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Alan C. Lloyd and Michael Weber of the University of Texas have it right in their article titled “Texas positioned to lead hydrogen revolution. For decades Texas has been the largest producer of transportation fuels United States. Based on current projections, demand for gasoline will decrease significantly in the coming decades because of a combination of fuel economy improvements and the dramatic shift to electric vehicles. These trends could give Texas calls for worry because they might undercut global demand for gasoline. Texas industry can also play a key role in the era of electrified transportation.

In the U.S., electric vehicles are expected to account for up to 35 percent of new car sales by 2030. Because of performance, energy diversity and environmental- and climate-related benefits and the impending arrival of autonomous vehicles, the surge in electric vehicles will continue worldwide. Furthermore, an increasing number of cities are proposing to ban diesel vehicles.

Texas is ideally situated to be a leader in producing hydrogen for the new energy system and for the next generation of electrically powered vehicles. Texas is the largest producer in the nation of hydrogen and has accumulated excellent knowledge of the production, storage, transport and safe handling of hydrogen.

The hydrogen society has been talked about for decades, but its potential has gained attention recently. For example, 13 major international companies recently created a Hydrogen Council to pool their resources to promote hydrogen in the energy transition. These companies invest about \$2 billion per year on hydrogen and fuel cells.

Of the 13 companies in the council, three have significant operations in Texas — Air Liquide, Shell and Toyota. Air Liquide already is a major hydrogen producer in Texas. Shell has its U.S. corporate headquarters in Houston and has major oil and gas production and exploration, refinery and gas station network operations in the state. Toyota has a manufacturing plant in San Antonio and recently moved its U.S. corporate headquarters to Plano.

Texas has a great opportunity to join with these companies not only to be the leader for today’s fuel but to keep making money while the energy sector reduces its environmental footprint and gets transformed. This is where Texas has excelled — not through mandates but in partnering with industry to create an environment to attract business and create jobs.”

Our coalition Urban Renewable Hydrogen [URH2] seek to accelerate the broad commercialization and deployment of fuel cells and renewable hydrogen in the State of Texas.

URH2 will develop a Hydrogen Energy Storage and transportation demonstration project. Off Grid Logistics and URH2 partners will build a dual purpose fueling station for renewable hydrogen fuel cell and electric battery vehicles. Located at a “clusters” as the DOE calls it, an operation with multiple users of hydrogen and fuel cells. A cluster at a port or airport. We will set up at an industrial distribution center complex near an airport or port.

We will demonstrate that Ports and Airports can be cleaned up through expanding use of fuel cells. Grow the market and businesses through ground support equipment, trucks, buses, trains and forklifts using fuel cells. The Houston Galveston Port area is a great example; at the north end of the port in Houston, Walmart and Home Depot distribution centers which both have fuel cell forklift programs. At the south end in Galveston, Del Monte plant and dozens of other potential customers.

We will demonstrate that you can build the hydrogen infrastructure you need starting with the industrial customers. If you took the top dozen distributor and logistics companies in the US included their stores, you have over 50,000 potential dual [fuel cell and battery] purpose refueling stations. Amazon, Walmart, Home Depot, Safeway, 7-11, Walgreens, Kroger, Albertsons, Supervalu, Target, CVS, and UPS. By developing the industrial and transportation applications first, we can set up enough fuel stations to service the entire country.

In 2015 URH2 was part of the team that successfully completed of the landfill gas- to-hydrogen project at the BMW Manufacturing Co.’s Spartanburg, South Carolina, facility.

The DOE supported project explored the economic and technical feasibility of converting landfill gas into hydrogen of sufficient purity to power fuel cell vehicles, including material handling equipment. BMW's facility currently operates a fleet of more than 350 pieces of material handling equipment across the 5.6 million square foot production facility, all powered by hydrogen fuel cells.

We were able to prove that landfill gas-to-hydrogen is a viable business model and can be made for large scale operation. We plan to do this in Texas from biomass, wind, and solar to renewable hydrogen projects.

We have the ability to turn energy users into energy suppliers, to save customers money and to free them from increasing energy costs and air pollution. Hydrogen is the common denominator to CO2 emissions reduction and a cleaner energy future for these industries. Playing a significant role in reducing emissions and enhancing global energy security.

The Hydrogen Energy in Texas Summit on April 22, 2016, 35 government and business leaders met to explore the potential for Texas to be the U.S. leader in hydrogen energy markets and applications, technologies and new business opportunities and jobs. The group was looking for a Texas approach to creating jobs and business opportunities in this new energy field. The agenda was designed to produce an understanding of the global perspective, Texas opportunities, issues, barriers, and the benefits of growth of hydrogen energy business in the state. The speakers were:

- Lieutenant Governor, and President of the Texas Senate, Dan Patrick
- Texas Railroad Commissioner and President of the Texas Senate, Ryan Sitton
- Plug Power President and CEO, Andy Marsh
- Air Liquide Director of Hydrogen Energy, Bob Oesterreich
- Former Public Utility Commissioner and Railroad Commission Chair, Barry Smitherman

- Hydrogenics President and CEO, Daryl Wilson
- Toyota Advanced Technologies Group Director, Craig Scott
- Nuvera Fuel Cell President and CEO, Jon Taylor

The event was created by host Trammell S. Crow, Jeff Serfass, President of Technology Transition Corporation and assisted by Ray Gwin CEO of Urban Renewable Hydrogen. The Summit held at Earth Day Texas 2016 was about how Texas could help bring the World into the next renewable energy era with renewable hydrogen, fuel cells and energy storage.

If Texas wants to continue to attract the world's best companies, sustainability and CO2 reduction will be part of the plan. Being hydrogen friendly is a game changer and should come natural for Texas. It will help attract Amazon, Walmart and the RE100 that have committed to 100% renewable energy.

The "Amazon Effect" is disrupting the entire logistics supply chain and all retail markets. It has increased the demand for speed in distribution centers and the forklifts they use. Traditional thinking about distribution equipment is obsolete.

The best solution for increasing speed and efficiency in a distribution center forklift is a hydrogen fuel cell. Big Box chains are increasing their financial commitment to hydrogen fuel cells for distribution center. There are 20,000 hydrogen fuel cell forklifts in the U.S. today. From the first commercial sales in 2007 the industry has exploded and will have double digit growth for the next few years. Hydrogen Fuel Cells and Renewable Hydrogen is an industry that Texas should lead not follow.

Emissions reduction: An example; fuel cells help the distribution industry reduce CO₂ emissions. Home Depot's decision to switch from lead-acid batteries to hydrogen fuel cells, providing annual savings of more than 800 tons of greenhouse gas emissions. These savings could increase to 9,000 tons of CO₂ over the life of the project; the equivalent of removing more than 1,800 cars from the road.

The trend to renewables is being set by the world's largest companies. United States industry is moving to renewables. The Climate Group's RE100 have made a commitment to 100 percent renewable energy. RE100 members Walmart and General Motors are the biggest buyers of renewable energy and fuel cells and hydrogens are part of their solution. <https://www.theclimategroup.org/RE100>

For over a 100 year the internal combustion engine had a good run. By most accounts a change is coming. Gas-powered vehicles will be replaced by electric drive fuel cell and battery vehicles. Google Alerts, that were in the hundreds 10 years ago are now in the millions showing just how rapidly that change is happening across the globe.

The United States and the rest of the world is involved. Automobile manufacturers say between 2025 and 2030, the cost of battery and fuel cell electric vehicles will fall below the cost of combustion engines. Many countries will ban the internal combustion engine starting in 2030. Several countries have already laid out ambitious plans to eliminate fossil fuel-powered automobiles.

The industrial fuel cell market is experiencing explosive growth. Fuel cells for forklifts has reached \$1 billion in sales in 2017. Our team will focus on fuel cell and renewable hydrogen solutions for some of the largest users of fuel cells in the transportation, logistics and manufacturing industries.

Texas has long been at the forefront of the energy industry. Leading the way in hydrogen fuel cell energy is a natural progression for our energy-forward state. We are the largest energy producer in the U.S., and the only state with our own power grid. Texas is the largest producer of wind-generated electricity and a solar energy leader, as well. Using Wind and solar to make renewable hydrogen is happening all over the world. Texas should grasp the opportunity to be a leader in this area as well.

Transportation and Logistics are the fastest growing contributors to CO2 emissions. This CO2 emissions level is not sustainable. Texas can create a collaboration to continue to develop the technology, production, and infrastructure necessary for hydrogen to play a major role in transportation. Fuel cells and renewable hydrogen can reduce or eliminate greenhouse gas emissions in the supply chain.

Hydrogen generation will grow from \$117 billion to \$154 billion in 2021. According to the new research report by Global Market Insights the Fuel Cell Market size is expected to reach \$25.5 billion by 2024; driven by environment friendly and better alternative than existing options.

Companies with hydrogen and fuel cell business have significant operations in Texas — Air Liquide/Airgas, Shell, Toyota and Air Products. Air Liquide already is a major hydrogen producer in Texas. Shell has its U.S. corporate headquarters in Houston and has major oil and gas production and exploration, refinery and gas station network operations in the state. Toyota has a manufacturing plant in San Antonio and recently moved its U.S. corporate headquarters to Plano.



7-11 has contracted Toyota to develop an exclusive line of hydrogen fuel cell powered delivery trucks.



Toyota and FuelCell Energy are installing a fuel cell power plant at the Port of Long Beach. SureSource™ A 10.2 megawatt on-site power plant. Toyota says the facility will supply all Toyota fuel cell vehicles moving through the port, including new deliveries of the Mirai sedan and

Toyota's heavy-duty hydrogen fuel cell class 8 trucks. Power generation will also be sold back to the grid. Why not Texas?



Air Liquide purchased Airgas for \$13.5 billion and has markets for 13,000 kg/day of renewable hydrogen. The Airgas brand will be used for material handling and service stations for autos.



Sysco Corporation contracted with Air Products to supply hydrogen and hydrogen fueling technology for Sysco's new, 585,000 sq. ft. distribution center in Houston, Texas. The fueling station is used to fuel a combined fleet of over 100 hydrogen fueled pallet and reach trucks used in daily operations.



Ace Hardware recently announced it will deploy a fleet of 65 lift trucks with Plug Power GenDrive® fuel cell systems at its newest Retail Support Center in Wilmer Texas.



Walmart fleet 135 fuel cell forklifts. Sanger Texas DC.



The Houston-Galveston Area Council (H-GAC) and the Center for Transportation and the Environment (CTE) are deploying 18 UPS Fuel Cell delivery vans in the Houston-Galveston area. The goal for this project is to demonstrate the capability of all-electric delivery vehicles to perform at the same level of operation as similarly sized diesel delivery vehicles, while also significantly reducing vehicle emissions and petroleum consumption.



Hydrogen fueling station. University of Texas Pickle Research Center, Austin, TX. Reformer, processing, storage. System can produce 60 kg per day. 2009. To advance commercialization of hydrogen-powered transit buses and supporting infrastructure.

The DOE says at the end of 2017, roughly 3,500 fuel cell electric vehicles (FCEVs) had been sold or leased in the United States to the general public, and there are now more than 30 public retail stations in use. Industry launched new applications such as heavy-duty trucks and created the Hydrogen Council, now with over 20 global company CEOs committed to move the industry forward. Its roadmap cites the potential for \$2.5 trillion in revenues and 30 million jobs globally by 2050.

Navigant Research says H₂ consumption for non-traditional applications (outside the petroleum and chemical sectors) will grow from 168 million kilograms in 2013 to nearly 3.5 billion kilograms in 2030. Navigant Research forecasts a 20-fold increase in the H₂ merchant market to \$50 billion by 2030 with stationary fuel cells, fuel cell vehicles and energy storage being major contributors.

Business Wire concluded the market for all fuel cells, all transportation included: 22.2 million hydrogen fuel cell vehicles will be sold or leased worldwide by 2032. These sales will generate collective revenues upwards of \$1.1 trillion by 2032. By 2050, hydrogen fuel cell vehicles will become the fastest growing segment of the global automobile and industrial market. In 2015, nearly every major automaker announced plans for zero emissions cars no later than 2050. The transportation and logistics industries are converting mobile equipment to fuel cells.

