worldwide should continue to drive down costs, while increased demand for solar and wind needed for the production of hydrogen should drive additional scale and further cost declines. We estimate that by 2030, onshore wind and solar will be ~$25/MWh, and by 2050 could dip below $20/MWh (cheaper than fossil fuels).

Exhibits 32 & 33: The cost of solar and wind power has declined substantially, with some regions having substantially lower cost resources.




Source: Bloomberg NEF, BTIG Research

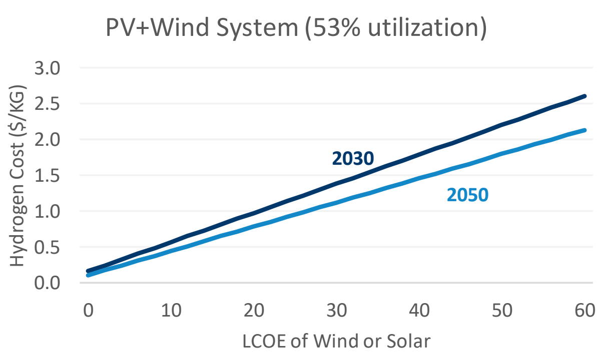



Source: Bloomberg NEF, BTIG Research

- **Converting the LCOE of energy into $/kg of hydrogen:** It currently requires 50KWh of electric energy to generate 1kg of hydrogen. Therefore, we multiply 50KWh needed to produce 1kg of hydrogen by the LCOE (Levelized Cost of Energy) of wind or solar, which at the low end is ~$40/MWh ($0.04/KWh). This points to an energy cost of $2/kg of hydrogen. As the LCOE of renewable energy declines, so should the cost of hydrogen. Also, as newer electrolyzers require less than 50KWh to produce a kg of hydrogen (the theoretical minimum is 39KWh), over time this too could reduce the cost to produce 1kg of hydrogen.

- **Hydrogen price sensitivity:** Assuming fixed forecasts for electrolyzer capex in 2030 and 2050, the LCOE becomes the biggest cost variable. Assuming a wind and solar system has 53% utilization (think time sun or wind is present), we could see the cost of hydrogen in 2030 at an LCOE of $50/MWh translate into a cost of hydrogen of just over $2/kg, while an LCOE of $30/MWh translates into the cost of hydrogen sub-$1.50. To dip below $1/kg, we would need to see the LCOE of wind and solar drop below $20/MWh.

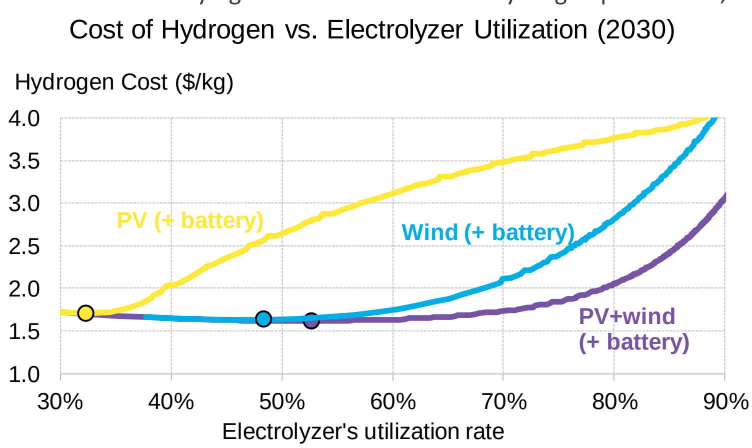
Exhibit 34: The difference between renewable energy costs of $50/MWh and $30/MWh in 2030 implies a cost of hydrogen north of $2/kg and sub $1.5/kg.




Source: BNEF, BTIG Research

- **Renewable electrolyzer utilization rates:** Because the sun and wind are intermittent sources of energy, the maximum utilization rates for solar-powered electrolyzers without the use of backup power are usually in the low 30% range, while utilization for wind-powered electrolyzers is in the high 40% range. Combining solar and wind puts utilization into the low 50% range before overlaying the system with batteries. Because the cost of batteries is higher than solar or wind, using batteries to raise utilization increases the cost of hydrogen. When using solar alone, increasing utilization by 10% raises the cost of hydrogen by $0.60/kg, when using wind alone it costs $0.40/kg, and when using combined solar and wind the cost is under $0.05/kg for the first 10% and $0.15/kg for the next 10%. Ultimately, the optimum utilization for a hydrogen electrolyzer will depend on the market price of hydrogen, and if the higher cost power from batteries can still generate a good return.

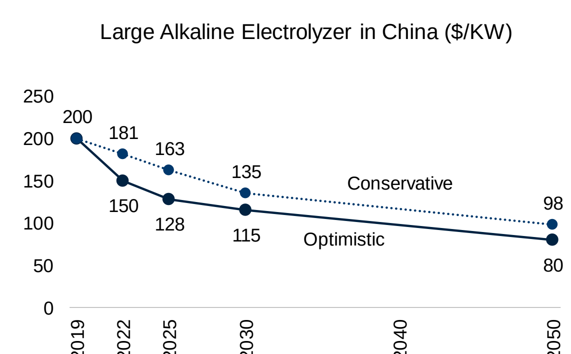
Exhibit 35: Overlaying batteries can increase hydrogen production, albeit at a higher cost of production.



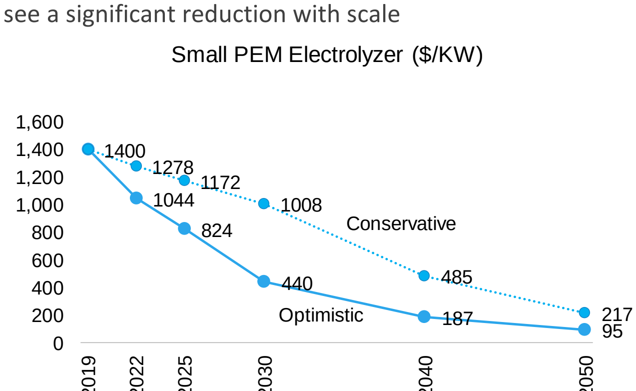

Source: BNEF, BTIG Research

- **Electrolyzer Evolution:** In the 1950s, it cost $3,000/kW and in the 1980s it dipped below $2,000/kW, and then stayed flattish into the mid-2010s. More recently the cost of electrolysis has dipped below $1,000/kW for an average western produced PEM electrolyzer with prices quoted as low as $500/kW, while in China alkaline electrolyzers are $200/kW, although channel checks suggest that the $200 figure may exclude certain cost components and may require more maintenance. Economies of scale have helped drive efficiencies with the average electrolyzer 20 years ago ~0.1MW versus about ~1MW currently. And as hydrogen projects move towards commercial production (larger electrolyzers) efficiencies are only set to increase with electrolyzers reaching 5MW on their way to over 10MW. All the while we see further cost reduction from modular construction techniques including increased automation. And with demand increasing from about ~135MW of electrolyzers shipped in 2018, vs. 200MW in 2020, on its way to over 1GW/yr, manufacturers are improving the production process.

Exhibits 36 & 37: The cost of electrolysis is expected to see a significant reduction with scale



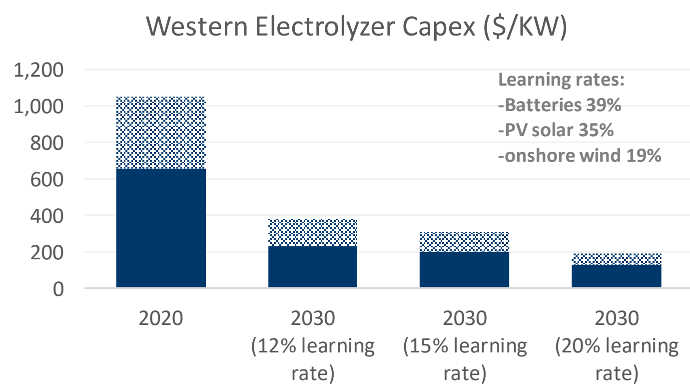

Source: Bloomberg NEF, BTIG Research




Source: Bloomberg NEF, BTIG Research

- **East vs. Western Electrolyzers:** The two electrolyzer technologies in the market are Alkaline and PEM with most electrolyzers currently Alkaline as this is an older technology and has seen greater cost reductions. Currently, 85% of electrolyzer sales are for Alkaline, and given its scale is likely to see larger cost reductions going forward. PEM electrolyzers are more likely to be used for niche applications (think space constraints given PEMs smaller footprint). Alkaline electrolyzer costs are estimated at $200/KW in China and $500-1,000/KW in the West, despite material costs being ~$100/KW. The high markup is due to the low utilization, unpredictable order sizes, and high marketing and R&D costs (as with any niche industry). Not surprisingly Chinese electrolyzer manufacturers benefit from lower costs of labor and material, as well as higher factory utilization (electrolyzer demand in China is more consistent); however, channel checks also point to higher operating costs and potentially shorter useful life with most potential electrolyzer buyers (now these are Western companies) more interested in buying Western electrolyzers than from China.

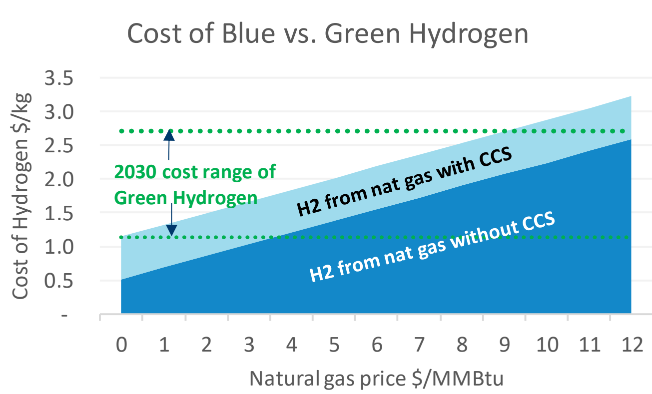
Exhibit 38: We see a substantial cost decrease potential for hydrogen electrolyzers, based on their learning rates. A learning rate implies a drop in cost per every doubling of manufactured volume. Assuming a 12% learning rate, electrolyzer costs could drop over 60% by 2030 while a 20% learning rate points to an 80% drop in costs.




Source: Hydrogen Council, BTIG Research

- **Blue hydrogen with CCS:** Hydrogen from natural gas is currently the cheapest option, costing ~$1/kg, at a natural gas price of $3/MMBtu. However, this type of hydrogen has substantial GHG emissions, hence we looked at Blue Hydrogen alternatives (overlaying CCS). We estimate blue hydrogen production costs $0.50-$1.50/kg for depending on cost of natural gas, while CO2 storage costs at ~$50-70/t of CO2 (translates to ~$0.50/kg of hydrogen production), which puts blue hydrogen at $1-2/kg, which is well below current green hydrogen prices of ~$3-$5/kg. Meanwhile, it is estimated that there are between 10,000 and 50,000 gigatonnes of CO2 storage capacity on earth, vs. 30-40Gt of CO2 production per year.

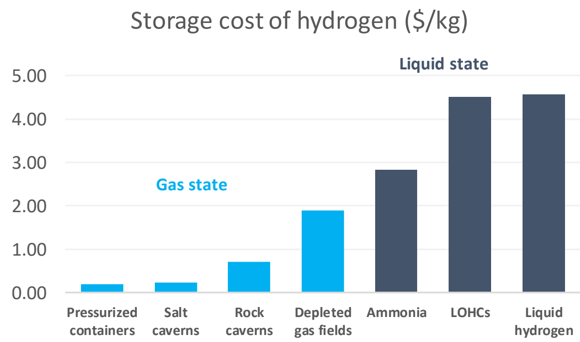
Exhibit 39: Blue hydrogen with CCS is a more economic alternative than green hydrogen in the near term.




Source: Hydrogen Council, BTIG Research

- **Hydrogen storage and transportation costs:** These range from $0.20/kg for H2 gas to north of $3/kg for liquid hydrogen. Storing gaseous hydrogen and transporting it by pipeline is rather inexpensive while liquefying, shipping, and regassifying costs substantially more. Small scale storage (5-1,000kg) is done in pressurized tanks while large scale (300-10,000t) can be done in salt caverns. And while salt caverns are the most economic, they require specific geology, which while available in Europe and the US, is less of an option in China or Japan. We note there is no shortage of storage options being explored (liquid hydrogen, storing as ammonia, rock caverns, and others), but the winners will be the cheapest options and right now that is salt caverns at ~$0.70/kg, while other solutions can cost $2-5/kg. Because green hydrogen comes from renewables (variable power), it could require up to 20% of annual capacity in storage. Assuming global hydrogen demand of 300MT-600MT by 2050, that points 60-120MT of storage, which points to 6,000-12,000 salt caverns at a cost of $300-600B (we note there are ~100 natural gas salt caverns today).

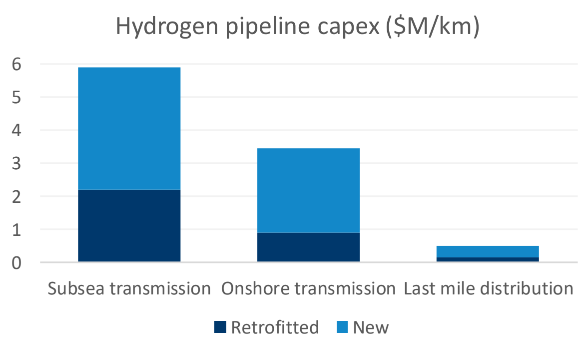
Exhibit 40: Pressurized containers for small-scale storage and salt caverns for large-scale storage are the most economic.




Source: BNEF, BTIG Research

- **Pipelines:** This is the cheapest way to transport hydrogen and can transport 10x the energy at 1/8 the cost compared to electric transmission lines. The capex associated with hydrogen pipelines is similar to natural gas, and more so, there is the possibility to repurpose natural gas infrastructure. And while hydrogen is ~3x greater than nat gas volumetrically, it does travel at 3x the speed which puts the overall cost of transporting hydrogen over 100km of high capacity pipeline at ~$0.10/kg. There are three types of pipelines: onshore transmission pipelines, subsea transmission pipelines, and distribution pipelines focused on last-mile delivery. Not surprisingly, subsea transmission is the most expensive at ~$2M/km to retrofit and $6M/km for a new pipeline. Onshore transmission is roughly half the cost of subsea pipelines, costing ~$1M/km to retrofit and ~$3M/km to build. Lastly, distribution network pipelines are the least expensive requiring a capex ~$100-200k to retrofit and $500k to build new. Key to hydrogen adoption will be its continued production closer to the area of consumption and its ability to be blended into natural gas up to 20%, with new pipelines and retrofits a longer-term investment as hydrogen is adopted.

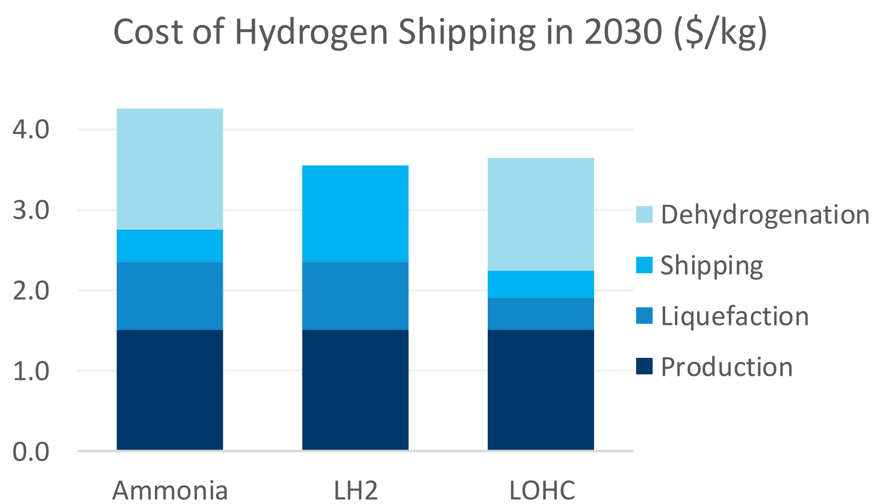
Exhibit 41: New pipelines cost 3x of a retrofit, but hydrogen can be blended up to ~20% with natural gas.




Source: BNEF, BTIG Research

- **Maritime and over-the-road:** There is a lot at stake for a lot of countries and industries in the ongoing energy transition with the potential for legacy industries to fade away. Not surprisingly some of the largest shipbuilding nations in the world are allocating a lot of capital and resources towards building ocean-going hydrogen carriers. Not unlike liquified natural gas (LNG) it will most likely be converted into a liquid: (i) LH2, pure liquid hydrogen, (ii) LOHC, liquid organic hydrogen carriers, or (iii) Ammonia. Pure hydrogen is unstable hence, a derivative compound could win out. And while it is early days, initial chatter points to $0.50-$1.00/kg for shipping alone, while together with liquefaction (prior to shipping) and dehydrogenation pointing to a total cost of ~$2-$3/kg. A liquid state is also expected to be used over the road for long distances (300-400km) at ~$3+/kg while short-haul moves in the form of compressed gas could cost around ~$1/kg.

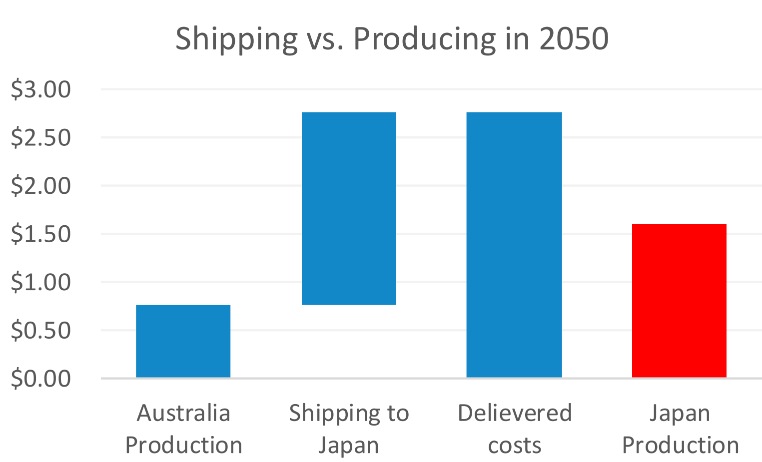
Exhibit 42: Cost of liquefaction, shipping, and dehydrogenation could add over $2/kg to the cost of hydrogen.




Source: Hydrogen Council, BTIG Research

- **Locals Rule?** With cost differences between regions for hydrogen production only expected at $1-$2/kg, and the cost of shipping expected to be north of $2/kg this suggests that local production will be preferred unless it could be transported by pipeline (under $1/kg). However, there are multiple scenarios where shipping still makes sense such as regions that have not invested in hydrogen infrastructure, or in regions where water is scarce. Yet, long-term local productions look to be the way to go.

Exhibit 43: Locally sourced hydrogen may be more economic than shipping from low-cost regions




Source: Hydrogen Council, BTIG Research

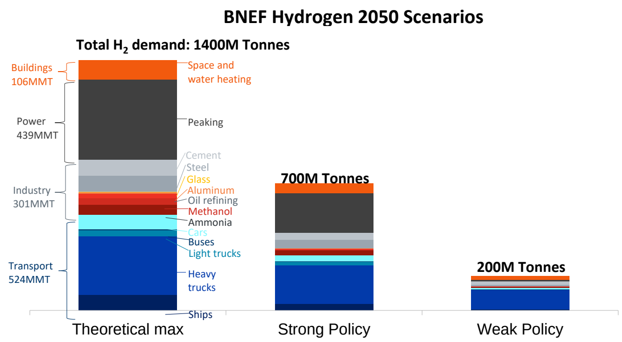
## VIII. Hydrogen Demand – Think Industrial and Transportation Applications

- **Hydrogen a Means of Storing Energy:** The energy transition to renewable energy from fossil fuels (mainly molecules) will require energy storage owing to the intermittency of renewable energy. Not surprisingly, utility-scale batteries are expected to enter a super-cycle on the back of the need for power on demand. Looking at hydrogen, it is one of the most viable molecules that can store energy created from renewables (think electrolysis) which does not produce greenhouse gases and has water as the by-product. Hydrogen's other advantages include it can be stored and transported, it is more energy-dense than batteries and can be refilled quicker than recharging a battery, and it can be created anywhere (need access to water). However, it does have drawbacks namely it is currently expensive to make and while there are paths to cheaper hydrogen it will require policy, technology, and capital working together.

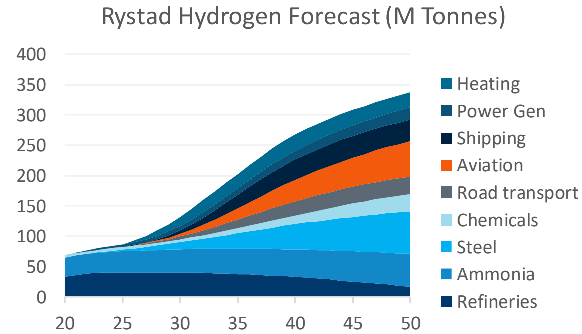
- **The Transition...** Energy consumption is set to grow 30% over the next thirty years, while we annually produce about 35GtCO2, of which 1/3 comes from hard to decarbonize industries, which should provide ample opportunities for hydrogen to grow as a share of the global energy mix. And while hydrogen fuel cells continue to gain momentum which should drive increasing demand for hydrogen as a transportation fuel over the next few decades, we view the near-term path of least resistance for hydrogen in heavy industries like steel, refining, chemicals, and other industrial applications. One of the gating factors for hydrogen as a transportation fuel in the medium term will be hydrogen infrastructure (think the combination of production, liquefaction, transportation, storage, and delivery), while for industrial applications hydrogen can be produced on-site by plugging the electrolyzer to a power source (think wind, solar or hydro-electric for green hydrogen and even fossil fuels in the near term to start the transition).

- **...Will Take Time.** The need for lower costs whether through technology, economies of scale, carbon taxes or credits, or cheaper renewable energy for the electrolyzers helps explain why hydrogen demand is only expected to grow from 70M tonnes (largely gray hydrogen emitting 800KtCO2) to 200M-700M tonnes (depending on policy initiative) coming largely from green hydrogen over the next 30 years.

Exhibits 44 & 45: BNEF estimates hydrogen demand of 200M-700M tonnes/year by 2050 depending on policy scenarios. While Rystad forecasts hydrogen demand of about 330 MT by 2050 (5x current levels).




Source: BNEF, BTIG Research

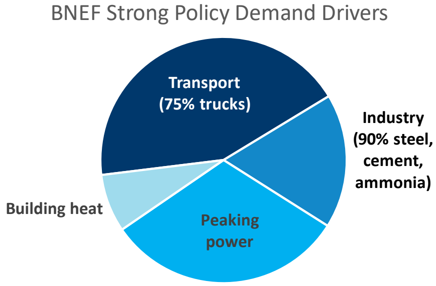



Source: Rystad Energy, BTIG Research

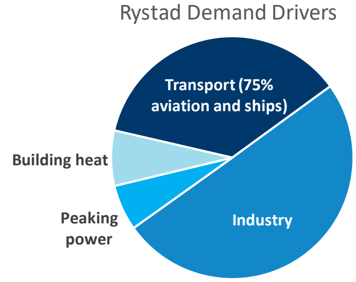
- **Theoretical maximum and BNEF scenarios:** According to BNEF the theoretical maximum hydrogen demand for all hard to decarbonize sectors in 2050 is 1,400M tonnes, which is equivalent to ~200 Exo-Joules or 30% of 2050 energy needs. The current BNEF forecast for hydrogen demand in 2050 hinges on government policy. In a weak policy scenario, 2050 hydrogen demand would be ~200M tonnes (~3x today's levels), largely coming from heavy trucks, while in a strong policy scenario 2050 hydrogen demand would amount to ~700M tonnes (10x current levels), of which ~40% would come from transportation (75% of this trucks), 30% from peak power, 20% from industrial uses and 10% from heating as hydrogen can be blended with natural gas up to 20% without the need for new equipment.

- **Rystad's hydrogen demand forecast:** According to Rystad, about half the global CO2 emissions can be addressed by hydrogen, although its 2050 forecast assumes Hydrogen demand of 330MT, about 5x current levels. Rystad also forecasts hydrogen demand by year and estimates that by 2030/2040 hydrogen demand will reach 130MT/270MT. This implies a 10yr CAGR of 7% in the 2020s and 12% in the 2030s. However, unlike BNEF, Rystad sees Industrial demand as the biggest driver at 50% of hydrogen demand, while power is substantially smaller (less than 10% vs. BNEF's 30%). When looking at transport, Rystad's forecast similar to BNEF's assumes this driving ~40% of demand, but Rystad sees 75% of this coming from aviation and shipping, vs. BNEF that sees 75% of this coming from trucking.

Exhibits 46 & 47: BNEF and Rystad forecast transportation is likely to represent 40% of H2 demand in 2050, but BNEF sees this mostly coming from trucking while Rystad has it coming from aviation and shipping. According to Rystad the biggest driver of demand is industry at about 50% of the total with building heat and peak power each accounting for less than 10%, while according to BNEF industry is only 20% of demand while peak power is 30%.




Source: BNEF, BTIG Research

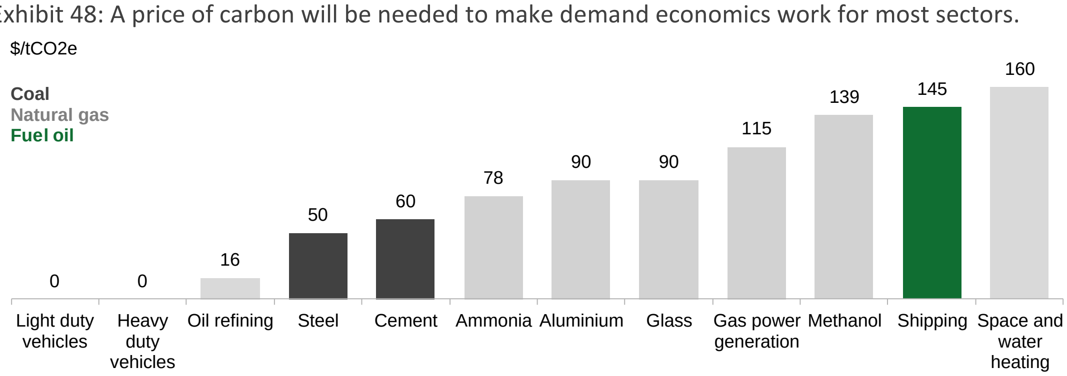



Source: Rystad Energy, BTIG Research

- **Where hydrogen makes sense vs. batteries:** Batteries are currently the most popular form of clean energy storage, but for some applications battereies are less than ideal due to (i) lower energy density and thus heavier, (ii) longer recharge times, and (iii) need for electric infrastructure. Current battery technology falls short in a number of sectors including heavy-duty long-haul trucking (although this may change), steel production, certain high-temperature manufacturing processes, long-distance shipping, and aviation. Fossil fuels are also used as feedstocks for chemicals where substituting electric power is not an option. Even dispatchable electric power generation beyond a few days cannot be solved by batteries alone. Not unlike a recent North American rail company that plans to overlay hydrogen with batteries for power, we view hydrogen as a complement to some battery power, not a competitor.

- **Cost of carbon key to make the economics work:** Industrial uses of hydrogen will mostly require a cost of carbon of $50-100/t, while gas power gen will require a cost of carbon of $115/t, shipping would require $145/t and heating will require $160/t. The cost of carbon in Europe has already surpassed $50/t this year and similar systems put in place around the world could help drive hydrogen demand growth.

Exhibit 48: A price of carbon will be needed to make demand economics work for most sectors.

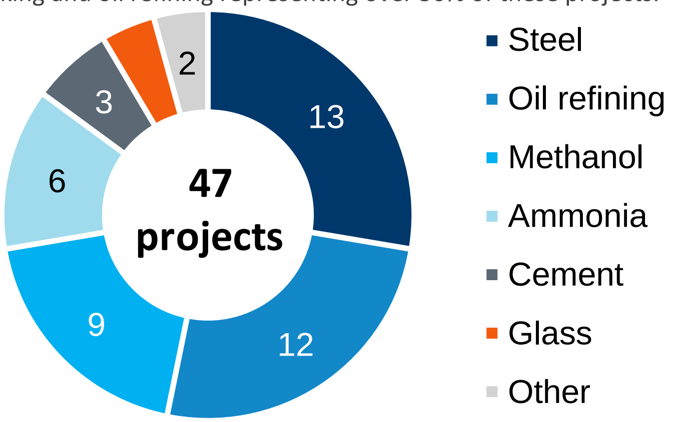



Source: BNEF, BTIG Research

- **Industrial uses make sense for hydrogen:** Industrial uses of hydrogen include steel, refining, ammonia production (largely for fertilizer), cement, and a few others. Many of these industries either already use hydrogen, which is not produced from renewable sources, or would use hydrogen in place of fossil fuels. Industries like refining and fertilizer (think ammonia: $NH3$) are the low hanging fruit as they already use hydrogen, so the switch to green hydrogen would have no switching costs, other than the higher price of green hydrogen, which can be offset by favorable policy and a price on carbon (price of carbon of $50/t when hydrogen reaches $1/kg). Other industrial production can substitute fossil fuels with hydrogen. Steel makers can use hydrogen in electric arc furnaces (30% of global steel production) in place of coal or natural gas with relatively few modifications. This is because the process of direct reduction used in arc furnaces involves using coal or natural gas to make H2, so using hydrogen directly can be very efficient. Aside from steel, the production of cement, aluminum, and glass requires high levels of heat and currently burns fossil fuels to generate that heat. Hydrogen can be used here as an alternative, and even with a price of hydrogen reaching $1/kg by 2050, these industries would require a price of carbon of $60/t for cement and $90/t for glass and aluminum.

- **Industrial H2 uses favored by national policies:** Industrial uses of hydrogen are often emphasized in national policies, with Europe leading the way. France replaced its previous hydrogen strategy focused on transportation, with a new one in 2020 focused on industrial uses. The idea of industrial clusters is becoming popular, such as a consortium project in Germany including 700MW electrolyzer which would support a refinery, a cement manufacturer, a utility, an offshore wind manufacturer, and an airport. The idea of industrial clusters makes sense as hydrogen can be produced on-site and delivered directly to a wide range of adjacent facilities, eliminating the cost of transport and storage which can unfavorably swing the hydrogen economy. Many of these clusters could be located near the sea where they can draw energy from offshore wind, or near natural gas pipelines, which can be repurposed for hydrogen once natural gas fields they service dry up.

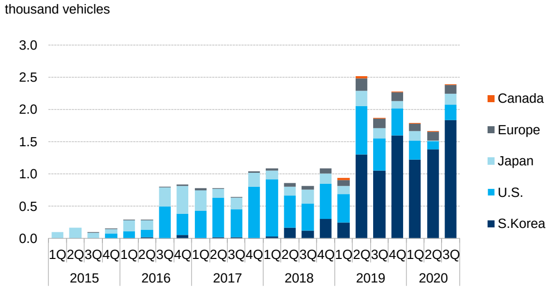
Exhibit 49: We saw a total of 47 industrial hydrogen projects in 2020, with the majority located in Europe and steel making and oil refining representing over 50% of these projects.



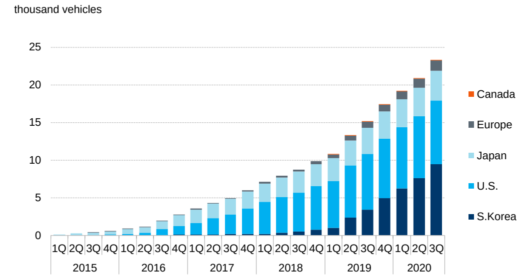

Source: BNEF, BTIG Research

- **The Battle Ground:** We see the biggest potential opportunity for hydrogen in on-the-road transportation in long-haul trucking, where some noticeable advantages over batteries exist. While we see a stronger argument for hydrogen (most likely a derivative) as a fuel for deep-sea shipping and aviation, where batteries are just too big/heavy (we note hydrogen for deep-sea shipping and aviation is still in its very early stages of development). Not surprisingly, heavy-duty transportation is the battleground for hydrogen and batteries with BNEF's forecast and Rystad's forecast both assuming that transportation could account for over 1/3 of hydrogen demand by 2050, yet BNEF's forecast sees 75% of that demand driven by long-haul trucking, while Rystad believes that batteries will dominate the trucking market and hydrogen would largely be relevant in shipping and aviation.

Exhibits 50 & 51: There have been about 25,000 hydrogen fuel cell vehicles sold globally, with the latest sales coming largely from South Korea. This compares to over 8M electric vehicles sold globally.



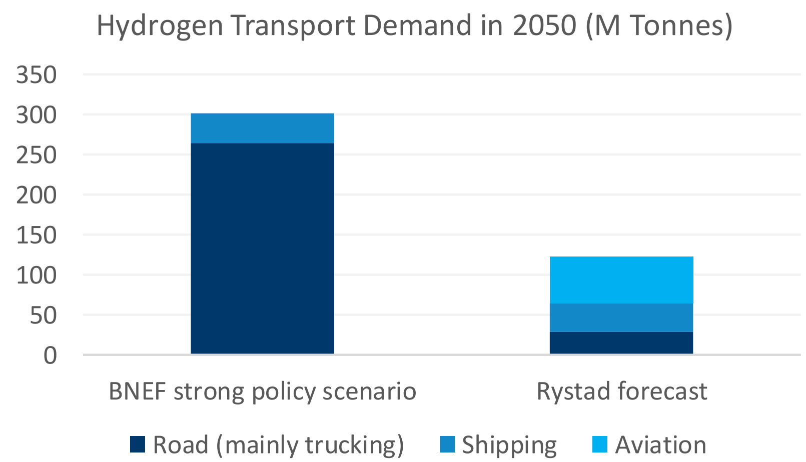

Source: BNEF, BTIG Research




Source: BNEF, BTIG Research

- **Road transport:** Hydrogen fuel cells are a viable alternative to gasoline or diesel cars and trucks. However, much of the on-road vehicle decarbonization has been dominated by Battery Electric Vehicles (BEVs), given the availability of electricity and fast buildout of electric charging stations. While FCEVs may still carry some advantages such as faster refueling times, lighter drivetrains, and longer range, these differences are not significant enough to overcome the positives of an established BEV infrastructure. Longer-term the disadvantages of BEVs are likely to shrink as technology advancement continues. The biggest hurdle to FCEVs taking off is the lack of infrastructure compared to battery technology. Currently, there are over 1.3M public charging connectors globally. Assuming 3-4 connectors per station, this points to 300,000-400,000 public EV charging stations versus ~1,000 hydrogen fueling stations worldwide.

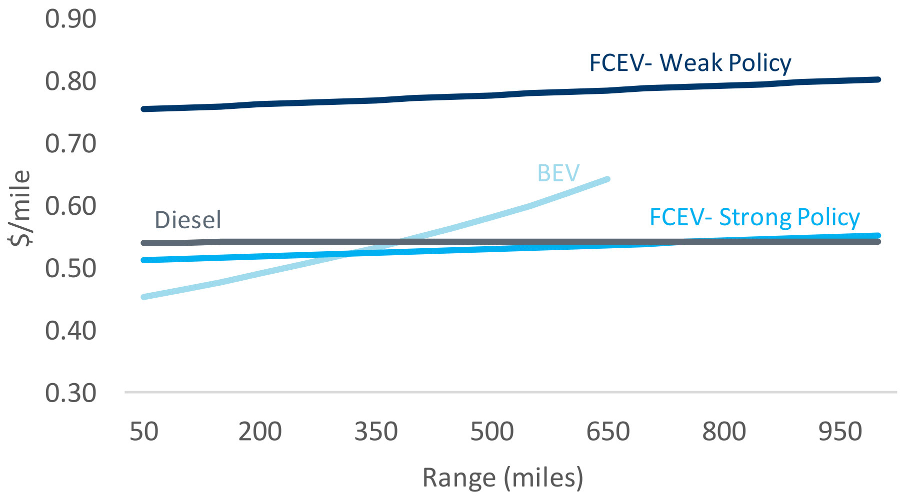
Exhibit 52: The debate around hydrogen use for transport is clear when comparing the BNEF and Rystad hydrogen demand forecast in 2050. BNEF's strong policy scenario sees strong demand for hydrogen used in trucking, while Rystad's forecast sees a larger proportion of hydrogen demand coming from shipping and aviation.




Source: BNEF, Rystad Energy, BTIG Research

- **Long-haul trucking:** The economics of hydrogen for long-haul trucking become competitive vs. batteries in a strong policy hydrogen scenario. Currently, the Total cost of Operation (TCO) for diesel trucks is $0.50-$0.60/mile, and in a strong policy hydrogen scenario, where the cost of hydrogen at the pump is $4/kg (it's $16/kg today in California), this would make hydrogen competitive with diesel. However, as Nikola (NKLA, Buy, $18 PT) has demonstrated by securing cheap renewable power from a local utility, the ability to source cheap renewable power quickly makes the math work; NKLA expects to produce hydrogen at $2.5/kg. Meanwhile, BEV trucks with a range greater than 400 miles become less competitive, with a TCO above $0.60/mile and approaching $0.70/mile when the range reaches 600 miles. We note battery technology should continue to improve pushing these costs lower over time. Bottom line: while it is certainly possible for hydrogen to play a meaningful role in decarbonizing heavy-duty trucking (~30-35M Class 8 trucks globally), it will be a challenge.

Exhibit 53: In a strong hydrogen policy scenario, long-haul heavy-duty fuel cell trucks with a range above 400 miles could be competitive with battery-electric trucks in 2030. However, the ability to source cheap renewable power as NKLA has contracted to do dramatically increases the value proposition of hydrogen.

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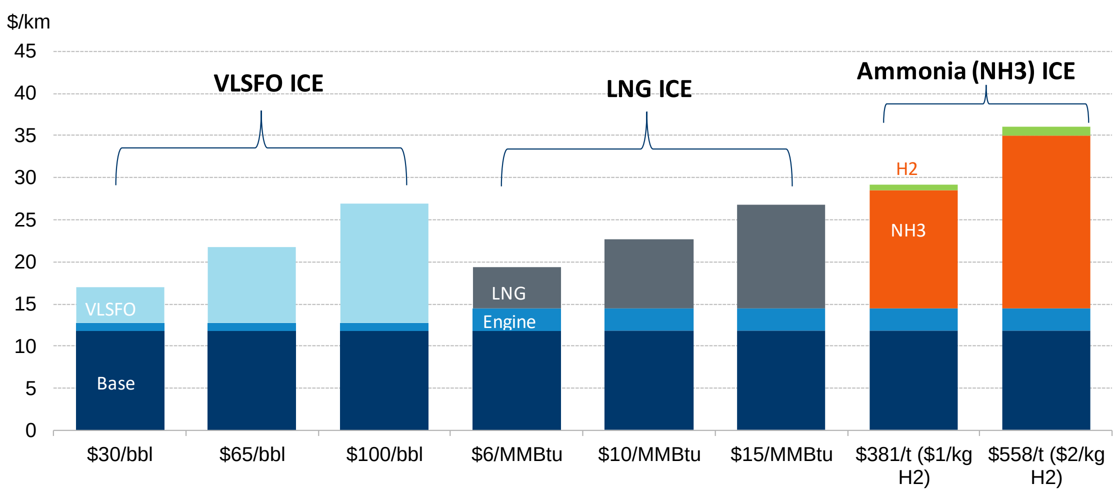
Source: BNEF, BTIG Research

- **Shipping:** *Short-distance:* While ferries can run on batteries (the first battery-electric ferry in the US was delivered in 2019), Norway is set to take delivery of the first hydrogen ferry in 2022 (it's a lot bigger than the US ferry), the ferry market looks up for grabs with both batteries and fuel cells viable depending on the ferries' utility. Shifting to the *Deep-sea:* Ships traveling long distances require significantly more energy than a battery could provide, which points to hydrogen or ammonia as a viable replacement for oil-based fuels (we expect LNG to be a bridge fuel in deep-sea shipping). And while ammonia would likely be more suitable (more stable than hydrogen) ammonia when burned in an internal combustion engine, produces Nitrous Oxide, which could be mitigated through the use of scrubbers. The technology to develop an ammonia engine is currently in the early stages of development. Running the numbers, ammonia requires a price of carbon of $100/t in 2030 and $30/t in 2050 to be competitive versus the very low sulfur fuel oil (VLSFO) price of $100/bbl, assuming hydrogen prices reaches $2/kg by 2030 and $1/kg by 2050.

Exhibit 54: Shipping using an Ammonia ICE engine would be competitive with VLSFO fuel at $100/bbl if the price of hydrogen is just $1/kg and there's a $30/t tax on CO2. At $2/kg a $100/t tax on carbon would be required.

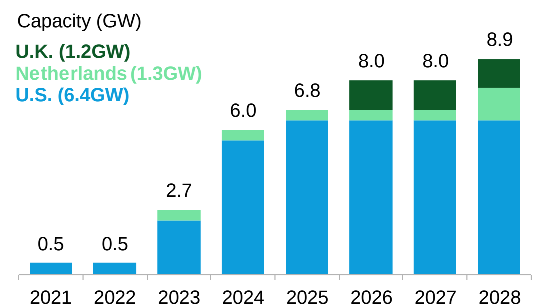



Source: BNEF, BTIG Research

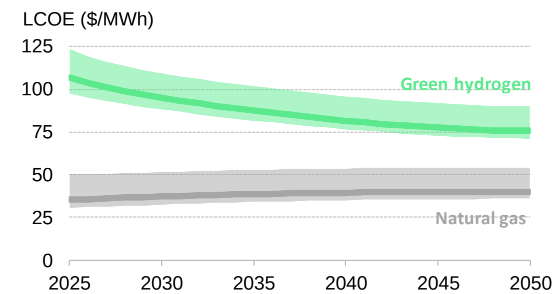
- **Aviation:** When it comes to aviation there are strict weight and space limitations that allow an aircraft to fly and carry the needed payload (a lot more so than water or road transport). While hydrogen carries 3x more energy per unit of weight than jet fuel, it requires 5x the volume of space to carry that fuel. *Short-haul:* Hydrogen fuel cells can be viable on short-distance flights, powering an electric engine. The substantially lighter weight of a fuel cell vs. direct battery power may be more advantageous, especially for planes slightly bigger than the smallest private planes that may be able to fully electrify. The first hydrogen fuel cell-powered flight took place in 2020, and while it lasted only 20 minutes and still cannot compare to oil-based fuels in terms of distance and load, there are currently a number of pilot projects aimed at commercializing hydrogen flight. *Long haul:* Long-haul aviation is one of the most difficult to abate sectors, given it requires a great deal of lightweight and energy-dense fuel, and using hydrogen would take an exorbitant amount of space. Airbus (AIR.PA, Not rated) is paving the way for long-haul hydrogen technology, with its ZEROe program aimed at developing hydrogen-powered commercial aircraft by 2035. The sweet spot may be in medium-haul aircraft, as two-hour flights were recently banned in France.

- **Power generation:** Since electric power from renewable sources is required to run an electrolyzer and create hydrogen, it does not make sense to use hydrogen for base-load power generation. However, hydrogen can be used to solve intermittency issues or as peak power plants. While battery storage will likely remain the primary method to store and shift electricity generation to hours of the day when solar and wind are not available, battery storage for power generation typically provides 4 hours of power generation, since costs rise significantly for longer storage durations. We believe hydrogen could be a viable way to eventually decarbonize natural gas peaking power plants. Turbines that run on hydrogen have already been produced, and there are currently 9GW of hydrogen power generation capacity projects that have been commissioned (mainly in the US and some in Europe) likely to be online by the mid/late 2020s. As the cost of hydrogen declines, we estimate that hydrogen could be competitive with natural gas at a price of carbon of $200/t in 2030 and $100/t in 2050. This is necessary to bridge the gap of LCOE from natural gas at around $40-50/MWh by 2050 and hydrogen at around $75/MWh.

Exhibits 55 & 56: We estimate 9GW of hydrogen power gen capacity projects have been commissioned mainly in the US and some in Europe. By 2050, the LCOE of hydrogen power generation is likely to decline to become competitive with natural gas, assuming a price of carbon of $100/t.




Source: BNEF, BTIG Research




Source: BNEF, BTIG Research

- **Heating:** Using hydrogen to heat homes or to heat water requires 5-6x more energy than electric heat pumps, so using hydrogen to decarbonize space and water heating is not likely. However, currently, a great deal of heating is provided through natural gas, and hydrogen can be blended into natural gas networks at 5-20% of total gas volumes (depending on the network), without affecting existing infrastructure or appliances. Higher rates of blending would require an upgrade to pipes and appliances and therefore a lot more costly. There are 30 hydrogen network projects today across Europe, US and Canada, Japan, and Australia, of which 20 are focused on blending hydrogen up to 20% into existing natural gas systems. Unfortunately, due to a low volumetric energy density of H2, the decarbonization achieved through blending is quite low. The other 10 projects (located in UK, Netherlands, Spain) focus on converting natural gas infrastructure into pure hydrogen infrastructure.

ENERGY TRANSITION EQUITY RESEARCH

May 27, 2021

# Nikola Corporation (NKLA, Buy, $18 PT)

## The Class 8 Truck Market is Ripe for Disruption. Initiating with a Buy Rating and an $18 PT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**WHAT YOU SHOULD KNOW:** Despite some growing pains over the last year, NKLA continues to move forward with its dual-pronged strategy of helping transition the heavy-duty Class 8 truck market to battery-electric trucks (BETs) and hydrogen fuel cells (FCEV) with 14 Tre BETs in Beta testing ahead of the Tre BET moving into production later this year. And while we only model a handful of Tre deliveries (below guidance) this year, given the challenges of bringing a new vehicle to market combined with supply chain disruptions we would not be surprised to see first deliveries slip to next year. It is more about getting it right than delivering it a few months earlier as the Class 8 truck energy transition is going to be a multi-decade process. We think the dual vehicle approach makes sense as the Tre BETs limited range (~300 miles) limits the BET solution to only 20-30% of the North American Class 8 market, while the hydrogen FCEVs (still in development) is targeting production in 2023 is positioned to compete in the long haul Class 8 market. Bottom line: while we expect some initial production delays, we expect BET production to start ramping in 2H22 with the hydrogen FCEV solution hitting the market by 2024. We initiate with a Buy rating and an $18 PT.

- **Beta Testing Underway.** Phase 1 for the Tre BET started in 1Q21 with 5 Tres hitting the road for Beta testing (think cold weather and operating performance, safety, and software) with Phase 2 (includes another 9 Tre BETs) either on the road or delivering this quarter for additional safety testing and customer trials. We note a lack of battery cells (industry-wide issue) has slowed the rollout of Tre's beta testing, but management believes it will still be ready for production by year-end.
- **Funding the Business.** Management has noted it plans to raise ~$1B in 2021 to help fund the development of the fuel cell business; however, with the hydrogen network build-out largely being customer-driven, NKLA should have some flexibility around the timing of additional capital raises. In the near term, NKLA has ~$760M in cash to complete its factories and for the Tre production. Bottom line: while dilution remains an overhang, we view incremental equity for the fuel cell business as a positive as it points to increasing demand for NKLA's FCEV solution.
- **Best of Both Worlds.** We expect both BETs and FCEV to gain market share in the Class 8 truck market this decade with BETs leading the charge. And while NKLA believes FCEV is the company's long-term future having a BET solution which we expect to improve as battery density increases on its way to a 1MW battery (think 600-mile range) is a nice hedge. Bottom line: NKLAs dual product truck offering of BETs and FCEVs are positioned to replace ICE trucks longer term.
- **Managing Expectations.** 2021 revenue guidance stands at $50M-$100M (consensus ~$21M) and points to Tre sales of 200-400 (pre-merger guidance was 600 units). We model a slower ramp with only a few deliveries this year and our 2022 revenue estimate of $100M (implies 400 Tre sales) is ~55% below consensus estimates. We note while we expect the timing of alternative fuel truck sales to push right, as demand picks up NKLA is positioned to win its fair share.
- **Valuation:** NKLA is a pre-revenue company, hence our $18 PT is based on a 5.5x multiple on our 2024 revenue estimate of ~$1.4B (~4,100 BEV trucks and ~650 FCEV trucks) and is in line with our blended peer average of alternative fuel heavy vehicle manufacturers and companies engaged in the hydrogen economy.

| Company Data | |
|---|---|
| Closing Price | $11.98 |
| Price Target | $18.00 |
| Market Cap (M) | $4,702.03 |
| Enterprise Value (M) | $3,996.52 |
| Shares Out (M) | 392.49 |
| Avg Daily Vol-3 Months (M) | 13.7 |
| Dividend / Yield | $0.00 / 0.0% |

| Revisions | Previous | Current |
|---|---|---|
| Rating | - | Buy |
| Price Target | - | $18.00 |
| FY21E EBITDA | - | (343.37) |
| FY22E EBITDA | - | (383.94) |
| FY21E REV | - | 3.00 |
| FY22E REV | - | 134.87 |

| EBITDA (Adjusted) | | | |
|---|---|---|---|
| FY Dec | 2020A | 2021E | 2022E |
| Q1 | (29.24) | (53.43)**A** | (97.06) |
| Q2 | (46.98) | (95.69) | (97.60) |
| Q3 | (58.77) | (95.69) | (95.12) |
| Q4 | (65.50) | (98.56) | (94.17) |
| **FY EBITDA** | **(200.49)** | **(343.37)** | **(383.94)** |
| FY EV/ EBITDA | - | - | - |

| Revenue (M) | | | |
|---|---|---|---|
| FY Dec | 2020A | 2021E | 2022E |
| Q1 | 0.06 | 0.00**A** | 14.75 |
| Q2 | 0.04 | 0.00 | 26.22 |
| Q3 | 0.00 | 0.00 | 40.54 |
| Q4 | 0.00 | 3.00 | 53.36 |
| **FY REV** | **0.10** | **3.00** | **134.87** |
| FY EV/S | - | - | 29.6x |
| FY P/S | - | - | 34.9x |

Source: FactSet, BTIG Estimates and Company Documents reported as $ currency.
**FY** = Fiscal Year **CY** = Calendar Year

## Investment Thesis

Nikola is a new OEM entrant into the Class 8 truck market that seeks to offer two alternative fuel solutions with its battery-electric, and hydrogen fuel-cell electric vehicles. Nikola is a pre-revenue company that expects to be an early mover, with its first commercial BEV trucks hitting the road by 2021, and its first commercial FCEV expected on the road 2023. We expect BEV vehicles to gain market share in urban environments in the near-term, with FCEV and Hydrogen infrastructure driving medium to long term growth.

## Upcoming Catalysts

- Completion of BEV Tre Beta testing
- Completion of production Facilities in Arizona and Germany
- Delivery of first BEV Tre's expected late 2021
- Development of FCEV production expected to hit roads in 2023

## Base Case Assumptions: **$18 Price Target**

Our base case is that NKLA is able to carve out a niche in Class 8 trucking, initially with its BEV Tre which we expect will focus on urban markets driving near-term growth opportunities, leading to the FCEV and Hydrogen fueling driving medium to long term growth opportunities.

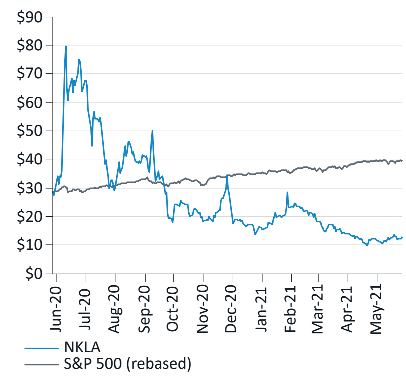
## Upside Scenario

Our upside scenario is that consumer preference, as well as supportive policies, drive alternative fuel vehicle demand in class 8 trucks higher than expected, and NKLA is able to capture substantial market share in the near term with its BEV offering and in the medium to long term with the FCEV offering.

## Downside Scenario

Our downside scenario is that technology leaps, consumer preference, and/or non-supportive government policies lead to a slower adoption rate for alternative-fueled heavy trucks and NKLA is unable to win substantial market share both in the near term with its BEV offering and long-term with its FCEV and hydrogen infrastructure offering.

## Price Performance




Source: FactSet

## Company Description

Nikola Corporation operates as a zero-emissions transportation and infrastructure solution provider. The Company is a designer and manufacturer of battery-electric and hydrogen-electric vehicles, electric vehicle drivetrains, vehicle components, energy storage systems, and hydrogen fueling station infrastructure.

# Nikola (NKLA) – Helping Drive the Energy Transition of Class 8 Trucks

## I. Executive Summary

1. We Initiate on Nikola Corporation (NKLA) with a Buy rating and an $18 PT. NKLA is looking to disrupt the heavy-duty Class 8 truck market with the Nikola Tre battery-electric truck (BET) with first deliveries targeted by year-end. And for an encore, NKLA expects to start delivering its Nikola Two hydrogen fuel cell vehicle (FCEV) by mid-2023. As an upstart OEM offering new technology drive trains with its Tre BET and Two FCEV, we believe it is more about getting the trucks right (strong performance out of the gate) than hard delivery timelines. And with the recent LOI with Total Transportation Services (Private) for 100 trucks (30 BETs and 70 FCEVs) another green light in addressing demand for NKLA trucks, the focus is now about execution.

2. **Tre Beta Testing Underway.** Beta testing on the Nikola Tre BET started earlier this year with the delivery of five Betas which are being put through various testing (think safety, operations, and software) with another 9 Betas hitting the road this quarter. In February, management reiterated its production start-up target of 4Q21 for the Tre BET with updated vehicle sales guidance of 50-100 units (down from 150). The 50-100 unit production guidance was reaffirmed in May. Given the normal challenges in bringing a vehicle to market we only expect a handful of deliveries in 4Q21, before a production ramps in the middle of 2022.

3. **Dual Pronged Attack.** The Tre BET will be NKLAs first truck on the road (which we view as a nice standalone business on its own), and will target the urban truck market given its limited range. While NKLA's FCEV (hydrogen fuel-cell electric vehicle) two models (Tre and Two) and their ability to disrupt the long-haul truck market is how we believe the long-term success of NKLA will be measured. And while we expect battery electric vehicle to largely dominate the passenger and most of the commercial EV market, we see the Class-8 truck market as one of the niche transportation markets where hydrogen makes sense.

4. **Hydrogen FCEV Leasing Model.** The lack of hydrogen infrastructure remains a major hurdle for the widescale adoption of hydrogen as transportation fuel even for a niche market like Class 8 trucking. NKLA has taken an approach similar to an upstart EV company over a decade ago in providing fueling infrastructure as part of its product offering. NKLA's FCEV solution is more than just the vehicle, it is a full-service solution (includes the fueling network) that is wrapped into the lease. Initially fueling stations are expected to be able to service ~200 trucks/day but are being designed for expansion up to ~1,000 trucks per day as FCEV acceptance increases (a multi-year process). We note longer term we see the potential for the hydrogen fuel network to be a standalone business outside of NKLAs core truck manufacturing business.

5. **The Energy Transition.** Class 8 trucks are a key driver of global trade, but also one of the largest carbon emitters in the transportation industry. Estimates put the Class 8 trucks in the US at ~2.8M with 35M-40M globally. The Clean Air Task Force estimates that a Class 8 truck generates ~170 tonnes of $CO_2$ annually (on ~100K miles driven) with the EPA noting that heavy-duty trucks produce ~6% of the US GHGs. And while technologies like BETs and hydrogen FCEV were not viable competition to internal combustion engines (ICE) trucks just a few years ago (we note FCEV still has work to do) total cost of ownership (TCO) is moving towards parity. However, patience is required as while US Class 8 truck sales are ~250k/year, BET sales are expected to remain in the 100s near term before climbing into the 1,000s mid-decade, with FCEVs lagging BETs by a few years.

6. **Price Target.** Given NKLA's position as a pre-revenue alternative fuel commercial truck company, our $18 PT is based on a 5.5x multiple on our 2024 revenue estimate of ~$1.4B (~4,100 BEV trucks and ~650 FCEV trucks) and is in line with our blended peer average of alternative fuel heavy vehicle manufacturers and companies engaged in the hydrogen economy.

## II. Who, What, Where – Repositioned and Refocused

- **Building the Business.** Nikola, is an upstart alternative-fuel heavy-truck manufacturer (no production vehicles on the road yet) focused on the Class-8 (think Semis) truck market that plans to deliver its first BET Class-8 trucks later this year, with an eye on delivering its first hydrogen FCEV trucks in 2023. The company was founded in 2014 and went public in June of 2020 through a SPAC merger. The company's two initial models, the Tre (a day cabin design) and the Two (sleeper cabin design) are pursuing battery-electric and hybrid hydrogen-electric offerings. And given the lack of hydrogen infrastructure, the company also plans to concurrently build out a network of Green Hydrogen refueling stations (think if you build it they will come strategy) along key customer routes (think initially around major cities and along interstates).

- **The Tre…** Nikola is pursuing two model trucks (day cab Tre and sleeper cab Two) with the Tre being designed around two power train technologies (BEV and FCEV) while the Two (think long-haul) is being designed exclusively with FCEV for now (major technology breakthroughs in 5-10 years could result in a BEV power train for the Two). With BET technology ready to go, albeit at a limited range (around 300 miles), we think the battery first, hydrogen second strategy (FCEV technology still needs to develop and hydrogen infrastructure poses more challenges than battery charging) makes sense. The BEV Tre is expected to hit the market later this year, at a selling price of ~$300,000 with up to a 750 KWh battery which is expected to produce a ~300-mile range (fully cargo loaded versus a diesel equivalent). However, we note battery technology is only getting better as changes to the chemistry (includes the anode and cathode) has some battery company's pointing to ~1MW batteries with ~600 mile ranges later this decade with also the potential of faster charging times.

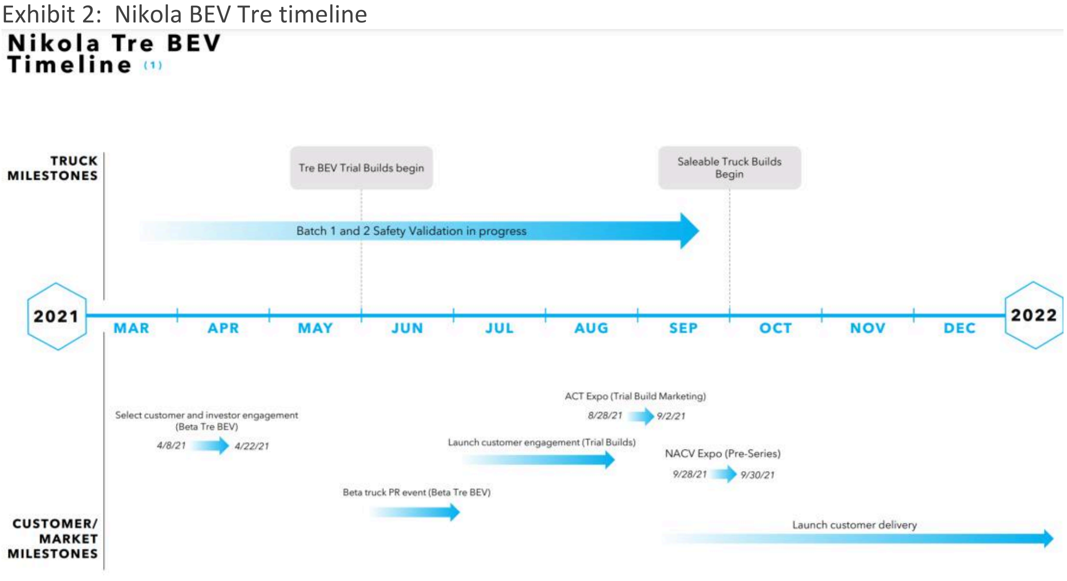
Exhibit 1: Nikola day cab Tre (Left) and sleep cab Two (Right)


Source: Company Data

- **…and the Two.** The second drivetrain (FCEV) is expected to hit the road in North America around mid-2023 (and Europe in 2024) with the Tre and Two FCEV around $235,000. The FCEV will utilize hydrogen to power its electric motors which should enable the same performance benefits of the BET with a much longer range (targeting ~900 miles) and only a 20-minute refueling time (on par with current diesel trucks today) but roughly a 90% quicker charging time than the current design of Tre BET (about 2-2.5 hours and only for ~300 miles of range). Additionally, the FCEV solution is also on equal footing in terms of comparable load with a diesel truck (think equal performance, only with net-zero emissions). And while the cost is significantly higher than a diesel truck (~$125,000) at roughly $235,000, it is worth noting a diesel truck produces ~170 tonnes of carbon annually which at a carbon price of $100/tonne points to $17,000 annually or ~$170,000 of carbon costs over a trucks life.

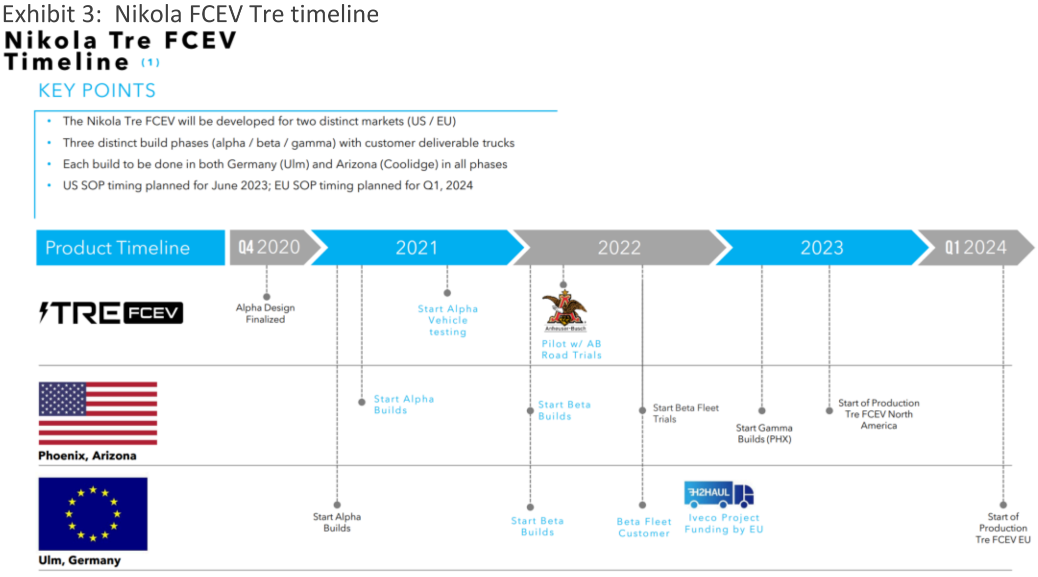
- **Timeline to Production.** With the initial 5 Tre Betas on the road for testing (Cold Weather, Brake Testing, Road Load Data, Software and HMI development, Vehicle Dynamics testing) since Q1 and the final 9 Betas completed with ~4 already in testing and the remaining ~5 in transit from Europe (all are expected to be in Arizona for assembly by June), management is targeting the first Tre deliveries in late 2021. The vehicles will primarily be made out of NKLA's Coolidge, Arizona facility, which is still under construction but expected to be completed by late summer. Manufacturing equipment is set to begin installation with facility power be switched on in June with trial production beginning later this summer. Nikola's second facility, which is a JV with Iveco (subsidiary of CNHI, Not Rated) in Ulm, Germany (where the Betas have been/are being built), is also expected to have the installation of manufacturing equipment completed in the next few weeks with trial production on target to begin in early summer. This facility is expected to be completed before the Arizona facility and will be the site of the early BEV Tre's production with the vehicles imported to the US.

Exhibit 2: Nikola BEV Tre timeline




Source: Company Data

Exhibit 3: Nikola FCEV Tre timeline




Source: Company Data

BTIG

## III. Taking Advantage of Partnerships Across the Hydrogen and Battery Electric Truck Value Chain

- **Key Partners Across the Platform...** On the hydrogen infrastructure side (management believes this will be key to a successful roll-out), Nel ASA (NLLSF, Not Rated) which is based in Norway jointly developed NKLA's first test hydrogen infrastructure Demo Station (1,000 kg) which was completed in 2019 at NKLA's Phoenix Headquarters. With over 40 public hydrogen fueling stations in the US (according to the Department of Energy) and companies like Chart Industries (GTLS, Buy, $165 PT) which also provides hydrogen fueling equipment, we believe hydrogen fueling networks across North America and Europe are probably not as far away as we would have thought just a year ago. With the infrastructure on the way, the focus turns to green hydrogen (from renewable power), which is where the cost equation becomes more complicated (green hydrogen is a relatively expensive fuel). NKLA uses Hanwha (000885.KS, Not Rated) for its solar arrays which the company plans to use to help generate green hydrogen.

- **...and For the Road.** On the vehicle side, Iveco (a subsidiary of CNH Industrial) a large European heavy truck manufacturer has partnered to provide design and industrial processes. Iveco sold over 160K total units in 2019. Additionally, NKLA has access to Iveco's supply chain and pricing for vehicle parts which the company believes will reduce costs and should also help speed up the validation process. Bosch (BOSCHLTD.NS, Not Rated), is NKLA's powertrain partner, providing the company's latest design rotors and stators for electric truck e-axles as well as state-of-the-art inverters. NKLA is also working with Bosch on the fuel cell assembly utilizing Bosch components. On the battery side, NKLA initially is using Romeo Power (RMO, Buy, $15 PT) for the Tre BETs with the battery using a modular design (think offering different price points depending on range).

Exhibit 4: Strategic Partners


Source: Company Data

- **Partner Ownership Stakes.** In March, Hanwha announced the sale of 11 million shares leaving Hanwha with ~11M shares (~3% ownership stake). The sale came on the heels of the Bosch share sale of ~4M shares in December which dropped Bosch's stake to ~19M shares (~5% ownership stake). We note these share sales were largely expected as Bosch noted its desire to own less than 5% of the company. Iveco owns ~26M shares (~7% of the company) and has not sold any stock since NKLA went public; however, over time we would expect Iveco to monetize at least some of its existing stock.

- **Total Cost of Ownership (TCO) Proposition.** Despite a high initial cost, the Tre BEV has a compelling TCO compared to internal combustion engine (ICE) trucks on an apples-to-apples comparison. So, while the average long-haul (60%-70% of the Class 8 truck market) truck travels ~100,000 miles/year, the 30%-35% of the market servicing urban and short-haul routes is where Nikola is targeting the Tre BEV (think limited range of ~300 miles or ~5 hours of open road highway driving). Unlike long-haul semis which travel over 100,000 miles annually, urban Semis typically only travel 60,000 miles a year (230 miles/day for 260 days a year). Using the average electricity cost in the US of ~$0.13/KWh and given NKLA's 720 KWh battery and 300-mile range we determined a 2.40 KWh/mile factor. And while diesel costs fluctuate we use a US average diesel price of ~$3/gallon and and average MPG of ~5. Bottom line: the Tre BEV provides ~50% fuel savings. Additionally, looking at maintenance costs, the use of regenerative braking and fewer moving parts in the engine/drive train points to the Tre BEV of having an estimated ~$0.07/mile in maintenance expense compared to a traditional diesel truck at ~$0.25/mile.

Exhibit 5: Total Cost of Ownership (TCO) Calculator

| | Base Case | | Bull Case | | Bear Case | |
|---|---|---|---|---|---|---|
| | NKLA BEV | Diesel Class 8 | NKLA BEV | Diesel Class 8 | NKLA BEV | Diesel Class 8 |
| Initial Cost | 300,000 | 125,000 | 300,000 | 125,000 | 300,000 | 125,000 |
| Years Owned | 7 | 7 | 7 | 7 | 7 | 7 |
| Mileage Per Year | 60,000 | 60,000 | 60,000 | 60,000 | 60,000 | 60,000 |
| Electricity Cost per KWh | $0.13 | NA | $0.10 | NA | $0.16 | NA |
| KWh/Mile | 2.40 | NA | 2.06 | NA | 2.88 | NA |
| Diesel cost per G | NA | $3.10 | NA | $3.50 | NA | $2.50 |
| Diesel MPG | NA | 5 | NA | 4 | NA | 6 |
| Total Fuel Cost | 131,040 | 260,400 | 86,400 | 367,500 | 193,536 | 175,000 |
| Maintenance Expense | 28,140 | 105,000 | 22,512 | 115,500 | 42,210 | 84,000 |
| Tax Credits | 0 | 0 | (120,000) | 0 | 0 | 0 |
| Size of Fleet | 50 | 50 | 50 | 50 | 50 | 50 |
| Total Cost | 22,959,000 | 24,520,000 | 14,445,600 | 30,400,000 | 26,787,300 | 19,200,000 |
| Total Cost Ex Incentives | 22,959,000 | 24,520,000 | 20,445,600 | 30,400,000 | 26,787,300 | 19,200,000 |
| TCO/Mile (Per Truck) | $1.09 | $1.17 | $0.69 | $1.45 | $1.28 | $0.91 |
| Savings/Truck | 31,220 | | 319,088 | | (151,746) | |
| Savings Ex Incentives/Truc | 31,220 | | 199,088 | | (151,746) | |

Source: Company Data, AAA, AFDC, Statistica, EIA, California HVIP

- **Carbon Pricing.** While there currently are no mandatory carbon pricing schemes in the US (compliance is voluntary) 16 countries in Europe tax emissions at between 1 Euro to over 100 Euro per ton, while the freely traded market carbon price in Europe is around $60/tonne. And despite the new US administrations attempt to reassert itself as a global leader in reducing emissions at the recent Earth Day conference it hosted, we would expect carbon pricing schemes to continue to develop throughout Europe years ahead of the US. Looking at the average $CO_2$ emissions of a Class 8 diesel truck it is estimated at ~170 tonnes annually. However, to make the carbon calculation on the Tre BET apples to apples we note the average miles driven of the Tre BET will be about ~60,000/year (below the fleet average of 100,000). Straight-lining $CO_2$ emissions versus miles driven (that is conservative giving urban driving has more idle time and fewer highway miles) points to ~100 tonnes of $CO_2$ emissions annually. Applying the current carbon price in Europe of ~$60/tonne points to an implied carbon tax (or credit) savings of ~$6,000 or over $40,000 in carbon savings versus an ICE truck over its useful life.

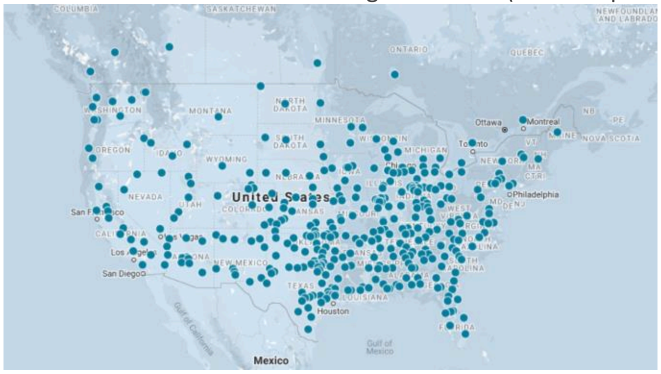
ENERGY TRANSITION EQUITY RESEARCH

## IV. Thinking Through the Hydrogen Fuel Network Value Proposition

- **Hydrogen Fueling Stations.** Key to NKLA's plan to sell FCEVs is hydrogen availability. Not unlike a fledgling EV company a decade+ ago, NKLA plans to address hydrogen fuel infrastructure concerns by building out a hydrogen fueling network through a dual approach of 1) On-site electrolyzers (think hydrogen on-demand) and 2) A more traditional hub and spoke model (like diesel/gasoline) with a central production facility with hydrogen being delivered to stations. A dual-pronged fueling network strategy makes sense as fueling requirements and will vary by station. While there is work to be done, the company expects hydrogen production sites to have an initial capacity of 8,000 kg/day (utilizing eight 1-ton/d electrolyzer stacks which utilize ~2.2 MWh) which could support ~210 trucks/day (hydrogen production will be managed based on demand). Not surprisingly, the production sites being targeted are strategic and expected to be scalable to 40,000kg/d which could provide fuel for ~1,000 trucks/day. Key to NKLA's hydrogen fueling strategy will be the ability to produce hydrogen at a competitive rate with management targeting a cost of $2.47/kg, which points to ~$35/MWh energy with pricing in Arizona already locked in with Arizona Public Service Company (Subsidiary of PNW, Not Rated). NKLA is able to secure such a good deal on power because they are offtaking nuclear power throughout the night when the plant is still producing electricity but there is significantly lower demand. Additionally, initial hydrogen fueling station costs are estimated at ~$16M on average per station with the final configuration per station driving some variability around cost.

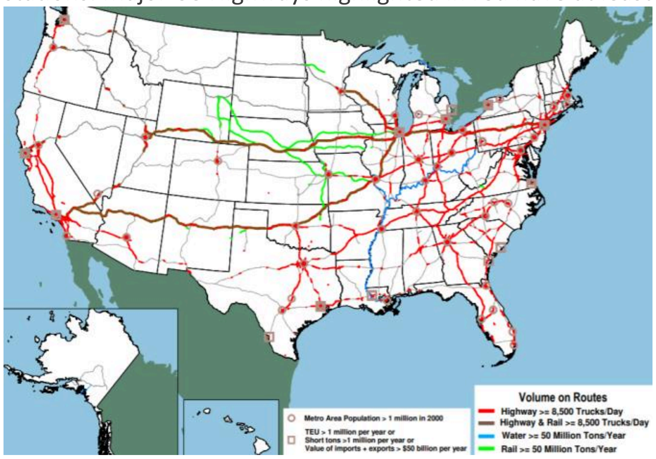
- **Travel Centers Collaboration.** In late April, NKLA announced a partnership with Travel Centers of America (TA, Buy, $45 PT; Analyst: Sullivan) to collaborate on the installation of hydrogen fueling stations for heavy-duty trucks at two existing TA-Petro sites in CA with a target of being commercially operational by 1Q23.

Exhibit 6: Potential footprint of a Hydrogen Fueling Network from Nikola's website. We note we expect the initial build-out to be a few strategic locations (for example LA-Phoenix) for key anchor customers.



Source: Company Data

Exhibit 7: A hydrogen fuel network for the bulk of the Class 8 truck market could be done with a few hundred stations. Major US Highways highlighted in red have at least ~8,500 Class-8 Trucks per day.




Source: FHWA, BTIG

- **Hydrogen Fueling Station Economics.** NKLA expects to eventually achieve green hydrogen at a cost of $2.47/kg (equivalent to ~$2/g diesel when accounting for efficiency gains of hydrogen-electric system) from its base-size 8,000 kg/d station. The two most important variables in pushing the hydrogen cost lower are 1) the electrolyzer efficiency (KWh/kg) and 2) the cost of electricity. At 100% energy efficiency during electrolysis, an electrolyzer would require ~40 KWh/Kg (theoretical energy conservation maximum), while today's leading-edge designs run ~50 KWh/Kg. NKLA is targeting a more conservative ~61 KWh/Kg. The cost of electricity is much more straightforward as the NKLA is targeting below $0.035 per KWh which we note is well below the average retail price of $0.13/KWh, and the average industrial purchase price of $0.067/KWh. For initial stations, NKLA has secured desired pricing with the Arizona Public Service Company (drawing power from a Nuclear facility at night when there is lower demand), should it expand hydrogen production into less accommodating electricity markets, at the average industrial price NKLA should be able to produce hydrogen at a cost of ~$4.50/kg (a diesel equivalent of ~$3.60/Gal). Current leading-edge large-scale renewable power plants (think ~500+ MWs) can produce power for ~$0.04/KWh, but with increasing efficiencies and economies of scale renewable power generation is expected to drop reach ~$0.03/KWh by 2030. In thinking about water (what rolls through the electrolyzer) efficiency and cost are also factors but to a much lesser degree (see next page). NKLA also assumes 100% station utilization, which while an aggressive assumption longer-term, we expect the early stations to largely be built to meet specific customer needs and along the most popular routes, and be fully utilized.

Exhibit 8: Hydrogen Fueling Station Calculator

| Hydrogen Station Breakdown | | |
|---|---|---|
| Variable Costs | NKLA Assumptions | Market |
| KWh per Kg of Hydrogen | 61.2 | 61.2 |
| Electricity Costs ($/KWh) | 0.035 | 0.055 |
| Gal of Water/ Kg of Hydrogen | 2.93 | 2.93 |
| Water Cost ($/1000 gal) | 4.59 | 4.59 |
| Utilization | 100% | 80% |
| Fixed Costs | | |
| Repair and Maintenance | 640,000 | 704,000 |
| Insurance Costs | 166,100 | 166,100 |
| Station Personal Cost | 115,500 | 115,500 |
| Station Useful Life (Depreciation) | 21 | 21 |
| Total Station Build CapEx | 16,100,000 | 16,905,000 |
| | | |
| Station KG/Day | 8,000 | 6,400 |
| Hydrogen Produced/Year | 2,920,000 | 2,336,000 |
| Trucks/Day | 210 | 168 |
| Hydrogen Sale Price ($/Kg) | 3.60 | 4.49 |
| Revenue/Year | 10,500,000 | 10,500,000 |
| Cost/Kg (Ex. Deprecation) | 2.47 | 3.80 |
| Cost/Kg (Incl. Deprecation) | 2.73 | 4.15 |
| | | |
| Annual Operating Expense (Fixed) | 921,600 | 985,600 |
| Annual Water Expense | 39,301 | 31,441 |
| Annual Electricity Expense | 6,254,640 | 7,862,976 |
| Total Operating Expense | 7,215,541 | 8,880,017 |
| Station Depreciation | 766,667 | 805,000 |
| Total P&L Expense | 7,982,208 | 9,685,017 |
| Margin | 24% | 8% |

| Return (NKLA Assumptions) | | |
|---|---|---|
| Year | Revenue | Operating Costs |
| 0 | 0 | (16,100,000) |
| 1-21 | 10,500,000 | (7,215,541) |
| Total | 220,500,000 | (167,626,364) |
| Implied 21 Year IRR: | | 20% |

| Return (Market Assumptions) | | |
|---|---|---|
| Year | Revenue | Operating Costs |
| 0 | 0 | (16,905,000) |
| 1-21 | 10,500,000 | (8,880,017) |
| Total | 220,500,000 | (203,385,356) |
| Implied 21 Year IRR: | | 7% |

Source: Company Data, BTIG Research

Exhibit 9: The largest driver in the cost of Hydrogen is electrolyzer efficiency and the cost of electricity.

| Cost per Kg of Hydrogen | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Price of Electricity ($/KWh) | | | | | | |
| KWh per KG of Hydrogen | $0.020 | $0.030 | $0.035 | $0.050 | $0.070 | $0.125 | $0.200 |
| 40 | 1.13 | 1.53 | 1.73 | 2.33 | 3.13 | 5.33 | 8.33 |
| 55 | 1.43 | 1.98 | 2.25 | 3.08 | 4.18 | 7.20 | 11.33 |
| 65 | 1.63 | 2.28 | 2.60 | 3.58 | 4.88 | 8.45 | 13.33 |
| 80 | 1.93 | 2.73 | 3.13 | 4.33 | 5.93 | 10.33 | 16.33 |
| 100 | 2.33 | 3.33 | 3.83 | 5.33 | 7.33 | 12.83 | 20.33 |

Source: Company Data, BTIG Research

## Water: Potentially a Longer-Term Issue (next decade) But Addressed by Desalination

- **Debunking Water Concerns...** Accessing freshwater (saltwater would need to be desalinated as running saltwater through an electrolyzer reduces its performance) is key for hydrogen production, as ~2.5 gallons of water are needed to produce 1 KG of hydrogen. A FCEV truck traveling 100,000 miles/year requires about ~37 KG of hydrogen per day (~7.5 Miles/Kg) so to power, ~210 trucks require about 8,000 KG/day which points to water consumption of 8-9M gallons of water annually. In terms of individual water consumption, Americans use 80-100 gallons/day while the average golf course uses ~310,000 gallons per day. Bottom line: the water required to power ~210 trucks annually is equivalent to the water usage of ~240 Americans, and the water consumption of the average golf course can power 2,700 trucks annually.

- **…Law of Large Numbers.** With the Colorado River water rights being called into question once again (water levels are at ~41% of the average rate) we thought it worthwhile to at least consider the call on freshwater to supply the Class 8 truck market with hydrogen. And while one or even 10 stations does not make a dent in the US water supply, transitioning the roughly 2.8M Class 8 trucks in the US to hydrogen (if that is even possible it would be a 2-4 decade process), could push water demand for the Class 8 truck market to ~110B gallons annually. That is equivalent to the usage of ~3,000,000 Americans or the water demand of ~1,000 golf courses. And while water is cheap in the USA at roughly $4-6 per 1,000 gallons, in a place like Belgium water costs can be as high as ~$25 per 1,000 gallons while in Germany it is ~$10 per 1,000 gallons. We note NKLA assumes a $4.57 water price which is in the middle of the range in the US. However, even at $25 per 1,000 gallons of water (high end in Europe) that only should add $0.10-$0.20 to the cost of a KG of hydrogen.

Exhibit 10: While freshwater costs have the potential to change over time (think increasing demand and climate change) increases to water costs should have a limited impact on the price of hydrogen.

| Cost per Kg of Hydrogen | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Price of Water per 1,000 Gallons | | | | | | |
| | | $3 | $5 | $7 | $10 | $15 | $20 | $25 |
| Utilization | 20% | 3.73 | 3.73 | 3.74 | 3.75 | 3.76 | 3.78 | 3.79 |
| | 40% | 2.94 | 2.95 | 2.95 | 2.96 | 2.98 | 2.99 | 3.00 |
| | 60% | 2.68 | 2.68 | 2.69 | 2.70 | 2.71 | 2.73 | 2.74 |
| | 80% | 2.55 | 2.55 | 2.56 | 2.57 | 2.58 | 2.60 | 2.61 |
| | 100% | 2.47 | 2.47 | 2.48 | 2.49 | 2.50 | 2.52 | 2.53 |

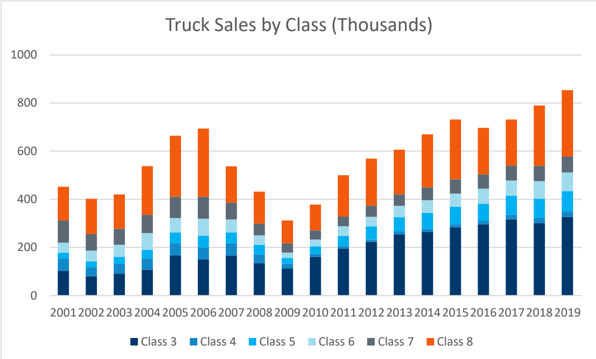
Source: Company Data, BTIG Research

## V. Macro Outlook – Start Your Engines.

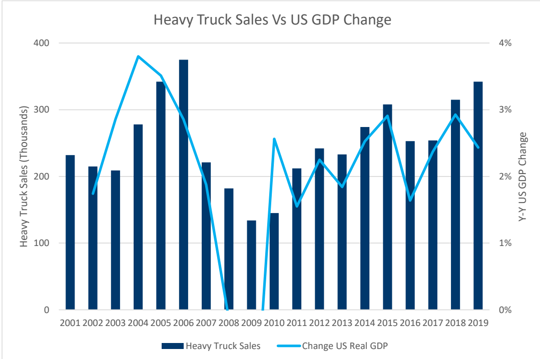
- **The Energy Transition.** The Class 8 truck market which is part of the lifeblood of global trade, unfortunately, is also one of the largest emitters of greenhouse gases (GHGs). And while cleaning up the heavy-duty truck market has been in environmentalists sights for over a decade, the rise of ESG investing and a push by major corporations from customers to banks to logistics to oil companies to move to net-zero emissions over the next few decades across Scope 1 (owned or controlled), 2 (indirect, think how energy is produced), and 3 (across the value chain and largely out of a company's control) points to the rubber starting to meet the road in the greening of the Class 8 market. We note while the technology is starting to come together, there is much work to be done on the economics which will be required to drive large-scale adoption of both BET and FCEV Class 8 trucks across North America, Europe, and the ROW. See (Long Haul Trucking).

- **Truck Sales.** Over the past decade, roughly 2M Class 8 trucks have entered the US market with roughly 2.8M Class 8 trucks currently on the road. There are ~25,000 alternative-fuel (primarily natural gas) Class 8 trucks in the US which gained popularity in the 2010s until the oil price collapse of 2016 stopped that momentum. Class 8 trucks are typically driven over 100k miles per year and typically have an average lifespan of ~750k miles (7-8 years) before needing a major overhaul and engine rebuild, which can keep the truck on the road over 1M+ miles. Interestingly, the heavy truck market share (vehicles on-road) dropped to 40% in 2018 from ~50% in 2001, as the rise of e-commerce has driven more localized networks and the push to faster delivery times which has seen an increase in share by Class 1-4 trucks.

Exhibit 11 & 12: As expected US Truck sales are correlated to US GDP, given trucking hauls ~70% of freight in the US. Truck sales have grown at a ~2% CAGR since 2001 in line with US GDP at roughly a 2% CAGR.

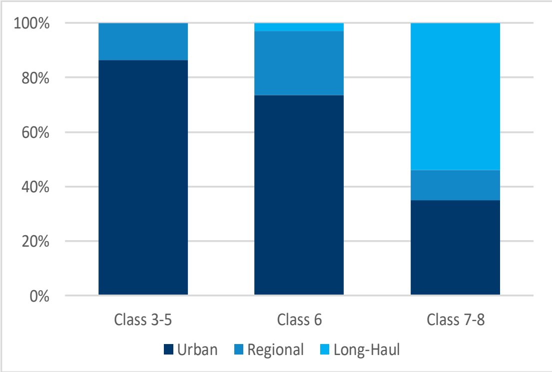



Source: Statistica, BTIG

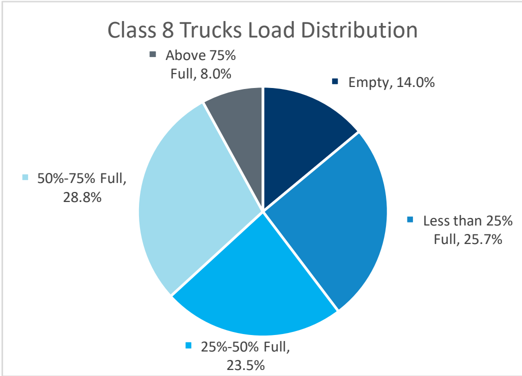



Source: Statistica, FactSet, BTIG

Exhibit 13 & 14: Class 7-8 trucks primarily haul freight long-haul (~65% of freight) with about 35% delivered locally. This two-tiered market (Long Haul/Urban) should provide opportunities for both BET and FCEV. On the right, empty Class 8 trucks weigh ~33,000 lbs with federal regulations allowing for total vehicle weight on interstates up to 80,000 lbs (some routes are grandfathered at over 100,000 lbs). However, we note trucks typically travel the majority of the time only 25%-75% full, which represents ~75% of all routes.




Source: Bloomberg NEF, BTIG




Source: Bloomberg NEF, BTIG

Exhibit 15: Competing Power Sources for the Class 8 Truck Market based on Average Market Data

| | Cost (2020 Truck) | TCO 2020 (Cost/Mile) | TCO 2030 (Cost/Mile) | Range (Miles) | Emissions | Current Infrastructure (US) | Challenges |
|---|---|---|---|---|---|---|---|
| **Diesel** | $125K | $1.17 | $1.15 | ~2000 | **1365 g/km CO2 | 110K+ Stations | The current standard, cheap but dirtier than other technology, limited improvement |
| **Hydrogen-(Electric)** | $265K | $2.14 | $0.91 | ~500-750 | *No Carbon Emissions | ~60 Hydrogen Stations (mostly in California) | Lack of infrastructure, technology still needs development to bring economic costs down |
| **Natural Gas (CNG/LNG)** | $180K/$200K | $0.84/$0.94 | $0.87/$0.97 | ~750 | **1016 g/km CO2 | ~1600 CNG/120 LNG Stations | Bridge Solution, still a fossil fuel, but more developed technology and cheaper than renewable options |
| **Electric** | $275K | $1.09 | $0.77 | ~500 | *No Carbon Emissions | 25K+ Stations | Limited range, increased weight and longer refueling times than other options |

*Using Renewables
**Well-to-Wheel total

Source: Company Data, BTIG, CleanEnergyFuels, Bloomberg NEF, Alternative Fuels Database

- **Solving Infrastructure…**While infrastructure is clearly a headwind in disrupting the Class 8 truck market, it has been tried before with roughly 1,600 natural gas truck stations (mainly CNG with a little over 100 LNG stations) in the US. Some of these stations (think on highways) are ripe to have either electric charging or hydrogen be added as additional fuel sources owing to their strategic locations along interstates but also having ample space for additional fueling infrastructure.

- **…For Both EV and Hydrogen Strategically.** There are over 25,000 electric charging stations for cars which with some capital investment could convert many of these stations to accommodate heavy-duty trucks (we note faster charging (think DC fast-charging) will be required). This compares to over 100,000 gasoline/diesel stations across the US. Meanwhile, hydrogen infrastructure is still in its infancy (~45 hydrogen stations in the US primarily in California) with plans to add roughly 300-400 hydrogen fueling stations over the next 3-4 years. However, key to both the roll-out of charging and hydrogen for the Class 8 market will be focusing on strategic locations (think ports, near major cities, and along interstates) and the routes anchor customers travel. And while it would be nice to service some mom and pops that operate a handful of trucks, initially we expect Nikola to focus on building infrastructure for its anchor customers that will look to have a FCEV fleet of at least 100 trucks.

## VI. Balance Sheet and Financing (Balance Sheet, CAPEX)

- **Building a Business Costs Money**. Nikola has ~$765M in cash on the balance sheet as of 1Q21 (with no debt and ~$14M in finance leases). At its 2020 analyst day management laid out potential CAPEX guidance through 2024 of $1.6B. However, nailing down medium and longer-term CAPEX timing is challenging owing to the bulk of this CAPEX being targeted for the company's hydrogen fueling network. Bottom line the bulk of ~$1.6B CAPEX target through 2024 includes roughly $1B for the hydrogen fueling network which includes roughly 60 hydrogen fueling stations. We note the cadence of the $1B of CAPEX for the hydrogen fueling network will be a function of FCEV sales with each fueling station estimated at $16M. Management expects to have ~34 fueling stations up and running in 2024 (~$600M in CAPEX) which translates to FCEV sales of ~7,000 units as each station is able to service about 210 FCEVs. Additionally, with estimated lead times of about 18 months for each station (think permitting, equipment, and construction), some 2023 and 2024 CAPEX will be for fueling stations coming online in 2025 and 2026.

- **Estimated CAPEX Schedule.** Management has guided to $210M-$230M in CAPEX for 2021 which includes the startup of its manufacturing facilities in Arizona and Germany (roughly $515M remaining on the two facilities) followed by roughly another $200M in CAPEX in 2022. Additionally, we estimate cash burn at $80M-100M per quarter (includes corporate spending and R&D), which should continue to draw down NKLAs ~$765M cash position. Management has noted its plan to raise roughly $1B in new equity at some point this year, owing to its expected growth CAPEX of ~$1.6B through 2024, but we expect management to be opportunistic with any capital raise owing to its ability to meet its near-term liquidity needs and the levers it can pull around both growth CAPEX and operating expenses. Bottom line: NKLA has ample liquidity to meet near its near-term CAPEX which gives management some flexibility about the timing of any capital raise. Additionally, another potential path forward for the CAPEX required for the hydrogen fueling network could be a joint venture (it takes money to make money). Given the potential value of the hydrogen fueling network, we view a joint venture as a low probability.

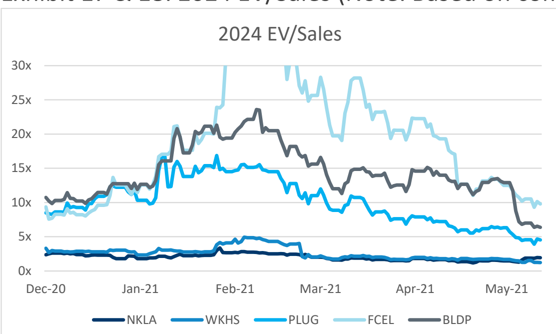
Exhibit 16: Nikola Facilities


Source: Company Data

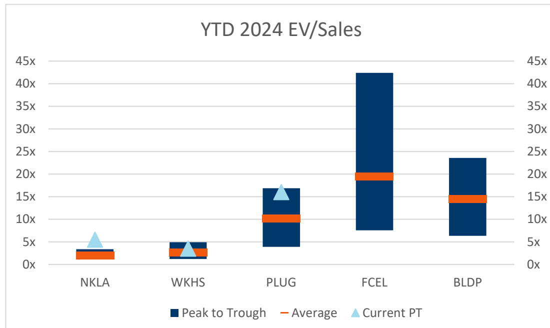
## VII. Valuation – Pricing in Exponential Revenue Growth Driven by the Roll-out of the Tre BET and Two FCEV

- As an upstart alternative energy truck manufacturer that is a pre-revenue company, we use forward EV/Sales as our primary valuation methodology. While the company has multiple business lines (BEV vehicles, FCEV vehicles, and Hydrogen infrastructure), we focus on vehicle sales in the near to medium-term which will be primarily driven by BETs. We note we see significant potential value creation from the hydrogen fueling network (depending on the build-out of the network) over time which could see the hydrogen fueling network being worth more than the combined truck manufacturing business. Looking at the comp group we used other up-start alternative fuel medium and heavy commercial vehicle manufacturers and companies levered to hydrogen. Our $18 PT is a 5.5x multiple on our estimated 2024 sales (~4,100 BEVs, and ~650 FCEV trucks sold), which is a slight premium to our blended comp group given NKLA's opportunity to continue to expand into the higher multiple hydrogen economy.

Exhibit 17 & 18: 2024 EV/Sales (Note: Based on companies in our comp group with available 2024 estimates).

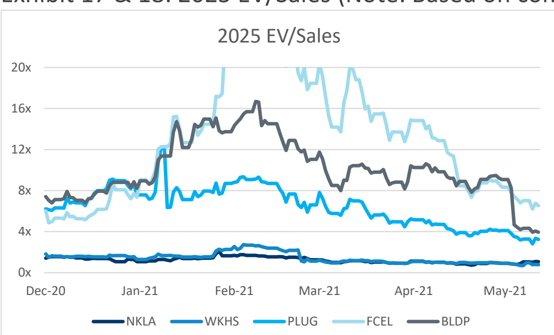



Source: FactSet, BTIG Research

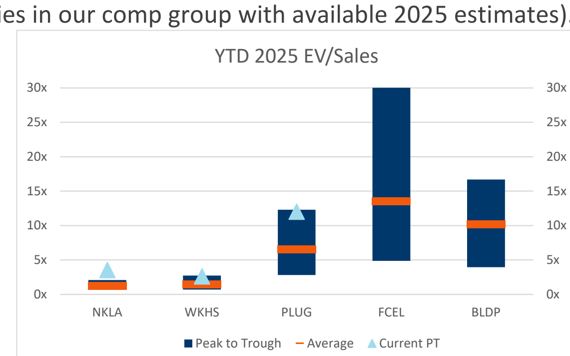



Source: FactSet, BTIG Research

Exhibit 17 & 18: 2025 EV/Sales (Note: Based on companies in our comp group with available 2025 estimates).




Source: FactSet, BTIG Research




Source: FactSet, BTIG Research

- **Sum of Parts Analysis**. While NKLA is focused on delivering trucks to the Class 8 truck market, we view NKLAs dual-pronged strategy (BETs and FCEVs) as two different businesses with distinct CAPEX programs. The BET business is straightforward (think realizing a profit margin on sales projects) with initial revenues expected in late 2021. We note our $10/share value for the BET business is based on our 2025 revenue estimate of ~$1.9B (assumes a ~140% CAGR from our 2022 revenue estimate) and assumes a 2x EV/Sales multiple. The FCEV business is a bit more challenging (and where we see the potential for exponential value creation if NKLA is successful in rolling out a hydrogen fueling network for its fleet and longer-term other hydrogen fuel cell trucks. We note management is targeting first revenues in 2023 and our 2025 revenue estimate for the hydrogen fuel cell business is ~$500M (240% CAGR from 2023-2025) which points to $8/share based on an EV/Sales multiple of ~9x which is a premium to other hydrogen leveraged names.

Exhibit 19: Comp Group

| Company | Ticker | Rating | Stock Price ($USD) | Market Cap ($USD) | 2021 EV/EBITDA | 2022 EV/EBITDA | Net Debt to Capital | 2021 EV/Sales | 2022 EV/Sales | 2023 EV/Sales |
|---|---|---|---|---|---|---|---|---|---|---|
| **Heavy Duty Alternative Fuel Transportation** | | | | | | | | | | |
| Nikola Corporation | NKLA | Buy | $ 12.10 | $ 4,765.59 | NA | NA | -82% | 175.6x | 16.4x | 3.6x |
| Workhorse Group Inc. | WKHS | Buy | $ 8.31 | $ 1,024.29 | NA | NA | -7% | 8.8x | 2.8x | 1.6x |
| GreenPower Motor Company Inc. | GP | Buy | $ 16.01 | $ 350.65 | 70.3x | 24.1x | 107% | 6.6x | 3.8x | 1.9x |
| Hyliion Holdings Corp. Class A | HYLN | Not Rated | $ 10.02 | $ 1,785.03 | NA | NA | -90% | *223.1x* | *5.3x* | *1.8x* |
| Average | | | | $ 1,053.32 | 70.3x | 24.1x | 3% | 79.5x | 4.0x | 1.8x |
| **Hydrogen** | | | | | | | | | | |
| Plug Power Inc. | PLUG | Buy | $ 27.20 | $ 15,458.24 | 730.8x | 108.4x | -37% | 20.0x | 12.7x | 8.3x |
| FuelCell Energy, Inc. | FCEL | Not Rated | $ 8.50 | $ 2,740.65 | NA | NA | 8% | 24.5x | 16.4x | 11.6x |
| Ballard Power Systems Inc. | BLDP | Not Rated | $ 16.25 | $ 4,873.29 | NA | NA | -81% | 29.6x | 20.9x | 13.0x |
| McPhy Energy SA | McPhy | Not Rated | $ 32.77 | $ 911.68 | NA | NA | -93% | 18.7x | 11.6x | 6.1x |
| Bloom Energy Corporation Class A | BE | Not Rated | $ 21.85 | $ 3,766.74 | 50.4x | 28.9x | 62% | 4.3x | 3.4x | 2.7x |
| Proton Motor Power Systems Plc | PPS | Not Rated | $ 0.80 | $ 619.46 | NA | 168.8x | NA | 32.3x | 9.9x | 6.2x |
| Chart Industries, Inc. | GTLS | Buy | $ 149.51 | $ 5,434.47 | 22.9x | 17.9x | 17% | 4.5x | 3.9x | 3.6x |
| Average | | | | $ 4,829.22 | 268.0x | 81.0x | -21% | 19.1x | 11.3x | 7.4x |
| **Total Average** | | | | $ 3,696.45 | 218.6x | 69.6x | -13% | 37.2x | 9.1x | 5.7x |
| **Total Median** | | | | $ 2,740.65 | 60.4x | 28.9x | -22% | 20.0x | 9.9x | 3.6x |

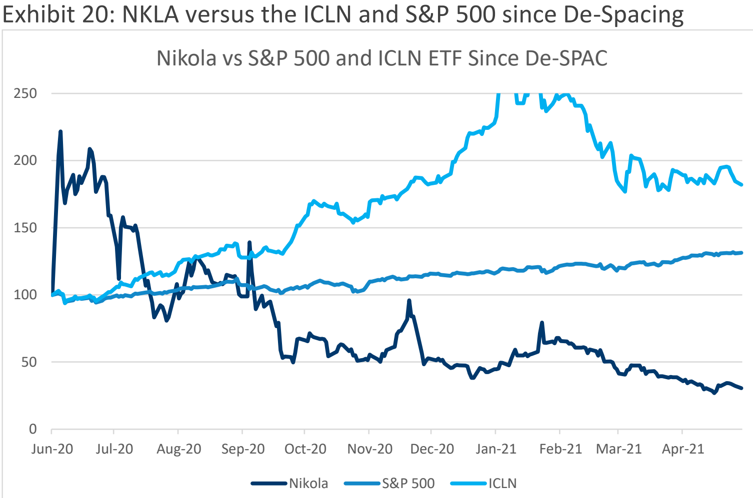
Source: Company Data, BTIG Research, FactSet

- **Risks to our Rating** include: technology advancement reducing value of Nikola products, changes in environmental laws and regulations, changes in government stimulus/aid, changes in customer preferences, key customer risk, supply chain risk, poorly timed or non-accretive acquisitions, failure to execute on plan on-time and budget, failure to raise additional capital, and changes to the competitive landscapes which the company competes in.

## VIII. Performance – Company Specific Events Driving Stock Performance

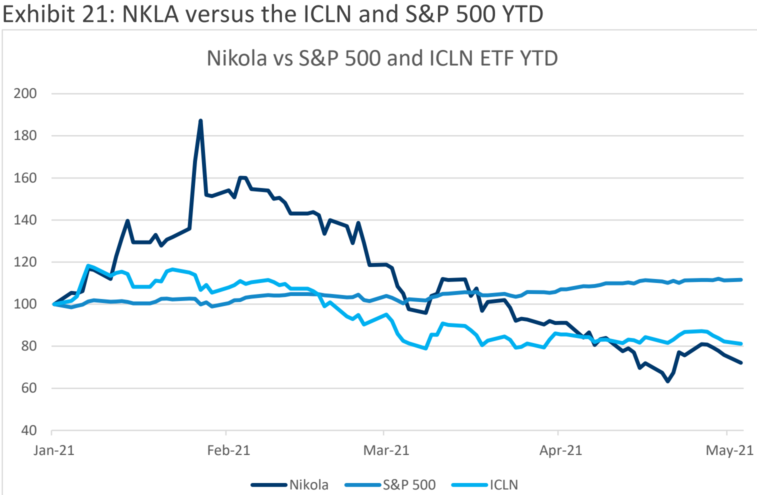
- NKLA de-spaced on June 4th, 2020 with the stock finishing the day at ~$34 and proceeded to quickly spike to over $80 and a market cap of over $30B. The stock has steadily pulled back since mid-June 2020 as the company has had to manage through multiple growing pains including the departure of the company's founder from the board, the breakdown of a potential partnership between NKLA and General Motors (GM, Not Rated), the breakdown of a partnership with Republic Services (RSG, Not Rated) to build a refuse truck, the start of an SEC investigation in 4Q20, and a pivot by management to focus solely on the heavy-duty Class 8 truck market. Bottom line: the stock has been driven more by company-specific news flow since its SPAC merger than broader market price action with NKLA down ~65% since the merger was completed in June 2020 significantly underperforming the ICLN (Clean Energy ETF) which is up ~90% and S&P 500 which is up ~35% over this period.

Exhibit 20: NKLA versus the ICLN and S&P 500 since De-Spacing




Source: BTIG Research, FactSet

Exhibit 21: NKLA versus the ICLN and S&P 500 YTD




Source: BTIG Research, FactSet

## NKLA- Income Statement

| Income Statement ($ mil) | Mar-21 | Jun-21 | Sep-21 | Dec-21 | Mar-22 | Jun-22 | Sep-22 | Dec-22 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sales | 0.0 | 0.0 | 0.0 | 3.0 | 14.8 | 26.2 | 40.5 | 53.4 | 0.1 | 3.0 | 134.9 | 562.9 | 1,440.0 | 2,409.0 |
| Cost of Sales | 0.0 | 0.0 | 0.0 | (5.0) | (19.2) | (30.2) | (40.9) | (51.8) | (0.1) | (5.0) | (142.0) | (489.2) | (1,117.3) | (1,780.8) |
| **Gross Profit** | **0.0** | **0.0** | **0.0** | **(2.0)** | **(4.4)** | **(3.9)** | **(0.4)** | **1.6** | **0.0** | **(2.0)** | **(7.2)** | **73.7** | **322.7** | **628.1** |
| G&A | (65.4) | (64.9) | (65.1) | (65.3) | (65.5) | (65.8) | (66.0) | (66.2) | (182.8) | (260.7) | (263.5) | (280.8) | (300.4) | (305.6) |
| R&D | (55.2) | (88.5) | (89.3) | (90.1) | (90.9) | (91.7) | (92.5) | (93.4) | (185.6) | (323.1) | (368.5) | (381.9) | (395.7) | (410.2) |
| Other | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Operating Income** | **(120.6)** | **(153.4)** | **(154.4)** | **(157.4)** | **(160.9)** | **(161.4)** | **(158.9)** | **(158.0)** | **(368.4)** | **(585.8)** | **(639.2)** | **(588.9)** | **(373.5)** | **(87.6)** |
| Interest Expense | (0.0) | (0.3) | (1.0) | (1.7) | (2.4) | (3.2) | (4.0) | (4.8) | (0.1) | (3.1) | (14.4) | (28.4) | (50.3) | (69.9) |
| Interest Income | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Other | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | (0.5) | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 |
| **Pretax Income** | **(120.4)** | **(153.5)** | **(155.2)** | **(158.9)** | **(163.1)** | **(164.4)** | **(162.7)** | **(162.5)** | **(368.7)** | **(588.0)** | **(652.7)** | **(616.4)** | **(422.8)** | **(156.7)** |
| Taxes | (0.0) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | (0.0) | 0.0 | 0.0 | 0.0 | 0.0 |
| Equity Income | (0.8) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | (0.6) | (0.8) | 0.0 | 0.0 | 0.0 | 0.0 |
| **Net Income - continuing ops** | **(121.2)** | **(153.5)** | **(155.2)** | **(158.9)** | **(163.1)** | **(164.4)** | **(162.7)** | **(162.5)** | **(368.3)** | **(588.8)** | **(652.7)** | **(616.4)** | **(422.8)** | **(156.7)** |
| Extraordinary Items | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | (29.1) | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Net Income - reported** | **(120.2)** | **(153.5)** | **(155.2)** | **(158.9)** | **(163.1)** | **(164.4)** | **(162.7)** | **(162.5)** | **(397.4)** | **(587.8)** | **(652.7)** | **(616.4)** | **(422.8)** | **(156.7)** |
| **Diluted EPS - cont. ops** | **(0.31)** | **(0.39)** | **(0.39)** | **(0.36)** | **(0.37)** | **(0.37)** | **(0.37)** | **(0.37)** | **(0.95)** | **(1.5)** | **(1.5)** | **(1.4)** | **(0.9)** | **(0.3)** |
| Extraordinary charges | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | (0.08) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Diluted EPS - reported | (0.31) | (0.39) | (0.39) | (0.36) | (0.37) | (0.37) | (0.37) | (0.37) | (1.03) | (1.5) | (1.5) | (1.4) | (0.9) | (0.3) |
| **EBITDA Reconciliation** | | | | | | | | | | | | | | |
| Operating Income | (120.6) | (153.4) | (154.4) | (157.4) | (160.9) | (161.4) | (158.9) | (158.0) | (368.4) | (585.8) | (639.2) | (588.9) | (373.5) | (87.6) |
| D&A | 1.8 | 4.8 | 5.8 | 5.9 | 10.9 | 10.9 | 10.9 | 10.9 | 6.0 | 18.2 | 43.4 | 45.4 | 47.4 | 51.4 |
| Stock Based Comp | 50.3 | 53.0 | 53.0 | 53.0 | 53.0 | 53.0 | 53.0 | 53.0 | 138.0 | 209.2 | 211.9 | 211.9 | 211.9 | 211.9 |
| Equity Income | 0.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.6 | 0.8 | 0.0 | 0.0 | 0.0 | 0.0 |
| EBITDA (Calc) | (67.7) | (95.7) | (95.7) | (98.6) | (97.1) | (97.6) | (95.1) | (94.2) | (223.7) | (357.7) | (383.9) | (331.7) | (114.2) | 175.6 |
| Other Adjustments | 14.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 23.3 | 14.3 | 0.0 | 0.0 | 0.0 | 0.0 |
| Adj. EBITDA | (53.4) | (95.7) | (95.7) | (98.6) | (97.1) | (97.6) | (95.1) | (94.2) | (200.5) | (343.4) | (383.9) | (331.7) | (114.2) | 175.6 |

Source: Company Data, BTIG Research

# Plug Power Inc.
# (PLUG, Buy, $40 PT)

May 27, 2021

Eyes of the World, Initiating with an Buy rating and $40 PT

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**WHAT YOU SHOULD KNOW:** Hydrogen as an energy source (really a means of storing energy) is still largely in its infancy despite being used in limited applications for decades. And while PLUG and others have greatly advanced the case of hydrogen as an energy source for a lower carbon world (PLUG stock is up over 500% over the last year), there is still a lot of work to be done (largely on the cost and infrastructure side) by PLUG and its partners across the value chain to make green hydrogen a widely accepted energy source for industrial and transportation applications (PLUG stock is down over 50% from its January peak). Bottom line: while we are still in the early innings of an energy transition away from fossil fuels (wind and solar are leading the charge), we expect momentum for green hydrogen to build this decade and next helped by an improving cost curve and government support. We initiate with a Buy, as we view PLUG as a well-capitalized, first-mover with strategic customers and partners across the green hydrogen supply chain.

- **Targeting Green Hydrogen With Partners...** PLUG has partnered with Brookfield Energy (Not Rated), which will supply hydroelectric power as it looks to roll out its first green hydrogen production (targeting 2022). Additionally, PLUG has partnered with Apex (private) which is a wind power producer as it looks to add ~8 green hydrogen facilities (3 projects have already commenced). We expect PLUG to partner with other renewable producers as it looks to establish an integrated green hydrogen network across the US.

- **...For Industrial and Transportation.** Industrial applications consume ~7% and road transportation consumes ~50% of the world's global oil demand, making both ripe for at least some hydrogen switching (we expect transportation switching to be for niche applications). Not surprisingly, while hydrogen has been used for decades, U.S. hydrogen infrastructure is limited, which is why PLUG and partners (with the help of anchor customers) are establishing a bit of an "if you build it, they will come" hydrogen network for power generation and niche transport applications.

- **Carbon Wildcard.** While efficiency gains in renewable power and economies of scale in hydrogen (think larger electrolyzers) are what has changed over the last decade and are paving the way for green hydrogen, it is still more expensive than fossil fuels. However, with a tonne of carbon already trading over $50 in Europe, any decision to implement a carbon tax could quickly change the cost equation. With a Class-8 truck producing ~170 tonnes of C02/year at $100/tonne (we have heard calls for $200+ by some shippers), that points to a $17k annual carbon tax.

- **Global Demand with Global Customers.** Europe is largely ground zero for green hydrogen (see Outlook), with many power producers and industrial manufacturers looking at green hydrogen as they work to achieve net-zero emissions in line with the Paris Agreement. In the U.S., demand is largely from big box stores (think warehouses) that are looking for clean energy solutions. We estimate that 3 customers represent ~60% of the PLUG revenue, and we like the customer concentration (each has a vested interest), as green hydrogen is still a nascent industry.

- **Valuation:** Our $40 PT is based on a 3-stage DCF with revenue growth projected as ~45% through 2025, dropping to ~30% through 2030 and 15% through 2040 as the industry matures (CAGR of ~25% from 2021E to 2040E). We expect EBITDA margins to stabilize in the low- to mid-30% range.

| Company Data | |
|---|---|
| Closing Price | $29.69 |
| Price Target | $40.00 |
| Market Cap (M) | $16,937.63 |
| Enterprise Value (M) | $18,603.83 |
| Shares Out (M) | 570.48 |
| Avg Daily Vol-3 Months (M) | 38.05 |
| Dividend / Yield | $0.00 / 0.0% |

| Revisions | Previous | Current |
|---|---|---|
| Rating | - | Buy |
| Price Target | - | $40.00 |
| FY20E EBITDA | - | (29.99) |
| FY21E EBITDA | - | (47.63) |
| FY22E EBITDA | - | 57.63 |
| FY20E REV | - | 331.81 |
| FY21E REV | - | 469.96 |
| FY22E REV | - | 738.03 |

| EBITDA (Adjusted) | | | |
|---|---|---|---|
| FY Dec | 2020E | 2021E | 2022E |
| Q1 | (6.10) | (25.10) | (9.75) |
| Q2 | 1.22 | (17.50) | 4.30 |
| Q3 | 24.00 | (2.32) | 29.09 |
| Q4 | (49.11) | (2.70) | 33.99 |
| **FY EBITDA** | **(29.99)** | **(47.63)** | **57.63** |
| FY EV/ EBITDA | - | - | 322.8x |

| Revenue (M) | | | |
|---|---|---|---|
| FY Dec | 2020E | 2021E | 2022E |
| Q1 | 43.02 | 67.40 | 114.38 |
| Q2 | 72.44 | 99.97 | 159.27 |
| Q3 | 125.62 | 155.74 | 234.57 |
| Q4 | 90.74 | 146.86 | 229.81 |
| **FY REV** | **331.81** | **469.96** | **738.03** |
| FY EV/S | 56.1x | 39.6x | 25.2x |
| FY P/S | 51.0x | 36.0x | 22.9x |

Source: FactSet, BTIG Estimates and Company Documents reported as $ currency.
**FY** = Fiscal Year **CY** = Calendar Year

## Investment Thesis

PLUG is positioning itself as a leader in Hydrogen with an integrated product offering across the Hydrogen economy. We expect PLUG to put its cash balance to use with additional bolt-on acquisitions, along with additional JVs to diversify and grow PLUG's market share in the rapidly expanding hydrogen economy.

## Upcoming Catalysts

- 1Q21 Earnings
- Seasonally stronger 2H for Material Handling segments
- Additional JVs
- Additional Bolt-On Acquisitions

## Base Case Assumptions: **$40 Price Target**

Our base case is that PLUG is able to reach management's stated goals and guidance of $475M of revenue in 2021 and $750M of revenue in 2022. We expect material handling to continue to be the core growth driver of the business.

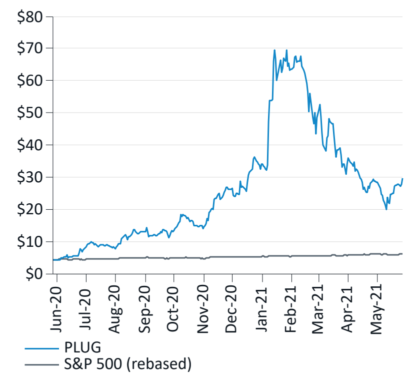
## Upside Scenario

Our upside scenario is that Hydrogen adoption is faster than anticipated and that PLUG is able to grow (both organically and inorganically) more quickly. We expect material handling to continue to be the core driver of the business.

## Downside Scenario

Our downside scenario is that Hydrogen adoption remains a niche market, failing to reach mass market appeal as other solutions, such as electric propulsion, take market share.

## Price Performance




Source: FactSet

## Company Description

Plug Power, Inc. designs, develops, manufactures and commercializes fuel cell systems for electric lift trucks and materials handling equipment. The Company offers its products globally to retail, grocery, and institutional food distribution centers, as well as to manufacturing facilities.

# Plug Power (PLUG) – Well Capitalized First Mover with Key Customers

## I. Executive Summary

1. We initiate on Plug Power (PLUG) with a Buy rating and a $40 PT. PLUG has established itself as a market leader in the nascent global hydrogen market, establishing a foothold in the material handling industry (~70% of 2020 revenue) with some of the largest global big box companies signed up as customers. With a cash war chest of $4B, we expect PLUG to continue to be opportunistic around bolt-on acquisitions and joint ventures as it looks to expand the company's scope and product offering as an integrated hydrogen player.

2. **Building a Business.** While hydrogen as a fuel is still largely in its infancy, key to PLUG establishing itself as a leading hydrogen fuel cell company was creating a market. And while there are many potential applications for hydrogen fuel cells across transportation (think heavy-duty trucks, ferries, cruise ships, rails, and aviation), large-scale warehouses look tailor-made for hydrogen fuel cells. One of the biggest sticking points (beyond the cost of hydrogen) for hydrogen road deployment is infrastructure, but a large warehouse (think over 100 forklifts) operating around the clock drives enough traffic on the network to be economically viable before any CO2 benefit is calculated. With large warehouse deployments the initial focus, PLUG has been able to build strong relationships with Amazon and Wal-Mart (AMZN, WMT, Both Not Rated), with these two customers driving roughly 70% of 2020 revenues. We expect improving costs and increasing corporate focus on ESG to provide continued growth in PLUG's forklift business over the next few years.

3. **Macro Tailwinds.** Despite being a roughly $120B market today, hydrogen (particularly green hydrogen) is still in its adolescence. However, hydrogen appears to be a piece of the puzzle as governments across the world look to develop net-zero economies (wind and solar can only do so much), with Europe looking to spearhead hydrogen growth with strong policy and economic legislation. Concurrently, the material handling market (~70% of PLUG's 2020 revenue) is expected to grow as e-commerce continues to integrate its way into society (think more warehouses), with an expected 9% CAGR through 2037.

4. **Cash War Chest and Strategic Partnerships**. Management has seen the good and bad times (IPO in 1999) for the potential of a hydrogen economy, and while PLUG is an industry leader in hydrogen fuel cells, sometimes too much time is the enemy. This is part of the reason PLUG has raised over $4.5B of capital over the last two years as it looks to solidify its position in a growing (timing will be choppy) hydrogen economy. The $4.5B of capital included a direct investment of ~$1.5B by SK Innovations (096770-KRX, Not Rated), which plans to help build a hydrogen economy in South Korea. Additionally, PLUG has formed two strategic JVs in Europe with Renault (RNLSY, Not Rated), to focus on commercial fuel cell vehicles, and with Acciona (ACXIF, Not Rated), a Spanish renewable and desalination company for green hydrogen production.

5. **Catalysts.** Near-term catalysts include the potential for 1) New contract awards with both new and existing customers, and 2) Strategic new partnerships that expand PLUG's product offering. Longer-term catalysts include: 3) Increased hydrogen application momentum (industrial, marine, heavy trucks), 4) Improving hydrogen economics, 5) Carbon prices (~up 45% YTD), 6) Large-scale hydrogen project FIDs, and 7) Government initiatives that drive local and regional hydrogen programs.

6. **Price Target.** Our $40 PT is based on a 3-stage DCF as the Hydrogen economy matures through 2040. In Stage 1 (2021-2025), we expect a revenue CAGR of ~45%, with EBITDA margins averaging in the mid-teens (finishing the period ~25%). In Stage 2 (2026-2030) and Stage 3 (2031-2040), we expect revenue growth of ~30% and ~15%, respectively, with EBITDA margins in the low- to mid-30% range.

## II. Who, What, Where – First Mover With A Lot of Partners

- **How We Got Here.** Plug Power was founded in 1997 with a focus on becoming an innovator in the Hydrogen sector. With over 20 years in the industry (and a lot of innovation and scar tissue along the way), PLUG has grown into a leader in hydrogen fuel cells, with over 40,000 fuel cell units deployed driving over 40 tons/d of hydrogen demand across more than 100 hydrogen fueling stations. The company has a diverse hydrogen portfolio across the hydrogen value chain, including fueling stations, electrolyzers, infrastructure, fuel cells, and storage tanks. While hydrogen for transportation and industrial applications is still largely in its infancy (economics and infrastructure still need to improve), PLUG has been able to build a niche business in the material handling industry (think warehouses), powering forklifts.

- **Material Handling** is by far PLUG's largest current end-market (~70% of 2020 revenues), wherein PLUG provides its GenDrive units to A) Class 1 (Electric Motor Riding Forklift), B) Class 2 (Electric Motor Narrow Aisle Riding Forklift), C) Class 3 (Electric Motor Hand Forklift), and D) Class 6 (Electric Motor Tractor Forklift) forklifts. Additionally, PLUG provides the fueling infrastructure (tanks and distribution) as well as the hydrogen. Bottom line: PLUG provides a One-Stop shop for customers looking to deploy hydrogen power solutions across the warehouse network. We note powering the forklift industry is highly competitive, with companies such as Enersys (ENS, Neutral), focusing on battery based solutions. We note we expect a two-tiered forklift market to continue to develop with PLUG's playing field large-scale warehouses (100+ forklifts) while conventional technology should continue to dominate smaller facilities. Luckily for PLUG, growing e-commerce points to continued growth in large-scale warehouse deployments.

Exhibit 1: PLUG's Material Handling Business Opportunity.


Source: Company Data

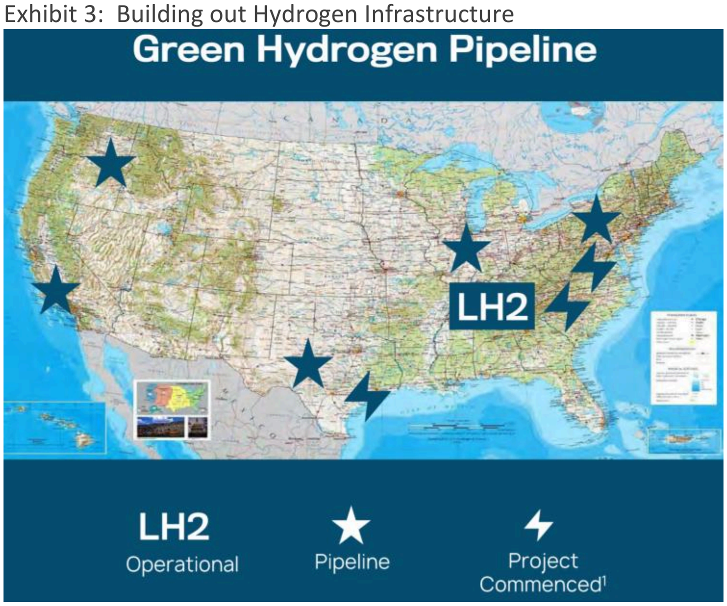
- **Blue Chip Customers.** Not surprisingly, PLUG's One-Stop carbon-friendly solution lends itself nicely to major warehouse users, with Walmart and Amazon PLUG's largest customers. We note that in 2017, PLUG solidified these relationships by issuing ~55M in warrants to each, which are linked to payments made to PLUG for products and services and fully vest as each reaches $600M in sales to PLUG.

Exhibit 2: PLUG's Material Handling Business Opportunity.


Source: Company Data

- **Green Hydrogen Build-Out.** While hydrogen has been around for decades (largely blue and gray hydrogen), the combination of decreasing renewable energy costs (think cheaper wind and solar) and the increased focus and urgency by some countries and companies to reach net-zero emissions targets by 2050 is expected to increase the demand for green hydrogen. We note there are many pilot projects underway around the world in green hydrogen intending to make green hydrogen more economical. With that out of the way, PLUG plans to build out ~8 (3 have commenced) US-based green hydrogen plants by 2024 with production of 100 tons of green hydrogen per day (the company already operates one blue hydrogen plant in TN). In March, PLUG announced partnerships with Brookfield Renewable Energy (BEP, Not Rated) to develop the first green hydrogen plant fueled by hydro-electricity, which is expected to generate 10 tons/d, and in September, PLUG announced its partnership with Apex Energy (Private) to develop a 30 ton/d plant powered by wind.

Exhibit 3: Building out Hydrogen Infrastructure




Source: Company Data

- **Proton Exchange Membranes Electrolysis (PEM).** Polymer electrolyte membrane electrolysis (most commonly used) is the electrolysis of water in a cell equipped with a solid polymer electrolyte that is responsible for the conduction of protons, separation of product gases, and electrical insulation of the electrodes. PEM electrolyzers currently run at ~80% electrical efficiency (how much energy is put into the process for the amount converted) but are expected to reach the high 80% range by 2030. PLUG partnered with Giner ELX (Private) in 2020 to help rollout its PEM electrolyzer, which has helped PLUG become a leader in the space with plans to deploy ~500 MW of electrolyzers by 2024 (gigafactory should start production around June 2021 and should be full run-rate by September). As part of its $1.2B revenue goal by 2024, PLUG plans aim to create a PEM Gigafactory with an output of 1.5 GW.

Exhibit 4: Plug plans to build out a PEM Gigafactory to accelerate electrolyzer growth.

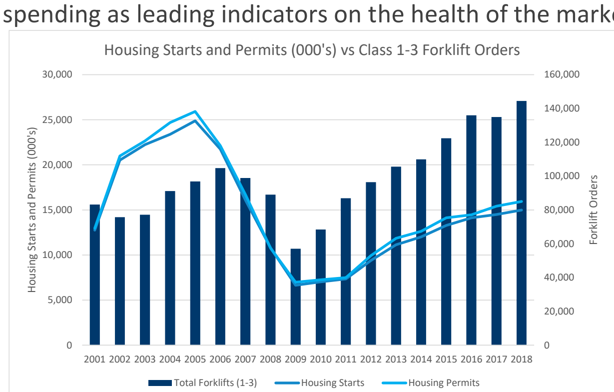

Source: Company Data

## III. Macro Outlook – Material Handling, Backup Power, Transportation

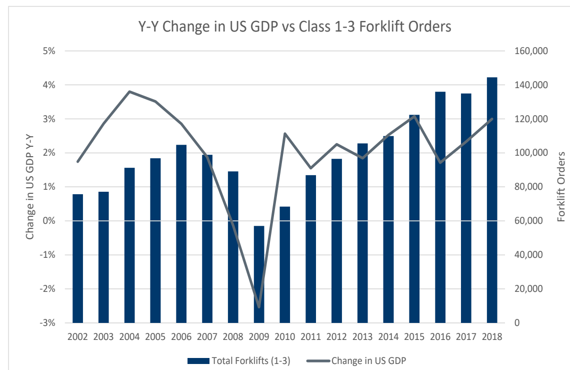
- **The Energy Transition**. Hydrogen is looking to carve out its niche of the ongoing energy transition. Demand will be driven by a combination of industrial applications, power on demand (energy storage), and transportation applications. Key to PLUG's success has been its ability to establish flagship material handling customers as a proving ground for its fuel cell technology, which the company now plans to leverage across other applications with an eye on back power and transportation.

- **Material Handling.** With ~70% of 2020 revenue coming from material handling, PLUG is levered to economic growth cycles. The global forklift market is roughly $50B and is expected to grow at a 9% CAGR from 2021 to 2027 to $90B (largely on the back of the global boom in E-Commerce, think a lot of home deliveries) when global forklift shipments are expected to exceed 2M units annually. PLUG makes products for Class 1-3 and Class 6 vehicles (think electric forklifts while Class 4-5 and Class 7 are internal combustion engine [ICE] forklifts). As forklifts are most utilized in warehousing facilities, the growth of the digital economy (home deliveries, which also now includes food deliveries) has been a significant tailwind for the Material Handling sector driven by companies like Amazon and Walmart.

Exhibits 5 & 6: Forklift Orders rely on Economic cycles with Housing starts, GDP, and consumer discretionary spending as leading indicators on the health of the market.



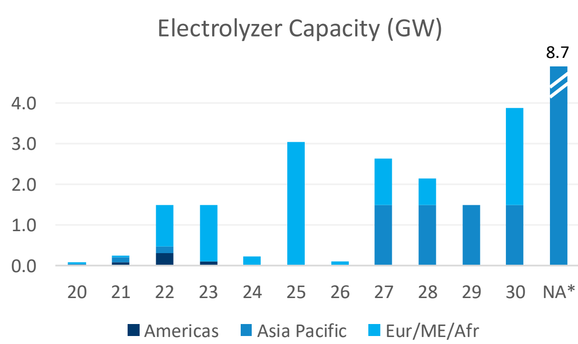

Source: FactSet, Industrial Truck Association, US Factory Shipments, BTIG



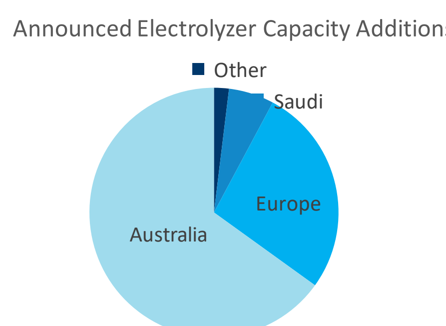

Source: FactSet, Industrial Truck Association, US Factory Shipments, BTIG

- **Electrolyzer capacity additions:** There are currently over 20GW of electrolyzer capacity planned to be added over the next 10 years. We estimate about 17GW of known projects in the planning stages scheduled to be delivered before 2030, with another 9GW of projects without a known start date, some of which we estimate would be completed this decade. Over half of these projects are in Australia, with most of the remaining projects in Europe or Saudi Arabia.

Exhibits 7 & 8: There are over 20GW of electrolyzer capacity projects in the pipeline over the next decade, with the majority in Australia and Europe.

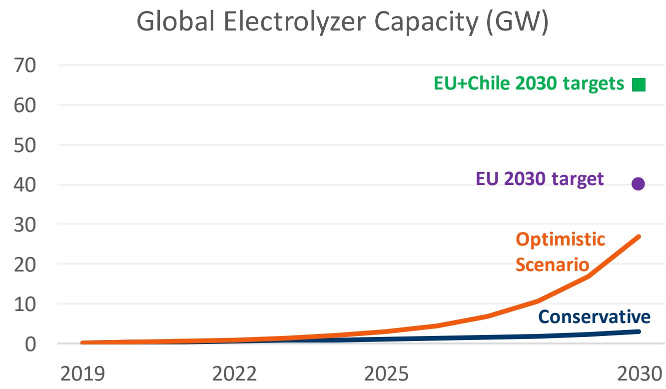



Source: Bloomberg NEF, BTIG Research




Source: Bloomberg NEF, BTIG Research

Exhibit 9: In an optimistic scenario, we see close to 30GW of global electrolyzer capacity built out by 2030, while a conservative scenario only sees 3GW come to fruition. Both are substantially below the targets put out by the EU and Chile of 40GW and 25GW, respectively, which would require substantial government support.



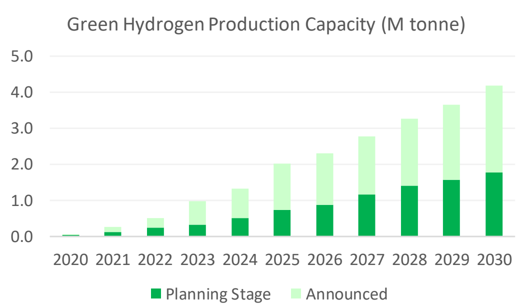

Source: BNEF, BTIG Research

- **Electrolyzer manufacturing capacity:** Shipments of electrolyzers have increased from 135MW in 2018 to 200MW in 2020, a nearly 50% increase, but still a very small amount. The current capacity to manufacture electrolyzers is 3-5GW/year, with over 2/3 in the hands of 5 companies. This is sufficient to meet current construction projects, but in order to meet larger long-term targets global electrolyzer capacity needs to increase exponentially.

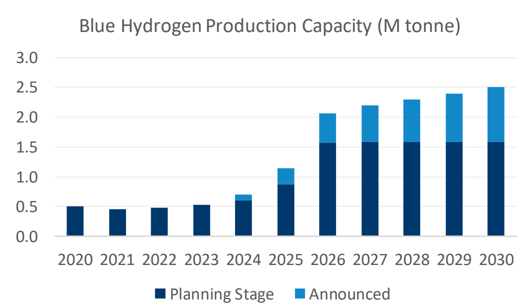
- **How much green hydrogen can electrolyzers produce:** Currently it requires ~50kWh of electricity to produce 1kg of hydrogen at 100% efficiency. This implies that at 100% efficiency a 1GW electrolyzer would produce around 175M kg of hydrogen per year. But because sun and wind (think power) are intermittent and at variable intensity levels, we expect an efficiency factor of 30-50%, implying that 1GW of renewable electrolyzer capacity will generate 50-90M kg of hydrogen per year. Or 20GW of electrolyzer capacity translates into 1-2B kg of hydrogen per year, or 1-2M tonnes. This pales in comparison to the 70M tonnes of blue/gray hydrogen being produced per annum for industrial use (there is a lot of work to do).

- **Total hydrogen capacity through 2030:** While we estimate the announced green hydrogen electrolyzer projects through 2030 could produce up to 2M tonnes of hydrogen at most, the Hydrogen Council (see next bullet point) estimates that announced green hydrogen projects could potentially bring green hydrogen production to 4M tonnes/annum by 2030. However, to date just under 2M tonnes of those have either been FIDed or are in the planning stage, with the rest considered more preliminary. In addition, there are another 2.5M tonnes of low carbon blue hydrogen projects, of which about 1.5M have either been FIDed or are in the planning stages. The total project pipeline of nearly 7Mtpa has tripled since 2019 (the pace is picking up).

Exhibits 10 & 11: According to the Hydrogen Council, there are 4Mtpa of green hydrogen and 2.5Mtpa of blue hydrogen projects in the pipeline through 2030, with just over 3Mtpa considered to be mature.



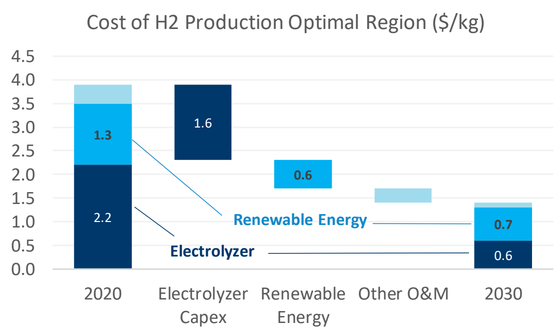

Source: Hydrogen Council, BTIG Research



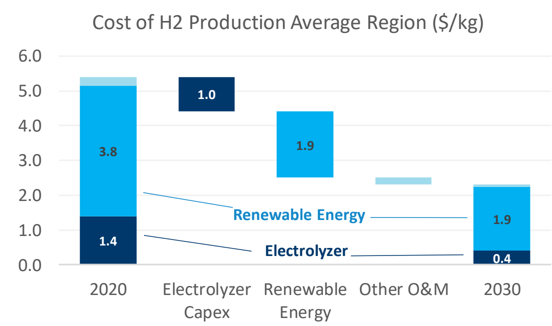

Source: Hydrogen Council, BTIG Research

- **Not All Hydrogen Markets Created Equally.** According to the Hydrogen council, hydrogen production in optimal regions is around $4/kg (higher than BNEF estimates, which is evidence of the diverging camps around costs). About $2.2/kg comes from the cost of the electrolyzer, and over $1.3/kg comes from the cost of renewable energy. Over the next 10 years, the total cost of hydrogen in optimal regions could dip below $1.5/kg, with the majority of the drop coming from a 70% drop in electrolyzer capex reducing the cost by $1.6M, and a 50% drop in renewable energy costs dropping the cost of hydrogen by $0.6/kg. However, we note the numbers are quite different in regions that do not enjoy the lower-cost renewable energy. According to the Hydrogen Council, hydrogen tends to cost over $5/kg in these higher-cost renewable power regions (think less sun and wind), with nearly $4/kg of cost from renewable energy and $1.4/kg from electrolyzer capex. The average region may see the cost of hydrogen production approach $2/kg, with the majority of the cost decline coming from cheaper renewable energy.

Exhibits 12 & 13: The potential exists for decreases in hydrogen production costs driven by lower electrolyzer and energy costs. Below we show the high end of the cost curve in 2020 and a cost decline bridge through 2030.



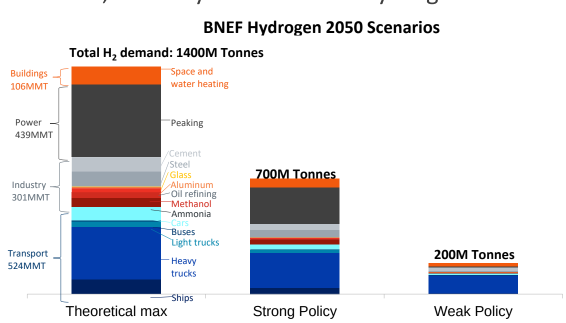

Source: Hydrogen Council, BTIG Research



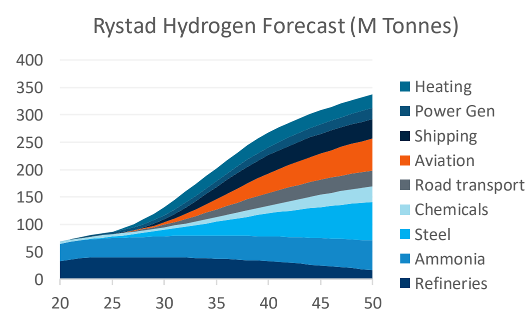

Source: Hydrogen Council, BTIG Research

- **Forecasting hydrogen demand:** Today 99% of all hydrogen produced is gray hydrogen (large CO2 emissions) for refineries and fertilizer application, which is a market size of about 70M tonnes. However, the growth in hydrogen demand is expected to come from green hydrogen used to power parts of the economy that are otherwise difficult to decarbonize with renewable power or batteries charged with renewable power. Currently, annual global CO2 emissions are around 35Gt, of which about 30% comes from difficult to decarbonize sectors. This includes heavy-duty trucking, peaking power generation, and large industrial processes, especially steel, ammonia, and cement manufacturing.

Exhibits 14 & 15: BNEF estimates hydrogen demand of 200M-700M tonnes/year by 2050 depending on policy scenarios, while Rystad forecasts hydrogen demand of about 330 MT by 2050 (5x current levels).




Source: BNEF, BTIG Research




Source: Rystad Energy, BTIG Research

## IV. Balance Sheet, Strategic Partnerships, and Joint Ventures

- **Energy Transitions Take Time and Money.** PLUG started trading in 1999 and along the way has had to take advantage of its public listing to keep the lights on through roughly 15 follow-on equity offerings. But with the technology finally catching up with the idea over the last few years and the stock pricing in the viability of hydrogen fuel cells as part of the global energy mix over the last year, management has built a war chest of cash to take advantage of its first-mover advantage and to help position PLUG for the increasing adoption of green hydrogen as a fuel. In January PLUG raised ~$3.6B (equity raise and direct investment) on the heels of ~$1.3B in equity in 2020, which puts PLUG's cash position at ~$4.8B.

- **CAPEX.** Management expects 2021 CAPEX to be around $750M with ~$340M (about 50%) earmarked for two green hydrogen facilities in New York and Pennsylvania. PLUG also expects to spend about $50M for its Gigafactory in New York, with the remainder of CAPEX (about $330M) expected to be deployed to help build out PLUG's joint ventures with Renault and SK Innovations. Additionally, in line with meeting its longer-term expansion goals, management has guided CAPEX through 2024 of between $2-$2.5B. Given the balance between PLUG's multi-pronged expansion opportunities but the time it takes to complete pilot projects ahead of taking large scale FID projects, we are modeling annual CAPEX of $500M from 2022 through 2024, which points us at the mid-point of CAPEX guidance through 2024 ($2.25B).

- **Green Hydrogen in Spain With Strategic Renewable Energy Producer**. In February, PLUG and Acciona announced plans to form a strategic partnership and joint venture with a goal of achieving a 20% market share of the green hydrogen market in Iberia by 2030. Acciona currently has 10GW+ of renewable power (Spain's largest 100% renewable power retailer), which the JV expects to utilize for green hydrogen. The JV has applied for ~500M-1B Euro out of the Spanish Government's available 2B Euro as funding to build production and distribution infrastructure throughout the region.

- **Hydrogen as a Transportation Fuel in Europe with Renault**. In January, Plug and Renault announced the creation of a 50/50 joint venture to commercialize fuel cell vehicles throughout Europe. The JV is targeting a 30% market share in Europe's LCV (Light Commercial Vehicle) market by 2030. With Europe at the forefront of achieving net-zero emissions by 2050 (think the Paris Agreement), addressing the CO2 emissions for heavy-duty trucks remains a key hurdle for the EU meeting its emissions targets. We note Renault is already a leader in the commercial ICE vehicle space through its Renault Master and Renault Trafic (vans), along with an established dealer network (required to work with fleet managers).

- **Hydrogen for Battery Production**. In January, Plug and SK Group (034730-KRX, Not Rated) announced plans to form a joint venture to grow the hydrogen economy in Asia. We note SK Group is a leading South Korean conglomerate that invested $1.5B (at ~$29/share) in PLUG. South Korea has a 2040 goal of 6M FCEVs, 1,200 hydrogen fuel stations, and 5M tons of hydrogen produced per year by 2040. Additionally, we expect an increased focus this decade and next on how battery cells (one of SKs core businesses) EVs are produced. Using coal to produce battery cells defeats one of the purposes of EVs, while battery cells produced from green hydrogen are clean, which we expect to be the standard in Europe sooner not later.

# V. Valuation – Pricing in Exponential Growth as It Should

- **The Case for Exponential Growth.** Despite the sell-off in PLUG stock since mid-February (down ~58%, in line with a broader sell-off in clean energy), PLUG is still trading at ~20x 2021 EV/Sales and ~12x 2022 EV/Sales (bottom line: rapid revenue growth is expected over the next few years). We note our 2021 revenue estimate (in line with consensus) points to ~42% Y-Y revenue growth, while our 2024 revenue estimate (~11% below consensus) points to a ~45% CAGR over the next four years. We note while green hydrogen was largely viewed as a science experiment a few years ago, green hydrogen continues to gain momentum as an energy transition fuel as renewable energy costs move towards parity with fossil fuels (even before thinking about potential carbon credits) and project sizes increase (think large-scale electrolyzers). Bottom line: hydrogen is positioned to be a disruptive energy source with a growing share of the global energy pie.

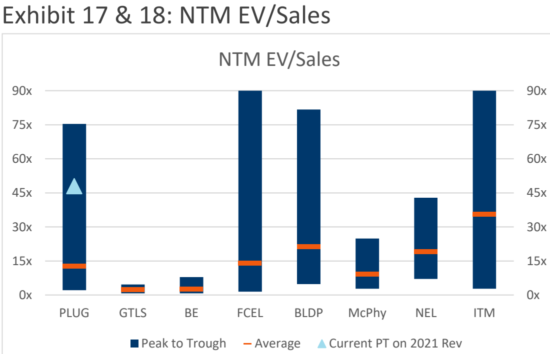
- **$40 DCF Price Target**. Given the potential for exponential growth in PLUGs business, we base our PT on a 3 stage DCF. In Stage 1 (2021-2025) we model in ~45% revenue growth, with average EBITDA margins in the mid-teens (ending ~25%). We expect PLUG to exit 2025 with just over $2B in revenue (~1% of expected hydrogen market). In Stage 2 we expect ~30% revenue growth as the industry matures (ending the period at just under $7.5B in revenue, representing ~2% of the hydrogen market), but expect PLUG to be able to push EBITDA margins higher, into the ~30% range. Lastly, in Stage 3 we expect a modest 15% annual revenue growth (ending at ~$30B which represents ~5% of the hydrogen market), with EBITDA margins in the mid-30% range. We held taxes constant throughout at 20%, as well as our discount rate of ~10%, to get our $40 PT.

Exhibit 16: DCF Outputs and Assumptions

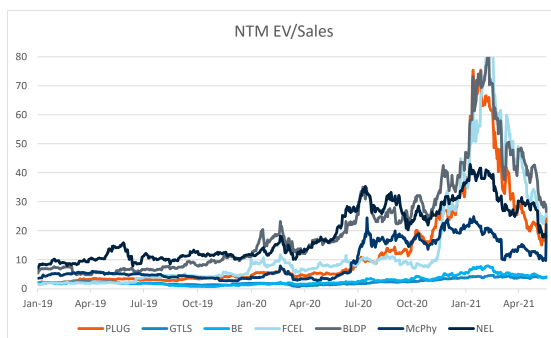
| DCF Assumptions | Stage 1 (2021-2025) | Stage 2 (2026-2030) | Stage 3 (2031-2040) |
|---|---|---|---|
| Revenue Growth | 45% | 30% | 15% |
| Avg EBITDA Margin | 14% | 30% | 35% |
| Avg Annual CapEx | (600) | (400) | (300) |
| Revenue CAGR (From 2021) | 45% | 36% | 25% |
| Revenue at End of Period | 2,056 | 7,488 | 30,291 |

Source: Company Data, BTIG Research

Exhibit 17 & 18: NTM EV/Sales




Source: Company Data, BTIG Research, FactSet




Source: Company Data, BTIG Research, FactSet

Exhibit 19: Comp Table

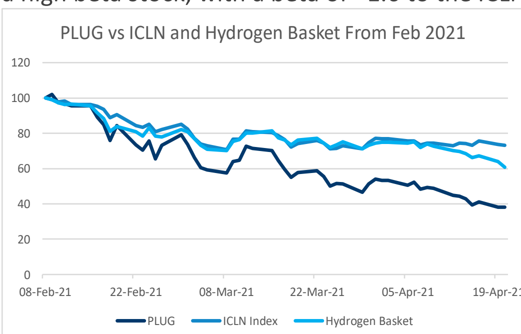
| Company | Ticker | Rating | Stock Price ($USD) | Market Cap ($USD) | 2021 EV/Sales | 2022 EV/Sales | 2023 EV/Sales | Net Debt to Capital | 2021 EV/EBITDA | 2022 EV/EBITDA | 2023 EV/EBITDA |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Hydrogen | | | | | | | |
| Plug Power Inc. | PLUG | Buy | $ 27.20 | $15,458 | 20.0x | 12.7x | 8.3x | -37% | 730.8x | 108.4x | 50.8x |
| Ballard Power Systems Inc. | BLDP | Not Rated | $ 16.25 | $4,873 | 29.6x | 20.9x | 13.0x | -81% | NA | NA | NA |
| Bloom Energy Corporation Class A | BE | Not Rated | $ 21.85 | $3,767 | 4.3x | 3.4x | 2.7x | 62% | 50.4x | 28.9x | 17.7x |
| FuelCell Energy, Inc. | FCEL | Not Rated | $ 8.50 | $2,741 | 24.5x | 16.4x | 11.6x | 8% | NA | NA | 154.8x |
| ITM Power PLC | ITM | Not Rated | $ 5.13 | $2,827 | 84.0x | 27.7x | 12.0x | -55% | NA | NA | 187.8x |
| Proton Motor Power Systems Plc | PPS | Not Rated | $ 0.80 | $619 | 32.3x | 9.9x | 6.2x | NA | NA | 168.8x | 33.1x |
| McPhy Energy SA | McPhy | Not Rated | $ 32.77 | $912 | 18.7x | 11.6x | 6.1x | -93% | NA | NA | NA |
| NEL ASA | NEL | Not Rated | $ 2.16 | $3,145 | 20.8x | 12.6x | 8.5x | -40% | NA | NA | 378.0x |
| Fusion Fuel Green Plc Class A | HTOO | Not Rated | $ 13.08 | $143 | NA | 1.2x | 0.4x | 3% | NA | NA | 2.3x |
| Chart Industries, Inc. | GTLS | Buy | $ 149.51 | $5,434 | 4.5x | 3.9x | 3.6x | 17% | 22.9x | 17.9x | 15.9x |
| New Fortress Energy Inc. Class A | NFE | Buy | $ 44.74 | $9,248 | 8.4x | 3.7x | 2.6x | 43% | 16.7x | 8.3x | 5.9x |
| Average | | | | $4,470 | 24.7x | 11.3x | 6.8x | -17% | 205.2x | 66.4x | 94.0x |

Source: Company Data, BTIG Research, FactSet

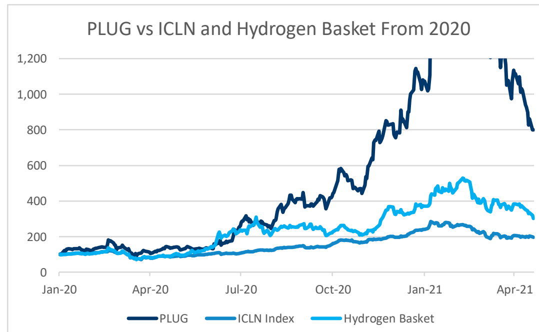
## VI. Performance – PLUG and Clean Energy Have Underperformed YTD

- **Clean Energy Bear Market.** The selloff in clean energy stocks, which accelerated in mid-February, has seen PLUG, other hydrogen stocks, and the broader clean energy sector pull back sharply, down ~58%, ~44%, and ~30%, respectively, since mid-February. Despite the sharp pullback in PLUG and other clean energy stocks, PLUG is still up ~600% over the last year while Clean Energy is up ~100%. Additionally, there have been more than a handful of new hydrogen companies that have come public (incremental capital from investors and governments are needed to help develop the industry) and even a Hydrogen (HDRO) ETF that was launched in March. We note the HDRO ETF only has ~$25M in AUM, with PLUG the largest holding at ~7%.

Exhibit 20 & 21: PLUG is the market leader (market-cap-weighted in hydrogen) and has a 4% weighting in the ICLN (clean energy ETF), which is weighted towards solar and wind. Additionally, and not surprisingly, PLUG is a high beta stock, with a beta of ~1.6 to the ICLN ETF.




Source: Company Data, BTIG Research, FactSet




Source: Company Data, BTIG Research, FactSet

## VII. Risks

- **Risks to our Rating** are twofold, those specific to the company and industry risks. Company risks include: 1) failure to execute, 2) dilutive transactions, 3) poorly timed acquisitions, 4) loss of a key customer, 5) project cost overruns on any of the company's slated projects, which include the Gigafactory, Green Hydrogen production facilities, and its co-investments with its joint-venture partners, 6) competition from existing and new entrants, 7) competing hydrogen fuel cell technologies, 8) disruptive technologies, 9) loss of a strategic partner or joint-venture.

- **Industry-specific risks for hydrogen include:** 1) competition from alternative power sources like batteries and natural gas, 2) changes in government policies towards hydrogen or a lack of incentives focused on green hydrogen, 3) reduced commitments by countries and companies around net-zero emissions that could reduce demand for green hydrogen, 4) new disruptive technologies, 5) higher renewable energy costs that make green hydrogen more expensive, and 6) failure of green hydrogen to gain market share.

## PLUG- Income Statement

| INCOME STATEMENT | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ($ millions) | 2019 | 2020 | 2021 | 2022 | 1Q20 | 2Q20 | 3Q20 | 4Q20 | 1Q21 | 2Q21 | 3Q21 | 4Q21 | 1Q22 | 2Q22 | 3Q22 | 4Q22 |
| Fuel Cell Systems | 151.9 | 236.8 | 381.9 | 627.3 | 21.0 | 50.2 | 99.7 | 65.9 | 47.0 | 78.8 | 133.1 | 122.9 | 89.1 | 132.7 | 206.0 | 199.5 |
| Services | 26.0 | 26.2 | 21.6 | 24.8 | 6.8 | 6.7 | 7.5 | 5.2 | 5.2 | 5.3 | 5.5 | 5.7 | 5.9 | 6.1 | 6.3 | 6.5 |
| Power Purchase Agreements | 27.3 | 29.4 | 29.8 | 34.2 | 7.0 | 7.2 | 7.5 | 7.7 | 7.1 | 7.3 | 7.6 | 7.8 | 8.2 | 8.4 | 8.7 | 8.9 |
| Fuel Delivered to Customers | 31.3 | 39.1 | 36.7 | 51.7 | 8.1 | 8.2 | 10.9 | 11.9 | 8.1 | 8.5 | 9.6 | 10.5 | 11.2 | 12.0 | 13.6 | 14.9 |
| Other | 0.2 | 0.3 | - | - | 0.1 | 0.1 | 0.1 | 0.1 | - | - | - | - | - | - | - | - |
| **Total Revenues** | **236.8** | **331.8** | **470.0** | **738.0** | **43.0** | **72.4** | **125.6** | **90.7** | **67.4** | **100.0** | **155.7** | **146.9** | **114.4** | **159.3** | **234.6** | **229.8** |
| Fuel Cell Systems | (96.9) | (171.4) | (288.6) | (426.5) | (13.7) | (33.7) | (68.5) | (55.5) | (38.1) | (61.6) | (99.8) | (89.0) | (62.1) | (91.3) | (139.8) | (133.4) |
| Services | (28.8) | (42.5) | (26.2) | (27.4) | (8.2) | (6.5) | (11.4) | (16.5) | (6.4) | (6.5) | (6.6) | (6.7) | (6.8) | (6.8) | (6.9) | (7.0) |
| Power Purchase Agreements | (40.1) | (64.6) | (54.5) | (59.3) | (14.2) | (13.7) | (14.1) | (22.6) | (13.3) | (13.5) | (13.7) | (14.0) | (14.5) | (14.7) | (14.9) | (15.2) |
| Fuel Delivered to Customers | (36.4) | (61.8) | (58.8) | (66.1) | (9.0) | (9.1) | (14.2) | (29.5) | (13.4) | (13.8) | (15.2) | (16.4) | (16.8) | (17.3) | (18.2) | (13.7) |
| Other | (0.2) | (0.3) | - | - | (0.1) | (0.1) | (0.1) | (0.0) | - | - | - | - | - | - | - | - |
| **Cost of Sales** | **(202.3)** | **(340.7)** | **(428.1)** | **(579.3)** | **(45.3)** | **(63.0)** | **(108.3)** | **(124.2)** | **(71.2)** | **(95.5)** | **(135.3)** | **(126.1)** | **(100.1)** | **(130.1)** | **(179.8)** | **(169.3)** |
| **Gross Profit** | **34.5** | **(8.9)** | **41.9** | **158.7** | **(2.3)** | **9.5** | **17.3** | **(33.4)** | **(3.8)** | **4.5** | **20.4** | **20.8** | **14.3** | **29.1** | **54.8** | **60.5** |
| R&D | (33.7) | (51.0) | (79.4) | (85.9) | (10.4) | (9.8) | (12.0) | (18.9) | (19.3) | (19.6) | (20.0) | (20.4) | (20.9) | (21.3) | (21.7) | (22.1) |
| SG&A | (44.3) | (75.9) | (121.7) | (131.8) | (11.0) | (21.7) | (14.3) | (29.0) | (29.5) | (30.1) | (30.7) | (31.3) | (32.0) | (32.6) | (33.3) | (33.9) |
| Other | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **Total EBIT** | **(43.5)** | **(135.8)** | **(159.2)** | **(59.0)** | **(23.7)** | **(22.0)** | **(8.9)** | **(81.3)** | **(52.6)** | **(45.3)** | **(30.4)** | **(31.0)** | **(38.5)** | **(24.7)** | **(0.2)** | **4.5** |
| Net Interest expense | (35.0) | (58.4) | (33.5) | (34.0) | (11.6) | (13.2) | (17.2) | (16.4) | (14.1) | (5.8) | (6.4) | (7.1) | (7.7) | (8.1) | (8.8) | (9.5) |
| Other | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| EBT | **(78.5)** | **(194.3)** | **(192.7)** | **(93.0)** | **(35.3)** | **(35.2)** | **(26.1)** | **(97.7)** | **(66.8)** | **(51.0)** | **(36.8)** | **(38.1)** | **(46.2)** | **(32.9)** | **(9.0)** | **(5.0)** |
| Income Tax | - | 30.8 | - | - | - | 17.7 | 6.5 | 6.6 | - | - | - | - | - | - | - | - |
| **NET INCOME (Operating)** | **(78.5)** | **(163.5)** | **(192.7)** | **(93.0)** | **(35.3)** | **(17.5)** | **(19.6)** | **(91.1)** | **(66.8)** | **(51.0)** | **(36.8)** | **(38.1)** | **(46.2)** | **(32.9)** | **(9.0)** | **(5.0)** |
| One-time items | (8.7) | (434.0) | - | - | (2.2) | 8.8 | (19.8) | (420.9) | - | - | - | - | - | - | - | - |
| NET INCOME (GAAP) | **(87.2)** | **(597.5)** | **(192.7)** | **(93.0)** | **(37.5)** | **(8.7)** | **(39.4)** | **(512.0)** | **(66.8)** | **(51.0)** | **(36.8)** | **(38.1)** | **(46.2)** | **(32.9)** | **(9.0)** | **(5.0)** |
| **EPS (Operating)** | (0.33) | (0.46) | (0.29) | (0.13) | **(0.12)** | **(0.06)** | **(0.05)** | **(0.21)** | **(0.12)** | **(0.07)** | **(0.05)** | **(0.05)** | **(0.07)** | **(0.05)** | **(0.01)** | **(0.01)** |
| **EPS (GAAP)** | **(0.37)** | **(1.69)** | **(0.29)** | **(0.13)** | **(0.12)** | **(0.03)** | **(0.11)** | **(1.20)** | **(0.12)** | **(0.07)** | **(0.05)** | **(0.05)** | **(0.07)** | **(0.05)** | **(0.01)** | **(0.01)** |
| **EBITDA Reconcilliation** | | | | | | | | | | | | | | | | |
| EBIT | (43.5) | (135.8) | (159.2) | (59.0) | (23.7) | (22.0) | (8.9) | (81.3) | (52.6) | (45.3) | (30.4) | (31.0) | (38.5) | (24.7) | (0.2) | 4.5 |
| D&A | 12.0 | 13.7 | 19.6 | 23.6 | 2.9 | 2.9 | 3.6 | 4.3 | 4.5 | 4.8 | 5.0 | 5.3 | 5.5 | 5.8 | 6.0 | 6.3 |
| Stock Based Comp | 11.0 | 17.1 | 12.0 | 13.0 | 3.0 | 3.1 | 3.1 | 7.9 | 3.0 | 3.0 | 3.0 | 3.0 | 3.3 | 3.3 | 3.3 | 3.3 |
| Other | 25.3 | 75.0 | 80.0 | 80.0 | 11.7 | 17.1 | 26.2 | 20.0 | **20.0** | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 |
| **EBITDA (Calculated)** | **4.7** | **(30.0)** | **(47.6)** | **57.6** | **(6.1)** | **1.2** | **24.0** | **(49.1)** | **(25.1)** | **(17.5)** | **(2.3)** | **(2.7)** | **(9.8)** | **4.3** | **29.1** | **34.0** |
| **EBITDA Margins** | 2.0% | -9.0% | -10.1% | 7.8% | -14.2% | 1.7% | 19.1% | -54.1% | -37.2% | -17.5% | -1.5% | -1.8% | -8.5% | 2.7% | 12.4% | 14.8% |

Source: Company Data, BTIG Research

## BTIG Covered Companies Mentioned in this Report

Plug Power Inc. (PLUG, Buy, $40 PT; Closing Price: $27.89; Analyst: Gregory Lewis
Nikola Corporation (NKLA, Buy, $18 PT; Closing Price: $11.98; Analyst: Gregory Lewis)

# Appendix: Analyst Certification and Other Important Disclosures

## Analyst Certification

I, Gregory Lewis, hereby certify that the views about the companies and securities discussed in this report are accurately expressed and that I have not received and will not receive direct or indirect compensation in exchange for expressing specific recommendations or views in this report.

I, Igor Levi, hereby certify that the views about the companies and securities discussed in this report are accurately expressed and that I have not received and will not receive direct or indirect compensation in exchange for expressing specific recommendations or views in this report.

I, Jacob Green, hereby certify that the views about the companies and securities discussed in this report are accurately expressed and that I have not received and will not receive direct or indirect compensation in exchange for expressing specific recommendations or views in this report.

## Regulatory Disclosures

### Ratings Definitions

**BTIG LLC's ("BTIG") ratings, effective June 12, 2017, are defined as follows:**

**BUY** – A security which is expected to produce a positive total return of 15% or greater over the 12 months following the recommendation. The BUY rating may be maintained as long as it is deemed appropriate, notwithstanding price fluctuations that would cause the target to fall outside of the 15% return.

**SELL** – A security which is expected to produce a negative total return of 15% or greater over the next 12 months following the recommendation. The SELL rating may be maintained as long as it is deemed appropriate, notwithstanding price fluctuations that would cause the target to fall outside of the 15% return.

**NEUTRAL** – A security which is not expected to appreciate or depreciate meaningfully over the next 12 months.

**NOT RATED** – A security which is not rated or covered by BTIG.

**UNDER REVIEW** – Effective immediately, coverage of the following securities is Under Review. Ratings, price targets, disclosures, and estimates for the companies listed below are suspended and should no longer be relied upon.

## Distribution of Ratings and Investment Banking Clients

BTIG must disclose in each research report the percentage of all securities rated by the member to which the member would assign a "buy", "neutral" or "sell" rating. The said ratings are updated on a quarterly basis. BTIG must also disclose the percentage of subject companies within each of these three categories for whom the member has provided investment banking services within the previous twelve months.

**Current Rating Distribution (as of May 27, 2021):**

| Coverage Universe | Count | Percent | Inv. Banking Relationships | Count | Percent |
|---|---|---|---|---|---|
| Buy | 287 | 70.0% | Buy | 108 | 37.6% |
| Neutral | 120 | 29.3% | Neutral | 24 | 20.0% |
| Sell | 3 | 0.7% | Sell | 0 | 0.0% |

For purposes of FINRA ratings distribution rules, BTIG's stock ratings of Buy, Neutral and Sell fall into Buy, Hold and Sell categories, respectively.

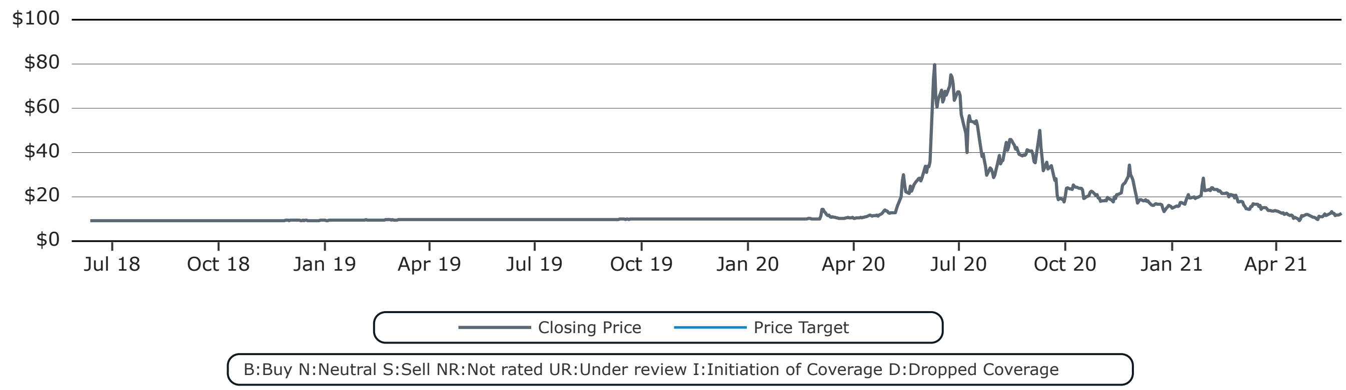
## Company Valuation and Risk Disclosures

### Nikola Corporation (NKLA, Buy, $18 PT)

**Valuation:** NKLA is a pre-revenue company, hence our $18 PT is based on a 5.5x multiple on our 2024 revenue estimate of ~ $1.4B (~4,100 BEV trucks and ~650 FCEV trucks) and is in line with our blended peer average of alternative fuel heavy vehicle manufacturers and companies engaged in the hydrogen economy.

**Risks:** Risks to our Rating include: technology advancement reducing value of Nikola products, changes in environmental laws and regulations, changes in government stimulus/aid, changes in customer preferences, key customer risk, supply chain risk, poorly timed or non-accretive acquisitions, failure to execute on plan on-time and budget, failure to raise additional capital, and changes to the competitive landscapes which the company competes in.

**Nikola Corporation Rating History as of 05/26/2021**

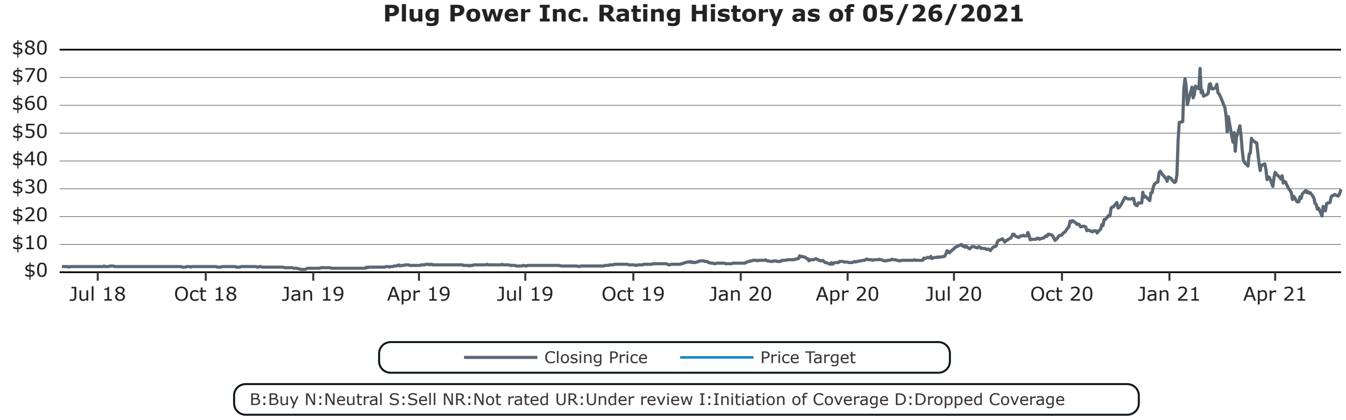



## Plug Power Inc. (PLUG, Buy, $40 PT)

**Valuation:** Our $40 PT is based on a 3-stage DCF with revenue growth projected as ~45% through 2025, dropping to ~30% through 2030 and 15% through 2040 as the industry matures (CAGR of ~25% from 2021E to 2040E). We expect EBITDA margins to stabilize in the low- to mid-30% range.

**Risks:** Risks to our Rating are two-fold, those specific to the company and industry risks. Company risks include: 1) failure to execute, 2) dilutive transactions, 3) poorly timed acquisitions, 4) loss of a key customer, 5) project cost overruns on any of the company's slated projects, which include the Gigafactory, Green Hydrogen production facilities, and its co-investments with its joint-venture partners, 6) competition from existing and new entrants, 7) competing hydrogen fuel cell technologies, 8) disruptive technologies, and 9) loss of a strategic partner or joint venture.Industry-specific risks for hydrogen include: 1) competition from alternative power sources like batteries and natural gas, 2) changes in government policies towards hydrogen or a lack of incentives focused on green hydrogen, 3) reduced commitments by countries and companies around net-zero emissions that could reduce demand for green hydrogen, 4) new disruptive technologies, 5) higher renewable energy costs that make green hydrogen more expensive, and 6) failure of green hydrogen to gain market share.

**Plug Power Inc. Rating History as of 05/26/2021**



## Company–Specific Regulatory Disclosures

BTIG LLC expects to receive or intends to seek compensation for investment banking services in the next 3 months from: Nikola Corporation (NKLA)

BTIG LLC expects to receive or intends to seek compensation for investment banking services in the next 3 months from: Plug Power Inc. (PLUG)

## Other Disclosures

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