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The electric car or
the hydrogen option?

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Out from the frying pan into the fire

On-road vehicles contribute more than 23 percent of total U.S. GHG emissions. EPA's proposed GHG standards for light-duty vehicles, a subset of on-road vehicles, would reduce GHG emissions by nearly 950 million metric tons and conserve 1.8 billion barrels of oil over the lifetime of model year 2012-2016 vehicles.

Juicing up an electric car in Texas would create about half as much carbon dioxide as a gasoline vehicle. But, based on data from the Environmental Protection Agency on Texas power plant emissions in 2008, an electric vehicle would be responsible for slightly more nitrogen oxides than a brand-new gasoline car.

Chevrolet's Volt, a plug-in hybrid due out in November, will draw 8 kilowatt-hours of electricity from the grid to go 40 miles. (The Volt also has a gasoline engine; hence, it's a hybrid.)

Plug in the Volt in Texas, and it will produce about 0.1 of a gram of nitrogen oxides per mile on electricity. The EPA recently tightened NO{+x} requirements for gasoline cars, so the average new car will emit only 0.07 of a gram of NO{+x} per mile.

Carbon dioxide emissions look better. A Volt would be responsible for 164 grams of carbon dioxide per mile traveled on the battery. A gasoline car emits 320 grams per mile.

Emissions issues for the rest of the country aren't any better. Some states, such as California, have cleaner power plants. Still, the average power plant in the U.S. creates more nitrogen oxides per kilowatt-hour of electricity than the average in Texas.

http://www.dallasnews.com/sharedcontent/dws/bus/stories/120509dnbusnuelectriccars.189e3e2.html

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Dan Greenbaum led a study for the National Research Council that found that plug-in vehicles in the U.S. would cause more health damage from pollution than other vehicle technologies.

First, half of the country's power comes from coal plants, said Greenbaum, president of the Health Effects Institute, a nonprofit that studies the health effects of air pollution. His sponsors include automobile manufacturers, government labs, foundations and Exxon Mobil Corp.

"The other factor was, it does take more energy to manufacture an electric vehicle, to manufacture the battery pack, etc., etc. Every time you spend energy to do that, then there are more emissions at the manufacturing site," he said.

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If 1.2 million Texans were to buy Chevy Volts and plug them into the state's grid at the same time, late on a hot afternoon, Texas would need more power plants to accommodate them. That many vehicles would wipe out the extra reserve margin, or the cushion of excess power plant capacity. ERCOT aims to keep at least a 12.5 percent reserve margin to ensure reliability.

If 3.4 million Volt drivers in Texas plugged in simultaneously on the afternoon of the hottest day of the year, the grid could black out.

That's an awful lot of electric vehicles.

"That's a really aggressive number and something that's highly unlikely ... that we'd see that in the next 10 years," said Rob Peterson, a spokesman for Chevrolet. He pointed out that President Barack Obama has set a goal of 1 million electric vehicles on the road by 2015 for the entire U.S.

Electrical engineers have been noodling on pollution and grid strain for years. The key is persuading electric car owners to plug in after about 9 p.m. That's when demand eases and there's plenty of grid capacity to handle the cars.

That's also when wind kicks up in West Texas. Most of the state's wind power comes online in the middle of the night, allowing dirtier power plants to dial down. In a perfect world, millions of electric vehicle owners would juice up around 3 a.m., making use of the cleanest power available on the grid.

http://www.dallasnews.com/sharedcontent/dws/bus/stories/120509dnbusnuelectriccars.189e3e2.html

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Environmental advocates say it's much easier to cut pollution at a few power plants than for millions of vehicles. The EPA is working on stricter nitrogen oxide regulations and has recently tightened rules for mercury emissions.

"As the way we generate power in the state becomes cleaner, we have the opportunity to feed cleaner energy into the grid, and drivers don't have to update their technology," said McCall Johnson, a clean energy advocate for Environment Texas.

Others argue that nitrogen oxides emitted by power plants in rural areas are less likely to combine with other pollutants to form smog than NO{+x} emitted by cars in a big city.

White argues that electric vehicles can help ease the burden on the grid. He expects electric vehicle owners to eventually be able to sell battery power back to the grid when demand shoots up.

"There are some days in the summer when the wholesale rate for power can be 30, 40 cents per kilowatt-hour," he said. So power companies must build plants that sit idle for most of the year and fire up only occasionally, on the days of greatest demand.

"Basically, the dilemma for the last century and a half, as we built out these power grids, has been the inability to store electricity economically. Through battery storage in vehicles ... at least we would have one resource that we could call on to reduce that peak demand for electricity."

What about Hydroge? It's the best solution!

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Diversification of primary energy [1]
Transportation depends up to 95% from oil. 22.5 Million Tons gasoline and 28.5 million tons of Diesel oil were consumed in Germany in 2006. Electrifying transportation will use electricity from a variety of primary energy carriers, from conventional and also from renewable sources.

According to the Wuppertaler Institute the fleet of 1 million electro-cars will demand 2 Twh. This is 1/300of the total energy consumed by Germany. The phaseout of nuclear energy in Germany is therefore not endangered, as sufficient electricity is already availiable, and 1 million cars will not be able to be build until 2020.

[1] Elektromobilitaet und Erneuerbare Energien
http://www.wupperinst.org/uploads/tx_wiprojekt/Energiebalance-AP5.pdf

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Electro car: Diversification of primary energy [1]

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Not quite realistic ideas

Tata Air Car

This model has only a compressed air tank. The car is powered by a turbine moved by compressed air.

It has a low range and depends on electricity of refilling stations with the proper air compressor.

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Market has changed

Fuel economy is premium quality. Downsizing cars becomes a symbol of high education standard.
Monster cars signal rudeness. The owner has to attract attention with materialistic exhibits.

Modern transportation is changing its fuel.
Electric cars for specific users will be part of the new technology. However the core fuel business will be divert from conventional fuels to hydrogen.

Solar electricity and wind power will provide green energy for hydrogen electrolysis.

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Linde Corporation builds on Hydrogen as a new pilar of the global energy economy.
Linde starts the production of hydrogen from glycerin which is a by-product of Diesel oil production. Linde also produces hydrogen using steam reforming of natural gas. Both technologies produce CO2, so electrolysis of water using regenerative electricity is seen as the future of hydrogen as fuel for transportation.

Wolfgang Reitzle, CEO of Linde says that a lot of research has been done in the field of combustion engines and oil industry. Now that innovative techniques are needed to decarbonise fuels, a great investment in research and infrastructure will be necessary to accomplish this task. The change has already started:

Daimler will start the serial production of B class car equipped with a fuel cell.

VW will develop fuel saving combustion engines

Oil has no perspective, says Reitze, and natural gas will take its place because its supplies will last longer, are available in almost every country, so dependence on imports are reduced.
However, natural gas is not carbon-free, it will only be a temporary solution.

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Example of an evolving new market

Micro-Vett transforms Fiat cars in electric cars. The engine is being freplaced by batteries and an electric motor. 5,000 cars have already been transformed to green cars.
The German RWE electricity giant buys these cars to lease it. The fee is 899 Euro/month.
The Lithium-ion battery is what drives the price up.

ADAC_Motorwelt Heft 2 Februar 2010
www.adac.de

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The combustion of hydrogen with oxygen produces water as its only product:

$2H_2 + O_2 = 2H_2O$

The combustion of hydrogen with air however can also produce oxides of nitrogen (NOx):

$H_2 + O_2 + N_2 = H_2O + N_2 + NO_x$

Where under sunlight, oxides of nitrogen and volatile organic compound would form smog.

History of hydrogen internal combustion engines

Hydrogen internal combustion engine cars are different from hydrogen fuel cell cars. The hydrogen internal combustion car is a slightly modified version of the traditional gasoline internal combustion engine car. These hydrogen engines burn fuel in the same manner that gasoline engines do.

Francois Isaac de Rivaz designed in 1807 the first hydrogen-fueled internal combustion engine. Paul Dieges patented In 1970 a modification to internal combustion engines which allowed a gasoline-powered engine to run on hydrogen US patent 3844262.

Mazda has developed Wankel engines that burn hydrogen. The advantage of using ICE (internal combustion engine) such as wankel and piston engines is that the cost of retooling for production is much lower. Existing-technology ICE can still be used to solve those problems where fuel cells are not a viable solution as yet, for example in cold-weather applications.

HICE forklift trucks have been demonstrated based on converted diesel internal combustion engines with direct injection.

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The Boeing fuel cell demonstrator

In February 2008 Boeing tested a manned flight of a small aircraft powered by a hydrogen fuel cell. Unmanned hydrogen planes have also been tested.

For large passenger airplanes however, The Times reported that "Boeing said that hydrogen fuel cells were unlikely to power the engines of large passenger jet airplanes but could be used as backup or auxiliary power units onboard."

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Since hydrogen is a gaseous fuel at ambient conditions it displaces more of the combustion chamber than a liquid fuel. Consequently less of the combustion chamber can be occupied by air. At stoichiometric conditions, hydrogen dis-places about 30% of the combustion chamber, compared to about 1 to 2% for gasoline. Figure 3-3 compares combustion chamber volumes and energy content for gasoline and hy-drogen fueled engines. [1]

The power source-to-wheel efficiency [2]
The conversion of electric power into hydrogen energy and the distribution of hydrogen to the user are extremely inefficient. About 50% of the precious renewable electricity is lost. If hydrogen is re-converted to electricity with 50% efficient fuel cells, only 25% of the original electric energy will be available for practical use. This is a very poor alternative to direct energy transport by electrons through wires.

As only 50% of the original electrical energy is received by consumers, hydrogen energy will be about twice as expensive as grid power. The energy consumer has a choice. Hydrogen heat will cost twice as much as electric heat. As a consequence, hydrogen is unlikely to replace natural gas for space heating, but home owners will prefer electricity.

The power source-to-wheel efficiency of electric cars is somewhere between 60 and 70%, while only about 17% and 23% can be obtained with fuel cell vehicles energized with liquid or gaseous hydrogen, respectively (see "Efficiency of Hydrogen PEFC, Diesel-SOFC-Hybrid and Battery Electric Vehicles", www.efcf.com/reports).

However, mobility is directly bounded to rage. Hydrogen produced by water hydrolysis using solar energy or wind power will be the future fuel for transportation for cars and trucks. Solar and wind power is so abundantly available in the deserts, that these considerations lack any substance in face of the needs of the customers.

[2] Ulf Bossel: Efficiency of Hydrogen Fuel Cell, Diesel-SOFC-Hybrid and. Battery Electric Vehicles. European Fuel Cell Forum. 20 Oct 2003
http://www.efcf.com/media/ep031022.shtml

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Optimising the hydrogen internal combustion engine [1]

Internal combustion engines fed with hydrogen are considered preferable for universal use. In this range, hydrogen internal combustion engines are considered not just an intermediate but also a long-term solution with significant market share also for small and medium size cars. Hydrogen powered internal combustion engines also would be available earlier at reasonable prices, significantly lower than full size fuel cell power trains.

The hydrogen internal combustion engine also takes profit of the mature technology and all investment linked to the petrol combustion engine and would allow a direct link-up of natural gas and hydrogen, as the same engine could run on both fuels. Downsized engines with a similar performance than today's fossil fuel powered vehicles would be feasible.

At the recent Hydrogen Internal Combustion Engine conference organized by WestStart-CALSTART and the Federal Transit Administration, Robert Natkin of Ford's H2ICE Project noted that Ford is finding that using a next-generation hydrogen-internal combustion engine in a hybrid platform can deliver overall powertrain efficiency comparable to that of a hydrogen fuel cell vehicle platform. [2]

[1] Optimisation of hydrogen powered internal combustion engines (HYICE). 2007
http://www.ist-world.org/ProjectDetails.aspx?ProjectId=7eb0c57cdd8c47cfb94c15bc6357c08f&SourceDatabaseId=7cff9226e582440894200b751bab883f

[2] Green Car Congress: HyICE Concludes, Results in Optimized Hydrogen Internal Combustion Engine. 2007
http://www.greencarcongress.com/2007/03/hyice_concludes.html

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Direct Injection Systems

More sophisticated hydrogen engines use direct injection into the combustion cylinder during the compression stroke. In direct injection, the intake valve is closed when the fuel is injected, completely avoiding premature ignition during the intake stroke. Consequently the engine cannot backfire into the intake manifold.

The power output of a direct injected hydrogen engine is 20% more than for a gasoline engine and 42% more than a hydrogen engine using a carburetor.

While direct injection solves the problem of pre-ignition in the intake manifold, it does not necessarily prevent pre-ignition within the combustion chamber. In addition, due to the reduced mixing time of the air and fuel in a direct injec-tion engine, the air/fuel mixture can be non-homogenous. Studies have suggested this can lead to higher NOx emis-sions than the non-direct injection systems.

Crankcase Ventilation

Crankcase ventilation is even more important for hydrogen engines than for gasoline engines.

As with gasoline engines, unburnt fuel can seep by the piston rings and enter the crankcase. Since hydrogen has a lower energy ignition limit than gasoline, any unburnt hydrogen entering the crankcase has a greater chance of igniting. Hydrogen should be prevented from accumulating through ventilation.

[1] Hydrogen Fuel Cell Engines and Related Technologies: Rev 0, December 2001
http://www1.eere.energy.gov/hydrogenandfuelcells/tech_validation/pdfs/fcm03r0.pdf

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U.S. Armed Forces goe "green"

The Green Strike Group

Army has pursued "zero footprint" base camps, and the Air Force is looking into a variety of alternative propellants that could be turned into jet fuel. Now the Navy is going green, signing a memorandum of understanding with the USDA to demo a **Green Strike Group** of biofuel- and nuclear-powered vessels by 2012.

By 2020, the Department of the Navy also plans to halve the fossil fuel consumption entirely, across the entire force. That means ships, aircraft, tanks, shore vehicles and naval bases will all be switching to a half alternative fuel diet

The real thing is that fuel convoys have become popular targets for insurgents in Iraq and Afghanistan, and the Navy has to keep the supply lines open for the troops on the ground.

http://www.popsci.com/technology/article/2010-01/navy-pledges-green-strike-group-2012-cut-fossil-fuel-use-half-2020

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Unmanned Aerial Vehicle (UAV)

While most research directed at improving UAVs focuses on upgrading their weapons or sensor packages, the Naval Research Laboratory is also working to ensure that the next generation of killer drones are as fuel-efficient as they are deadly. And a recent test of their hydrogen-fuel-cell-powered Ion Tiger UAV proves how successful they have been: it staid aloft for just shy of 24 hours on a single fuel load.

READERS COMMENT: For air travel, however, hydro just can't touch good old fuel combustion. We are not talking about the environment or even a commercial fleet here. We are talking weapons of war and death. For military aircraft, there is no reason to replace fossil fuels until the horizon shows us a shortage of military access to jet quality fuel.

Now THAT! is an American revolution and innovation. We can do it. Let there be no doubt about it.
I'm thinking an entirely new class of carriers, loaded with inexpensive drones, unleashing swarms of hurt in the battlefield. Shoot one down??... no problem... switch pilot to another drone...

•Hydrogen-Powered Navy UAV Shatters Flight Endurance Record
http://www.popsci.com/technology/article/2009-10/hydrogen-powered-navy-uav-shatters-flight-endurance-record

The End