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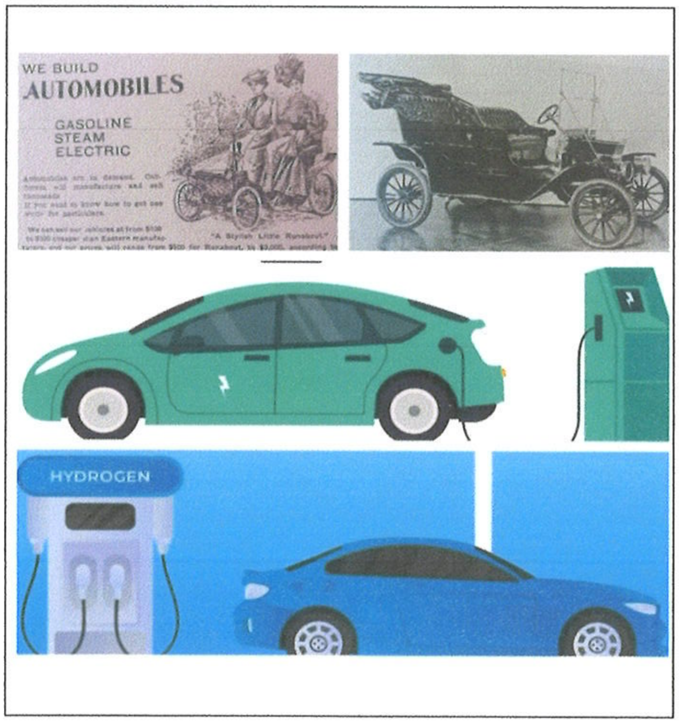
CAR WARS: THEN AND NOW



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CAR WARS: THEN AND NOW

by

Mark Cook

SUMMARY

Part I of this paper reviews the competition in the emerging automobile market around the turn of the last century. What advantages and disadvantages of steam, electric and gasoline engines led to the ultimate winner and losers of the first CAR WAR.

Part II explores the future of the re-emerging electric cars. Will improved battery technology and expanded recharging infrastructure lead to sufficient market support to enable the electric car to successfully replace the gasoline-powered car?

Part III discusses the possibility that electric cars will lose out again to a new competitor: the hydrogen fuel cell or hydrogen internal combustion engine for reasons that go beyond battery and range issues.

CAR WARS: THEN AND NOW

Part I: The Birth of the Competitive Automobile Market

In New York City in 1900 there were over 150,000 horses producing thousands of tons of waste. Streets were reeking in disgusting filth, the consistency of thick pea soup and the Board of Health found manure linked to an increase in infectious disease. From 1870 to 1900 the number of horses in American cities grew 4-fold while human population only doubled. At the time, it was as hard for people to believe that this environmental crisis would require replacing the horse, just as our generation struggles to imagine a world without fossil fuels. But the increasingly obvious solution was indeed to replace horsepower with the new self-propelling motor vehicles known as "horseless carriages". Which of the new technologies would succeed in replacing the horse: steam, electric or gasoline? It took over two decades to answer that question during which time hundreds of manufacturing concerns competed in the emerging car market.

Steam: Steam was clean, safe, reliable, and familiar because people had decades of experience with it in trains and boats and farm equipment. However, early steam cars required constant care and attention. There were three tanks for water (cold water, heated water and compressed steam to power the car). The water was heated onboard with kerosene fuel sparked by gasoline. It took at least 20 minutes to heat up a steam car and water had to be refilled every 30 minutes or so which made it impractical for any distance driving. Pressure gages on the dash had to be monitored to prevent a possible blow up under the driver's seat. Quick firing boilers eventually solved these problems but not before more efficient gasoline engines took over the market and made steam cars obsolete. However, for many years steamers were the "luxury" cars of the time as well as the first and fastest race cars.

Electric: Electric cars were lighter and quieter and cleaner than gas and didn't require cranking or gear shifts. By the early 1890s Thomas Edison had established the NYC electric grid and the Westinghouse Company was producing numerous electric motors for commercial and residential uses. City dwellers were thus very familiar with electrical power and as more urban homes accessed electricity, the market for EVs continued to grow. However, the battery capacity was small and their range was limited to only about 40 to 60 miles. To recharge took hours and there were no recharging stations. In 1897, The Electrobat Company launched a taxi cab service in NYC utilizing 12 electric vehicles with replaceable batteries which could be swapped out between fares as needed. The company was successful but the demand outside NYC was too low to sustain operations. In the years that followed, the electric car took on a new connotation as women's cars (short local trips, no hand cranking or gear shifting). In 1912 Henry Ford bought his wife Clara a Detroit Electric car rather than one of his own Model T cars. That year he collaborated with his friend Thomas Edison to develop a practical electric car. But even Henry Ford and Thomas Edison could not solve the basic problem: building a storage battery of light weight which would operate for long distances without recharging. They quietly abandoned the project. Sales of electric vehicles peaked in the early 1910s and as gasoline engines became more reliable, they left electric vehicles in the dust. Their limited range was the major problem then and continues to be a problem today.

Gasoline: In 1897 through 1903, the best-selling cars in the US were electric and steam (about 40% market share each). The gasoline cars were a distant third with 20% of the market. The gasoline internal combustion engines (ICE) had some definite disadvantages: the dirty emissions and smell, the noise and the sense of sitting on an explosion, and the hand crank starter that required considerable strength and could break an arm. To refuel you bought cans of gasoline from the drugstore and/or sidewalk vendors selling cans of gas. Eventually gasoline refueling moved off the curb and into "gas stations" with protective canopies and underground tanks and pumps. This was a major advantage of ICE cars: rapid and available refueling and the ability to carry enough fuel for longer trips and thanks to the oil barons like John D. Rockefeller of Standard Oil gasoline, the supply was large and relatively cheap.

Gasoline cars had been around since 1886 when Karl Benz received a patent for his 3-wheel carriage which is considered the birth certificate of the automobile. Then Ford opened his Ford Motor Company in 1903, selling 1,700 Model A cars the first year. But it was Ford's Model T (known as the Tin Lizzie) introduced in 1908 that changed the history of the car. A handmade Ford car cost $850 in 1900 but by 1924 the price of the Model T was only $265 (about 2.5 months of average wages as compared to about 10 months median salary today). The lower costs reflected the use of a moving assembly line which could build 146 cars per hour versus 7.5 per hour in traditional manufacture. Ford reportedly set out to build a car that was big enough for the family but small enough for one man to run and care for. Ford vowed that "no man making a good salary will be unable to afford one". Over the 20-year period from 1908 to 1928, there were 15 million Model T Fords sold. In the history of the automobile, that figure was surpassed only by the Volkswagen VW "bug" which was produced for 58 years. In 1908, there were a total of 5 million cars in the US; in the next five years, there were that many Model T Fords on the road. In 1908, 15% of the cars sold in the US were Fords; by 1923 Ford held 57% of the market. There can never be any dispute about who mass produced the first affordable car and secured the future domination of the gasoline-fueled automobile. There have been changes in design along with technological changes relating to the electronics that have made cars more comfortable, safe and easy to drive. But the basic gasoline-fueled technology has remained essentially the same for 100 years, playing a continuing and decisive role in our everyday life and national economy.

Part II: The Return of the Electric Car

In the 1960s there was a resurgence of interest in electric cars due to concerns regarding fossil fuel emissions. Ford and GM launched research and development of electric vehicles. GM developed 1964 prototypes for urban EVs (Electrovair and Electrovan built on Chevy Corvair body) but the technology was not sufficiently mature to produce commercially viable EVs. The current CAR WARS are once again pitting electric vehicles against the gasoline internal combustion engine. There are three main types of electric vehicles: The hybrid, the plug-in hybrid and the 100% electric engine (EV).

Hybrid

The hybrid was the first "electric" car in the modern era when the Toyota Prius was introduced in Japan in 1997 and then mass-produced for the global market starting in 2000. It was designed to save gasoline and limit carbon emissions. It utilized a small battery-powered motor in addition to a gasoline ICE engine, which could then recharge the electric battery via regenerative braking. There was no plug-in recharging option. Toyota has sold over 5 million of this Prius, currently one of the five Toyotas in the ten best-selling hybrid cars. The hybrids are lighter and simpler than plug-ins and EVs and are still popular because they are less expensive (around $30,000) and more reliable and convenient than the alternative electric vehicles because they do not require recharging. Although the hybrid car does reflect some reduced gasoline costs and emissions, it will not be sold after 2035 since it will not qualify under new California laws as an EV.

EVs

The first mass-produced EV (all electric battery powered vehicle) was the Nissan Leaf introduced in 2010. The Leaf was an easy affordable way to get into an EV, but It's lack of range and slow charging made it hard to live with. The driving range was less than 50 miles and recharging options were limited. The driving range of the current Leaf and all other EVs has increased considerably (up to about 250 to 350 miles) and charging times have decreased (around 45 minutes to a few hours for a rapid recharging in a commercial setting versus overnight with home charging.) However, for all electric vehicles, the ***effective range*** is significantly impacted by several operating factors: extreme heat or cold, use of accessories such as air conditioning or heating, the extent of battery degradation from too much rapid charging, will result in a lower than quoted range. In older models, the decrease in the effective range can be as low as 47%. Also, the stated range reflects mileage when the battery is at optimum charge which is between 20% and 80% which would require more frequent recharging. Furthermore, as the battery ages and "degrades" over time, which was a real problem with the Leaf, the stated mileage no longer applies. Earlier Leaf models were notorious for having poor battery life and the cost to replace a battery every five to six years or so is a major cost factor. In 2015, Tesla introduced its game-changing electric vehicle, the Model Y, which is still the most popular EV in the US and last year sold 771,300 cars globally.

Driving range and recharging availability and time remain major concerns for even the newer EV cars. But new technology and improved infrastructure will follow increased market demand as the deadline for gasoline engines nears. Commercial property owners are scrambling to adjust to the changing world of transportation by adding charging stations to new construction of office and condominium developments. Retail projects, restaurants and hotels are having to provide recharging options. Elon Musk is building a two-story "Supercharger Diner and Drive-In theater in Hollywood providing an American Graffiti-style pit stop with 29 fast superchargers and 5 level 2 chargers available around the clock. Walgreens already has 430 locations offering charging stations today. Other retailers like Subway and 711 have similar plans under way. Opening in January of 2024 is a large charging station between L.A. and Las Vegas which can serve 10,000 cars a month. Given incentives and improving technology and corresponding recharging infrastructure, automobile manufacturers are now adding new electric cars to their 2024-2025 line up. There will be EV models of trucks (Ford F-150 and Maverick pick-up) as well as sports cars including the Porsche, Corvette, Mustang and also luxury sedans like the BMW and the new Cadillac Celestiq which will cost $300,000.

The amount of EVs on the road has exploded from negligible in 2010 to over 26 million EVs in the world in 2022. Some of this growth is no doubt due in part to a growing consensus about the impact of fossil fuels and increasing CO_2 climate change. Governments around the world are committed to the process of eventually getting rid of the gasoline car and in reaching a net zero carbon world by 2050. Even the petroleum industry is preparing for a transition to cleaner energy. The dramatic rise in gasoline prices during 2022 also likely gave buyers more incentive to purchase an electric car. Now, as gas prices have come down there are some signs of a weaker market for electric cars including discounts to push unsold inventory. Some of the projected EV sales may have been lost to the growing Plug-In market.

Plug-Ins

Despite the positive trends toward EVs, almost as many Plug-In cars were sold in 2023. The first Plug-In hybrid was the Chevy Volt, introduced in 2010 had both a gasoline engine (for longer distances and range security) and a battery-operated electric engine for urban driving. The Plug-In will qualify for the 2024 electric vehicle tax benefit and about 20% of the post-2035 market sales can be PHEVs. A major disadvantage of the Plug-Ins is that they have two engines. The reduction in gasoline costs is less than for an EV and the overall costs of maintaining two engines may further reduce cost savings. However, Plug-Ins are attractive in the near term for several reasons. They are more affordable than all-electric but still provide a sizable reduction in gasoline costs and carbon emissions while providing a much longer range. Many of the major automobile manufacturers are "hedging their bets" on the electric car by providing Plug-In models. The sales of Plug-Ins in 2023 increased 76% from 2022 levels.

The Future of Electric Cars

Despite some market resistance, the major automobile manufacturers in the world now produce some type of electric vehicle. The Clean Vehicle Tax Credit for up to $7,500 of your purchase of a qualifying car has been a major incentive for the purchase of EVs or Plug-Ins. Government funding and mandates are major incentives to replace gasoline with electricity: funding for recharging infrastructure is part of the Biden's INFRASTRUCTURE ACT as well as the ban on the sale of gasoline vehicles by 2035 in California, New York, British Columbia and the EU. Electric cars definitely appear to be the car of the future. Newer batteries with solid state technology and/or lighter materials are in the development stage and the sodium-ion battery is coming on the market in early 2024. China and Europe, which have limited petroleum deposits and/or very high gasoline taxes, are well on their way to greater EV dominance. However, despite these current positive trends, there remain major on-going concerns about electric vehicles:

- China dominates mineral and industrial processing, currently producing 75% of all lithium batteries worldwide; it will refine 62.5% of all the worlds lithium supplies, 76% of cobalt, 65% of natural graphite, and 72.5% of synthetic Graphite. Although the U.S. has recently discovered deposits of lithium in the California Salt and Sea and deposits near the Oregon/Nevada border, ***there is simply not enough lithium and other rare earth minerals to provide electric vehicle batteries*** to meet 2050 standards given current technology.

- Also, electric grids are not available in many rural parts of the world and the electric grid in urban areas is already overloaded by current electric use and converting 1/3 of all the U.S. cars tomorrow to electric would reportedly "collapse the grid". ***A large portion of the worldwide car market cannot access sufficient electric power to support an EV.***
- Currently the cost of an EV, even with financial incentives and gasoline cost savings, is significantly higher than the cost of a traditional gasoline car or a hybrid or Plug-In car. In addition, there are added costs of recharging stations at home and periodic battery replacement. ***Many buyers simply cannot afford to drive an EV.***
- Finally, the environmental value of electric vehicles lies in the ability to decrease carbon emissions not just at the tailpipe but in the production of the electricity. However, the electricity used to charge the batteries may not be carbon free or "green energy" produced by wind or solar or thermal or hydro-electric or even nuclear energy instead of "blue" or "grey" or "brown" or "black" energy" which is the major source of our electricity produced by burning fossil fuels. In China, where almost 30% of new cars are electric, 90% of their electricity is currently produced by burning coal; the average Chinese EV is therefore a 90% coal car. In this light, EVs produced in France are a 70%+ nuclear car or in Norway a 90% wind power car or in Iceland a 100% hydroelectric dam powered car***!*** ***Replacing gasoline engines without switching out to "green energy" electricity will not be sufficient to lower CO_2 levels and reach our goal of a carbon-free world by 2050.***

The Search for Green Energy

As of 2020 the vast majority (85%) of our global energy was provided by burning fossil fuels – coal, petroleum and natural gas. Biofuels (plant and animal waste which are net zero CO_2) make up about 5%. The remaining 10% of our energy came from the carbon free sources: nuclear (6%), hydro-electric (3%), and renewables of wind and solar (1%). During the last four years there has certainly been an increase in renewables and a push to add thermal or pumped-hydro energy sources. Unfortunately, the contribution of the cleaner sources is unlikely to increase significantly because there is sizable opposition for environmental concerns or because the electricity produced has limited application. In the U.S. the industrial sector (mining, agriculture, construction and manufacturing) includes production of cement, steel, plastics and ammonia which are the largest users of energy, requiring extreme heat that electricity cannot deliver. Passenger cars and light trucks are only about 15% of our energy use. That is why there is currently so much research and development of carbon-free alternatives like hydrogen gas (H_2) to augment the "clean" renewable electric energy sources that alone cannot replace our dependence on fossil fuels. Benefitting from all that hydrogen R & D is the only reasonably feasible competition to the electric car, the emerging market for H_2 cars. Will these prove to beat out the EV and be the ultimate winner in our contemporary CAR WARS?

Part III: The Entrance of the H_2 Vehicles

There are two types of vehicles that can be powered by hydrogen gas: the fuel cell powered electric vehicle and the internal combustion engine (ICE) using H_2 instead of gasoline. H_2 Fuel Cell cars are powered using electricity produced by a chemical reaction when H_2 is combined with oxygen in the presence of a catalyst (platinum or iridium). The pure compressed H_2 gas is stored in a tank on the vehicle which can be refueled in five minutes and the oxygen comes from an air shaft. Although H_2 is a highly volatile gas, it is actually relatively safe. Unlike electricity which must be stored in batteries, H_2 can be compressed and shipped in pipes or stored in tanks and pumps for fuel cell cars. The fuel cell EV has a range of over 300 miles and produces no harmful tailpipe emissions; the oxidized H_2 produces an exhaust of water vapor and hot air.

There are two available H_2 fuel cells EVs on the market in the US: the Hyundai Nexo (about $60,000 retail) and the Toyota Mirai (around $50,000). These fuel cell cars have had limited market success in the US (year to date 2023 sales are about 2,700 Mirai and 150 Nexo) because of the cost and the lack of available refueling stations. In fact, outside of Hawaii they sell only in California, where there are only 62 current retail refueling stations, whose supply may be very erratic. Most of the existing refueling stations are in the Bay area and the greater L.A. area, including only one in the Inland Empire (Riverside). Outside of those two urban areas, there are only a few stations: Harris Ranch outside Bakersfield, Santa Barbara, Sacramento, Truckee and San Diego. However, there are already a total of over 100,000 H_2 fuel cell vehicles already on the road in Japan, Korea, the U.S. and E.U.

A second type of H_2 powered vehicle is the Internal Combustion Engine (ICE) that runs on H_2 gas, very similar to the standard gasoline car. In fact, in the 1960s teenager Roger Billings converted a Model A Ford to run on H_2 as a high school science project. In 1978 Jack Nicholson converted his 1977 Chevrolet Bel Air into an H_2 race car which he demonstrated at the 1978 Le Mans race meet. Although the technology to mass-produce an internal combustion engine car that runs on hydrogen gas appears to be very simple, the supply and infrastructure of H_2 gas is not available in necessary quantity to produce a cost-effective range-secure automobile. A recent white paper published by the University of Houston did report that retrofitting of existing natural gas infrastructure (pipes, storage tanks, pumps) for delivery of H_2 gas would be feasible in urban areas like Austin. Still, the current lack of fueling stations and storage facilities for H_2 vehicles is a major roadblock to mass marketing of these cars.

But the biggest problem for the both kinds of H_2 cars is producing sufficient amounts of "clean" or "green" H_2. Although H_2 is an abundant element, it is also the lightest; it will dissipate into outer space unless stored under pressure or combined with other elements like oxygen (H_2O or water) or in one of the hydrocarbons like Methane. While H_2 vehicles are *emission free at the tailpipe*, with an exhaust of water vapor, most of the H_2 must be produced by separating it from water via electrolysis and since the electricity required to do this still comes mostly from fossil fuel, the resulting vehicle reflects about 60% "dirty energy" overall. An easier and cheaper but even dirtier source of H_2 is heating methane, the major component of natural gas. Finding ways to produce cheap clean hydrogen gas will be critical to the political and economic feasibility of this technology.

Despite these concerns, there has been significant evidence of investment in the research, development and production of H_2 cars and other transportation vehicles in the past six months. A number of car companies are actively moving toward H_2 vehicles.

- **Toyota** has announced plans for developing an H_2 factory in Europe to commercialize hydrogen technology and systems and will include R&D, production and sales. The company will be focusing on the H_2 ICE which is needed to reach 2050 clean energy goals. They already have the protype H_2 race car that will compete at Le Mans in 2026. Toyota will also provide its Mirai H_2 fuel cell EV as the official cars of the 2024 Olympics in Paris.

- Although it has not produced an H_2 prototype as yet, **Ford Motor Company** already owns a patent on an H_2 Internal Combustion Engine.
- **NamX,** a Paris-based H_2 car start-up, will switch its H_2 Fuel Cell car to a V-8 ICE version. NamX is moving ahead with the H_2 internal combustion engine because it would eliminate the need to relay on rare earth metals (e.g. platinum) needed as catalysts in H_2 fuel cells.
- **Honda** showed off its new H_2 fuel cell system at the Brussels EXPO 2023. This drive train technology can be utilized in future vehicles including commercial vehicles.
- Both **BMW** and **Porche** are exploring options for future H_2 cars.

In addition to car companies, a number of commercial and industrial transportation companies have recently announced new H_2-related projects in heavy-duty long-haul trucking as well as air and marine and commercial applications where electric batteries are too large and heavy to be feasible. The currently available lithium-ion batteries necessary to power a container cargo ship or jet airline across an ocean would require up to 40% of the cargo/passenger space. Automotive concerns with H_2 heavy-truck projects include General Motors, Mercedes Benz, Volvo Group, Isuzu, Honda and Toyota. Hydrogen fuel cell buses and delivery vans are already on the roads. Most surprising is the December 2023 announcement that Amazon is purchasing in-house electrolyzers from Plug Power for all of its Fulfillment Centers; they will produce their own hydrogen gas (via electrolysis of water) to fuel their fleet of H_2-powered fork lift trucks.

Private H_2 industry players are relying on government regulation and incentives to discourage the use of fossil fuels and to support the development of clean economic H_2 as well as help to build the infrastructure to deliver it to the consumer. Recent support indicates such commitment.

- In the U.S. $7 billion in grants was included in the 2021 Infrastructure Law: these will fund 7 production hubs to produce clean H_2 gas fuel for heavy duty industrial uses in addition to fuel for cars and trucks. The current administration has also announced tax credit incentives for producing H_2 fuel.
- The State of California has approved $106 million to be used over the next six years on expanding H_2 fueling stations available to cars and medium duty vehicles. Although there are only approximately 12,000 H_2 passenger cars in the state, the funds are forward-looking because once convenient refueling is in place, it will be easier for Californians to make a choice of which type of passenger vehicle they would like to drive. This could be a big game changer in the current CAR WARS between H_2 and electric.
- Many individual countries or multinational partnerships are currently involved directly in scientific research and development projects to produce cheaper, cleaner hydrogen: South Africa and Japan, Australia and Canada, and Germany and the U.K. have announced joint ventures. Morocco is seeking partners for its proposed use of wind and solar power plants to produce “clean” H_2 gas. Governments also contribute to applied H_2 scientific research via grants at universities like Stanford, M.I.T., Arizona State University, University of Houston, Ohio State, University of Toronto and University of Adelaide.

Cheap Green Hydrogen"

The emerging H_2 vehicles will clearly be highly competitive with gasoline-powered or electric transportation **IF** there is a sufficient cost-effective supply of "clean" H_2. But if scientists **could** eventually reach a significant breakthrough in H_2 production, the rest will follow. Currently the cleanest available H_2 is from electrolysis of water using solar or wind electricity which, as noted earlier, still makes up only a small percentage of our energy source. The idea of giant off-shore floating windmills to power electrolysis of surrounding sea water to produce clean H_2 sounds interesting. A utility in Utah is replacing a coal-fired plant with wind and solar to power electrolysis; the resulting H_2 will be stored in near-by underground caves.

However, the best (most direct and cheapest) source of H_2 is pure "white" hydrogen (naturally occurring H_2 gas deep underground). Scientists have long believed that such deposits are extremely rare but still they have been referred to as the **"Climate Holy Grail"** that could revolutionize the Energy Sector. One of the most significant developments in our clean energy evolution took place last year when two scientists in France accidentally stumbled on a huge (estimated 46 million ton) deposit of pure "white" H_2 gas in the mining region of Lorraine. Equally exciting was the announcement in December 2023 that two scientists from Ohio State University have produced A.I. software that can identify probable locations of deposits of pure "white" hydrogen via aerial scans. Preliminary evidence suggests large deposits like those in France are much more plentiful than previously thought. These potentially significant deposits of 100% "green" H_2 gas would not require expensive processing and are a recurring resource in the earth's crust. Existing petroleum technology and infrastructure could be adapted to the drilling and distribution of hydrogen gas. Existing gasoline combustion engine design can be modified to burn H_2 fuel.

Conclusion: CAR WARS WINNER

We may not be around to see the fall-out of all this research and development. It is possible that battery technology will advance to the point that electric battery cars will take over the car market long before the H_2 car market has a chance to mature. But my odds are on H_2 cars long term, not just because they eliminate the weight and range limitations of battery electric cars, but because hydrogen power appears to be such a critical component of our overall clean energy goals. Once there is mass production of green H_2 for industry, electricity, and commercial transportation, a convenient and affordable H^2 car will be the clear winner of the current CAR WARS, the contemporary "Model T" that transforms and dominates the automotive market.

Bibliography

BOOKS

Early American Automobiles by Floyd Clymer; Bonanza Books/McGraw Hill, ISBN: 517091194

Numbers Don't Lie by Vaclav Smil; Penguin Books, 2020

One Hundred Years on the Road by Raymond Flower and Michael Wynn Jones; McGraw/Hill, 1981

People's Tycoon, Henry Ford and the American Century by Steven Watts; Alfred A. Knopf, 2005

PERIODICALS

Car and Driver Magazine

3/31/2023: *Brief History of the Electric Car* by Kevin A. Wilson

5/31/2023: *Worth the Wait* by Kevin A. Wilson

The Cool Down.com

11/1/2023: *Bill Gates Thermal Battery System*

11/10/2023: *New Lithium Mega Mine (OR/NV Border) to Expand US Production*

12/27/2023: *Students Test Solar Powered Car on 620 Mile Road Test in Desert* by Jeremiah Budin

1/4/2024: *French Scientists Discover "Climate Holy Grail" H2 Deep Underground* by Leo Collins

The Drive.com

6/10/2023, *Toyota Shows Off Hydrogen Burning Le Mans Prototype Racecar,* by Nico DeMattia

The Guardian.com

8/2/2021, *The Lost History of the Electric Car* by Tom Standage

Hydrogenfuelnews.com

2/21/2023: *Seawater Electrolysis produces Green H2* by Tami Hood

8/21/2023: *Transition to Hydrogen Buses,* by Frankie Wallace

9/19/2023: *New Advances of Green Energy* by Steve Hill (NH) and Dr. Naomi Bonese, Stanford

9/22/2023: *Future of H2 Planes* by Tami Hood

9/23/2023: *Hydrogen Station Reliability* by John Max

9/26/2023: *$106 Million Hydrogen Fuel Station Deal (California)* by John Max

9/26/2023*: Zero Avia Announces First Zero Emission Engines for Commercial Flight (Financing for R&D on Hydrogen fueled Airplanes in Conjunction with Airbus and Alaska Airlines)* by Tami Hood

10/2/2023: *Toyota Mirai H2 Cars in 2024 Olympics and Paralympics in Paris* by John Max

10/2/2023: *Japan and South Africa Deal to Support H2 Economy* by Erin Kilgore

10/3/2023: *Bramble Energy Lowers Fuel Cell Costs X 10* by Alicia Moore

10/4/2023: *Nuclear Energy Use to Power Low-Cost Electrolysis to Produce H2* by Jigar Shah

10/4/2023: *U. of Toronto, ASU., Granfield U. (UK), U. of Adelaid* by Angie Bergenson

10/4/2023: *UK and Germany Form Hydrogen Fuel Deal* by Tami Hood

10/13/2023: *Biden Pledged $7 Billion for 7 Regional Clean H2 Hubs* by Jake Banks

10/14/2023: *Ikea to Use H2 Delivery Vehicles* by Julie Campbell

10/20/2023: *BMW* and Sasol *to Produce H2 Cars in South Africa* by staff

10/24/2023: *Siemens Energy Tests First H2 Turbine in France* by Erin Kilgore

10/25/2023: *Toyota Groundbreaking Ammonia Engine* by Bret Williams

11/1/2023: *Norwegian Start Up Uses Solid H2 to Store Solar Energy* by Erin Kilgore

11/3/2023: *Toyota Sales of H2 Fuel Cell Cars Rise* by Bret Williams

11/15/2023: Toyota Says Best Option is H2 Internal Combustion Engines (ICE), by Erin Kilgore

11/21/2023: *Japan's First H2 Fuel Cell Passenger Ship* by staff

11/22/2023: *Honda Unveils H2 Fuel Cell Stack Modular Technology* by Angie Bergenson

11/29/2023: *Chinese/Japanese Collaboration to Produce H2 Fuel* Cell *SUV* by Bret Williams

12/6/2023: *Airbus Uses H2 Plane for Blue Condor Tests* by Alicia Moore

12/7/2023: *Toyota Announces Plans for European H2 Factory* by Julie *Campbell*

12/13/2023*: Europe's Largest H2 Fuel Cell Gigafactory Announced* by Tami Hood

12/14/*2023*: *Toyota Files Patents for Home Refueling of H2 Cars* by Julie Campbell

12/19/2023: *GM to Provide H2 Fuel Cells for Autocar's Heavy Vehicles* by Bret Williams

12/20/2023: *Paris Based NamX Start-Up Has Chosen H2 ICE Over Fuel Cells* by Alicia Moore

12/21/2023: *Unlocking Earths Hidden Energy: AI Leads Hunt for White H2 Reserves* by Julie Campbell

12/22/2023: *Nikola and FirstElement Fuel Team Up to Develop H2 Infrastructure* by Bret Williams

12/23/2023: *Mercedes Benz H2 Fuel Cell Trucks Undergo Test by Amazon* by Angie Bergenson

12/30/2023: *Biden's New H2 Tax Credit Policy Incentivizes Clean H2 Production* by Angela Linders

1/4/2024: *Rolls Royce Kicks Off H2 Fuel Cell Test for easyJet Airplanes* by Tami Hood

1/4/2024: *Amazon to Buy Electrolyzers to Produce In-house H2 for Forklifts* by Julie Campbell

1/5/2024: *Honda and Mitubishi to Test Recovery of H2 Waste* by Erin Kilgore

1/5/2024: *Nikola delivers 35 Class 8 H2 Fuel Cell Trucks to Canada & US* by Angie Bergenson

Los Angeles Times

9/30/2022: *Toyota Rejects Moving to All EVs* by Christina *Rogers* and River Davis

3/2/2023: *Hydrogen Needs to Play Bigger Role in Powering Cars* by George Skelton

9/11/2023: *Offshore Wind, Pumped Hydropower and Geothermal* by Sammy Roth

9/23/2023: *Going Too Big with Cars Extends to EVs* by Ira Boudway

9/25/2023: *Charging Stations in Disrepair* by Russ Mitchell

10/1/2023: *Replacing Hydroelectric Dam A Problem* by Sammy Roth

10/2/2023: *China Has Climate Lesson for California* by Alex Wang

10/6/2023: *Businesses and Landlords See Demand for EV Charging Sites* by Roger Vincent

10/11/2023: *Hate for Plug-in Hybrids* by Russ Mitchell

10/14/2023: *Clean-hydrogen Hubs Will Receive $7 Billion Boost* by Matthew Daly and Marc Levy

10/16/2023: *California to Get $1.2 Billion to Boost Hydrogen Energy Projects* by Hayley Smith

10/24/2023: *Hydrogen a Climate Fix and Distraction* by Sammy Roth

10/29/2023: *CEO Sees EVs as "Missing Piece" for Toyota* by Craig Trudell

12/1/2023: *Salton Sea Has More Lithium Than Previously Understood* by Sammy Roth

12/8/2023: *Rural Schools Highlight Issues with Electric Buses* by Hailey Branson-Potts

MIT Technology Review

12/2022: *EVs Won't Replace Hybrids Anytime Soon* by Casey Crowntal

San Bernardino Sun (Associated Press)

10/10/2023: *Laser Fusion Breakthrough with H2 Fuel Cell* by Kenneth Chang

12/3/2023: *US Bets on Small Nuclear Reactors* by Brad Plumer and Ivan Penn

The Verge.com

12/28/2023: *Amazon to Produce H2 for Fork Lift Trucks with Plug Power Electrolyzer* by Justine Calma

WEBSITES

energy.gov (DOE); USC- illuminmagazine.com; GreenCars.com; Electrek.com; thechemicalengineer.com; lowcarbon-exxonmobile.com; thoughtco.com; americangeoscience.org; climate.mit.edu

Mark Cook

Summary Resume

I received a BS in Business from the University of Southern California and went to work for Ford Motor Company in their Management Training Program. After moving through a few positions, I was recruited to become a member of the Start Up team for Ford's new division: Dealer Computer Services, whose goal was to automate the franchise dealerships. Computer experts in Detroit provided software programs and data processing; the hardware was provided by Texas Instruments and IBM, and the Ford dealers provided the money to purchase the equipment and programs. It was my job to convince them that the benefits would justify the added cost.

The original DCS operation was not streamlined: dealership data from Accounting and Parts Inventory was transmitted via teletype to the mainframe computer in Detroit for processing, then bulky printed results were airmailed back overnight. However, as computer technology transitioned dramatically, DCS programs expanded to automate the entire business of almost 90% of our Ford and Lincoln/Mercury dealerships using just an in-house processor and a network of desktop terminals. I effectively became a management consultant and problem solver helping to make the dealerships more profitable.

I was never a computer expert, but I know a lot about the automobile business. As a Ford retiree and stockholder and a lifelong "car guy", I still follow the automotive industry closely. My recent interest in the evolving car market led to this report.