Chapter 1 : The Hype about Hydrogen | Issues in Science and Technology

The Hype about Hydrogen was named one of the best science and technology books of by Library Journal. The New York Review of Books stated that the book gives "the most direct answers" to the question on the promise of a near-term hydrogen economy, calling Romm "a hydrogen realist".

Hydrogen and fuel cell cars are being hyped today as few technologies have ever been. Yet for all the hype, a number of recent studies raise serious doubts about the prospects for hydrogen cars. Hydrogen is not a readily accessible energy source like coal or wind. It is bound up tightly in molecules such as water and natural gas, so it is expensive and energy-intensive to extract and purify. Fuel cells are small, modular electrochemical devices, similar to batteries, but which can be continuously fueled. The most promising fuel cell for transportation uses is the proton exchange membrane PEM , first developed in the early s by General Electric for the Gemini space program. Current PEM costs are about times greater. A major technology breakthrough is needed in transportation fuel cells before they will be practical. Running a fuel cell car on pure hydrogen, the option now being pursued by most automakers and fuel cell companies, means the car must be able to safely, compactly, and cost-effectively store hydrogen onboard. This is a major technical challenge. At room temperature and pressure, hydrogen takes up some 3, times more space than gasoline containing an equivalent amount of energy. Current energy storage technologies are insufficient to gain market acceptance because they do not meet these criteria. Liquid hydrogen is widely used today for storing and transporting hydrogen. Indeed, for storage and fueling, liquids enjoy considerable advantages over gases: They have high energy density, are easier to transport, and are typically easier to handle. Hydrogen, however, is not typical. It can be stored only in a superinsulated cryogenic tank. Liquid hydrogen is exceedingly unlikely to be a major part of a hydrogen economy because of the cost and logistical problems in handling it and because liquefaction is so energy-intensive. Some 40 percent of the energy of the hydrogen is required to liquefy it for storage. Liquefying one kilogram kg of hydrogen using electricity from the U. Nearly all prototype hydrogen vehicles today use compressed hydrogen storage. For comparison, atmospheric pressure is about 15 psi. Working at such high pressures creates overall system complexity and requires materials and components that are sophisticated and costly. And even a 10,psi tank would take up seven to eight times the volume of an equivalent-energy gasoline tank or perhaps four times the volume for a comparable range because the fuel cell vehicle will be more fuel efficient than current cars. Practical hydrogen storage requires a major technology breakthrough, most likely in solid-state hydrogen storage. Hydrogen has some safety advantages over liquid fuels such as gasoline. When a gasoline tank leaks or bursts, the gasoline can pool, creating a risk that any spark would start a fire, or it can splatter, posing a great risk of spreading an existing fire. Hydrogen, however, will escape quickly into the atmosphere as a very diffuse gas. Also, hydrogen gas is nontoxic. Yet hydrogen has its own major safety issues. It is highly flammable, with an ignition energy that is 20 times smaller than that of natural gas or gasoline. It can be ignited by cell phones or by electrical storms located miles away. Hence, leaks pose a significant fire hazard, particularly because they are hard to detect. Hydrogen is odorless, and the addition of common odorants such as sulfur is impractical, in part because they poison fuel cells. Hydrogen burns nearly invisibly, and people have unwittingly stepped into hydrogen flames. Hydrogen can cause many metals, including the carbon steel widely used in gas pipelines, to become brittle. In addition, any high-pressure storage tank presents a risk of rupture. For these reasons, hydrogen is subject to strict and cumbersome codes and standards, especially when used in an enclosed space where a leak might create a growing gas bubble. Some 22 percent or more of hydrogen accidents are caused by undetected hydrogen leaks. An expensive fuel A key problem with the hydrogen economy is that pollution-free sources of hydrogen are unlikely to be practical and affordable for decades. Indeed, even the pollution-generating means of making hydrogen are currently too expensive and too inefficient to substitute for oil. Bridging the gap between current hydrogen technologies and the marketplace will require revolutionary conceptual breakthroughs. Natural gas methane, or CH4 is the source of 95 percent of U. The overall energy efficiency of the steam CH4 reforming process the ratio of the energy in the hydrogen output to the energy in the natural gas fuel input is about 70

percent. A kg of hydrogen contains about the same usable energy as a gallon of gasoline. This is more than three times the current untaxed price of gasoline. Water can be electrolyzed into hydrogen and oxygen by a process that is extremely energy-intensive. Typical commercial electrolysis units require about 50 kilowatt-hours per kg, an energy efficiency of 70 percent. Replacing one-half of U. From the perspective of global warming, electrolysis makes little sense for the foreseeable future. Burning a gallon of gasoline releases about 20 pounds of CO2. Producing 1 kg of hydrogen by electrolysis would generate, on average, 70 pounds of CO2. Hydrogen could be generated from renewable electricity, but that would be even more expensive and, as discussed below, renewable electricity has better uses for the next few decades. The goal is to validate the viability of the system by If a permanent storage location, such as an underground reservoir, can be found for the CO2, this would mean that coal could be a virtually carbon-free source of hydrogen. DOE is also pursuing thermochemical hydrogen production systems using nuclear power with the goal of demonstrating commercial-scale production by Biomass plant matter can be gasified and converted into hydrogen in a process similar to coal gasification. It is unlikely that any of these approaches could provide large-scale sources of hydrogen at competitive prices until after Stranded investment is one of the greatest risks faced by near-term hydrogen production technologies. For instance, if during the next two decades we built a hydrogen infrastructure around small CH4 reformers in local fueling stations and then decided that U. The chicken-and-egg problem Another key issue is the chicken-and-egg problem. Who will spend the hundreds of billions of dollars on a wholly new nationwide infrastructure to provide ready access to hydrogen for consumers with fuel cell vehicles until millions of hydrogen vehicles are on the road? And who will manufacture and market such vehicles until the infrastructure is in place to fuel those vehicles? Will car companies and fuel providers be willing to take this chance before knowing whether the public will embrace these cars? I fervently hope to see an economically, environmentally, and politically plausible scenario for how this classic chasm can be bridged; it does not yet exist. Centralized production of hydrogen is the ultimate goal. That will require some way of delivering massive quantities of hydrogen to tens of thousands of local fueling stations. Also, few automakers are pursuing onboard storage with liquid hydrogen. So after delivery, the fueling station would still have to use an energy-intensive pressurization system. This might mean that storage and transport alone would require some 50 percent of the energy in the hydrogen delivered, negating any potential energy and environmental benefits from hydrogen. Pipelines are also used for delivering hydrogen today. Yet we have very little idea today what hydrogen generation processes will win in the marketplace during the next few decades, or whether hydrogen will be able to successfully compete with future high-efficiency vehicles, perhaps running on other pollution-free fuels. This uncertainty makes it unlikely anyone would commit to spending tens of billions of dollars on hydrogen pipelines before there are very high hydrogen flow rates transported by other means and before the winners and losers at both the production end and the vehicle end of the marketplace have been determined. In short, pipelines are unlikely to be the main hydrogen transport means until the post period. Trailers carrying compressed hydrogen canisters are a flexible means of delivery but are relatively expensive because hydrogen has such a low energy density. Even with technology advances, a metric-ton truck might deliver only about kg of hydrogen into onsite high-pressure storage. A study by ABB researchers found that for a delivery distance of miles, the delivery energy approaches 40 percent of the usable energy in the hydrogen delivered. Without dramatic improvement in high-pressure storage systems, this approach seems impractical for large-scale hydrogen delivery. Producing hydrogen onsite at local fueling stations is the strategy advocated by those who want to deploy hydrogen vehicles in the next two decades. Onsite electrolysis is impractical for large-scale use because it would be highly expensive and inefficient while generating large amounts of greenhouse gases and other pollutants. The hydrogen would need to be generated from small CH4 reformers. Although onsite CH4 reforming seems viable for limited demonstration and pilot projects, it is impractical and unwise for large-scale application, for a number of reasons. First, the upfront cost is very high: Second, the cost of the delivered hydrogen itself in this option is also higher than for centralized production. Not only are the small reformers and compressors typically more expensive and less efficient than larger units, but they also will likely pay a much higher price for the electricity and gas to run them. We should not pursue a strategy to

reduce greenhouse gas emissions in transportation that would undermine efforts to reduce emissions in electric generation. This was the conclusion of a study for the California Fuel-Cell Partnership, a Sacramento-based public-private partnership to help commercialize fuel cells. Most of a CH4-based investment would also likely be stranded once the ultimate transition to a pure hydrogen economy was made, because that would almost certainly rely on centralized production and not make use of small CH4 reformers. In the California analysis, it takes 10 years for investment in infrastructure to achieve a positive cash flow, and to achieve this result requires a variety of technology advances in components and manufacturing. Also, even a small tax on hydrogen to make up the revenue lost from gasoline taxes appears to delay positive cash flow indefinitely. The high-risk and long-payback nature of this investment would seem far too great for most investors, especially given the history of alternative fuel vehicles. The United States has a great deal of relevant experience in the area of alternative fuel vehicles that is often ignored in discussions about hydrogen. The Energy Policy Act established the goal of having alternative fuels replace at least 10 percent of petroleum fuels in and at least 30 percent in By , some one million alternative fuel vehicles were on the road, only about 0. Compared to other alternative fuels, such as ethanol and natural gas, the best analysis today suggests that hydrogen will have a much higher price for the fuel, the fueling stations, and the vehicles. The fourth reason that producing hydrogen on-site from natural gas at local fueling stations is impractical is that natural gas is simply the wrong fuel on which to build a hydrogen-based transportation system. The United States consumes nearly 23 trillion cubic feet tcf of natural gas today and is projected to consume more than 30 tcf in Replacing 40 percent of ground transportation fuels with hydrogen in would probably require an additional 10 tcf of gas, plus billion kilowatt-hours of electricity, or 10 percent of current power usage. Politically, given the firestorm over recent natural gas supply constraints and price spikes, it seems very unlikely that the U.

Chapter 2 : The Hype About Hydrogen

The Hype about Hydrogen offers a hype-free explanation of hydrogen and fuel cell technologies, takes a hard look at the practical difficulties of transitioning to a hydrogen economy, and reveals why, given increasingly strong evidence of the gravity of climate change, neither government policy nor business investment should be based on the belief that hydrogen cars will have meaningful commercial success in the near or medium term.

Another -- Ssilvers All significant published points of view are presented, not just the most popular one. It should not be asserted that the most popular view or some sort of intermediate view among the different views is the correct one. Readers are left to form their own opinions. See [[3]] Besides, why do you care so much? You jumped in just minutes after the addition was made. Did you write the book??? In any case, the quotes you chose do not even present a balanced view of the review itself. I am trying to give you the benefit of the doubt here. Read the article on hydrogen vehicle. This review does not represent the "critical reception" for the book. NPOV policy does not mean that discredited viewpoints must be represented equally with the consensus of the scientific community. I believe the article gives a very different spin to the viewpoints of the environmental newsletters versus those of the UC Davis scientists. I think it is NPOV to call them scientists given that they publish peer reviewed articles in scientific journals. The NPOV policy states: I am open to your suggestions. It would not be productive, once again, to interleave your own point of view with short quotes from the UC Davis review. The assertions you make about the authors, even if you could cite them as facts, are prima facie evidence of political bias. Again, see the NPOV policy. I appreciate that you strongly disagree with the review. Here are my problems with what you added: I think that what is quoted from the review is too long considering the overall length of the article. I think that the writers of the review had an agenda, because they were working for government projects that had a strong interest in promoting hydrogen vehicles. Words like "decrying" are not NPOV. Is there any way we can compromise on this? As to editing the talk page, I merely added bolding on a word that you quoted, which is OK according to the WP policy that you cite. He [Romm] consistently relies on sources that tend to the high side of the cost range in the literature, and often cites only the highest cost case in referenced studies. Some of his hydrogen costs are roughly twice those in the recent National Academies study of hydrogen. Too often, he cites controversial research that has not been peer reviewed, ignores well-known studies that do not support his conclusions, or gives incomplete citations that leave the reader wondering about the source. The reviewers also expressed their concern that an unrealistically high estimate was employed of the fuel economy of gasoline hybrid vehicles, which are considered by some analysts to be the alternative to hydrogen vehicles. For example, to bolster a point about the near-term potential of advanced gasoline automobiles, Romm states that gasoline hybrids are approximately as energy efficient as hydrogen fuel-cell vehicles. Also, fuel efficiency is not the only issue consumer reports focuses on the cost to the consumer. But these are not the main focus of the book, which is that fuel cells do not work for cars, which point is amply discussed in the article on hydrogen vehicles that I had no hand in editing. See the new movie Who Killed the Electric Car? Running down a few cites would help. Can you give a citation about their advisory work for California and the US Government? I think Consumer Reports is more cautious and says hybrids offer only 10 or 20 percent fuel economy improvements, with the Prius being the statistical outlier at 45 percent. I have no idea what gave the commenter below that idea, except that the Foundation was originally endowed by Rockefeller in Like other charitable foundations, it has an independent Board of Directors. Read the Rockefeller Foundation article to find out more about this venerable foundation. There used to be a Romm bio here, but editors said that since there is a separate bio article under Joseph J. Romm that is wikilinked in the article that it should not be repeated. Personally, I would delete the Consumer Reports reference. Consumer reports did not review this book and does not even discuss the pros and cons of hydrogen vehicles. It is not really relevant here. Another point about the reviews: People normally talk about the hydrogen or more correctly - electro-chemical economy with this in mind. This book discusses objections to relying on hydrogen vehicles. If you look at hydrogen economy , that is an article about using hydrogen at power stations and all other purposes. This book does not object to power station

usage, only vehicle usage. Is that what you were asking? Best regards, -- Ssilvers The use of hydrogen vehicles does not infer a greater contribution to greenhouse gases at all. Carbon sequestration or a hydrogen economy implies nothing about producing hydrogen at the plant itself. Furthermore, the additional point of developing hydrogen vehicles, is to allow for easier reformation from biofuels to allow for carbon neutral vehicles. Currently the purity of fossil fuels is the major limiting factor in the development of effective on-board fuel processing and reformation technologies. I think it would be appropriate to mention that in this article as it does at least have the appearance of creating a pro-oil stance. While it is not definitive, it could be the reason that he is such a strong proponent of Gasoline and disel hybrid vehicles. Vehicles that will continue to utilize Fossil Fuels. This makes a pro-fuel cell position a pro-oil industry position, a priori. If the political affiliation of reviewers, real or perceived, is relevant, then we should note the political affiliation, real or perceived, of the book author. John Heywood of MIT writes in September Scientific American that it would take 10 to 15 years before one third of vehicles on the road would be hybrids, and that it would be 35 years until major impact page 62 of "Fueling Our Transportation Future". The tecnology is available, just not the political will. See also this article from the same issue Sept. If hybrids provide better mpg by themselves, what is the added benefit of increasing CAFE? It would give a few Washington bureaucrats something to do, I suppose. We keep our cars for 14 years on average. If everyone purchased a hybrid when their old car went kaput, the fleet would not turnover be all hybrid until until I think you may be a sock puppet. Be careful not to analyze and criticize the sources yourself in the article. Also, please let nobody call anybody a sock puppet without evidence, as an unwarranted accusation of sockpuppetry is a personal attack. Flores is right, the article is original research. The assertions in the book are simply restated here without citations or supporting arguments. None of these arguments were peer reviewed in journals. The book itself is from a point-of-view publisher rather than an academic press. Then the creator of this article, who knows the book author very well, he says, has allowed no one else to make substantive edits. It is not relevant whether you disagree with the book. The article, however, can be compared against Wikipedia policies. When we talk about original research, we are referring to wikipedia content policies, in particular verifiability and no original research. I believe our earlier comments say this. There are two ways to view this: If the former, then it needs citations. I do not believe it does, since the criteria call for sources to be either peer reviewed or, if books, published by an academic press, which Island Press is not. In short, these are all going to need citations. I invite everyone to comment on how to proceed. However, the book is the subject of the article, not its source, so it cannot be subject to Wikipedia source-related policies like you just said. If the article employs citations from the book, they should of course be marked as such "The book claims that Based on both of the above, the article should consist on an intro with author, publishing etc. Please go ahead and make the edits that you describe. I dare not touch the article or PotomacFever will get me. If I took out too much, feel free to restore what you feel necessary. Want to do the referencing on all my other articles? Other than that, looks great! I notice the image page specifies that the image is being used under fair use but there is no explanation or rationale as to why its use in this Wikipedia article constitutes fair use. In addition to the boilerplate fair use template , you must also write out on the image description page a specific explanation or rationale for why using this image in each article is consistent with fair use. Please go to the image description page and edit it to include a fair use rationale. Using one of the templates at Wikipedia: Fair use rationale guideline is an easy way to insure that your image is in compliance with Wikipedia policy, but remember that you must complete the template. Do not simply insert a blank template on an image page.

Chapter 3 : The Hype about Hydrogen | Revolvy

Natural gas (methane, or CH 4) is the source of 95 percent of U.S. racedaydvl.com overall energy efficiency of the steam CH 4 reforming process (the ratio of the energy in the hydrogen output to the energy in the natural gas fuel input) is about 70 percent.

Sustainable Energy Hype about Hydrogen For all the buzz about future highways filled with hydrogen-powered fuel-cell cars, the technological-and environmental-high ground will belong to gasoline-electric hybrids for decades to come. Romm March 17, Hydrogen and fuel-cell cars are being mightily promoted. Department of Energy has made them the central focus of its clean energy efforts. Yet for all this hype, hydrogen cars are likely to remain inferior to the best gasoline-electric hybrid vehicles such as the Toyota Prius in virtually every respect-cost, range, annual fueling bill, convenience, safety-through at least The Prius will even have lower overall emissions of many pollutants than cars running on the hydrogen that is likely to be available at fueling stations for the foreseeable future. And a premature push toward hydrogen cars would undermine efforts to reduce the heat-trapping carbon dioxide emissions that cause global climate change. In addition, the nation will have to shift its energy policy dramatically toward renewable energy sources such as wind and solar. I am a strong proponent of hydrogen as a possible fuel for the future. I believe that continued research into hydrogen remains important because of its potential to provide a pollution-free substitute for oil post As Peter Flynn, an engineering professor at the University of Alberta, concluded in a study of the effort to commercialize natural gas vehicles: This goal rests on two pillars: Hydrogen is not a readily accessible energy source like coal or wind. It is bound up tightly in molecules like water H20 and natural gas primarily composed of methane, or CH4 so it is expensive and energy-intensive to extract and purify. More than 95 percent of U. Yet delivering hydrogen from natural gas to the tank of a fuel-cell car in usable form costs four times as much as gasoline with an equivalent amount of energy. Hydrogen from pollution-free sources, such as renewables, is even more expensive. Fuel cells are small, modular, electrochemical devices, similar to batteries, but which can be continuously fueled. The technical challenges are enormous. In September , a U. Department of Energy panel on basic research needs for the hydrogen economy, chaired by MIT professor of physics and electrical engineering Mildred Dresselhaus, reported that transportation fuel cells are times more expensive than internal combustion engines. The most mature hydrogen storage systems-using ultrahigh pressure-contain seven to 10 times less energy per unit volume than gasoline, and require a significant amount of compression energy. Major advances would also be required in hydrogen infrastructure and safety. Alternative fuel vehicles AFVs are a greater challenge, because they must overcome a trillion-dollar investment in the gasoline fueling infrastructure. Two major efforts to commercialize AFVs in the past two decades-electric vehicles and natural gas vehicles-both failed, even though electricity and natural gas are widely available and inexpensive. Hydrogen, by contrast, is hardly available anywhere and is relatively expensive. Our cars and our fueling infrastructure are designed around liquid fuels, which have high energy densities and are easier to handle than diffuse gases like hydrogen. Based on my discussions with experts around the country, I think it unlikely that hydrogen cars will achieve even a five percent market share by But in fact, hydrogen is no greener than the energy sources used to produce it. Yet, given the constraints on the North American gas supply, we would just be trading imported gas for imported oil. The best new hybrids have sharply reduced their fuel consumption and hence greenhouse gas emissions. The least expensive hydrogen, however, is dirty. Equally important, such a strategy would divert natural gas from a variety of better uses. A coal-fired generator releases more than 1, kilograms of carbon dioxide into the air for each megawatt-hour of electricity it produces. The best gas-fired plants, by contrast, release only about kilograms of carbon dioxide per megawatt-hour generated. Similarly, one megawatt-hour of electricity from renewables, if used to make hydrogen for a fuel-cell vehicle, would save around kilograms of carbon dioxide compared to a Prius running on gasoline. That is some kilograms less than the savings from displacing coal power-and these savings can be achieved without spending hundreds of billions of dollars on fuel-cell vehicles and hydrogen infrastructure. This means that hydrogen cars will have no real value as a

global warming strategy until after While hydrogen vehicles might have limited value replacing fleets powered by diesels engines in very polluted cities before , fuel-cell cars are unlikely to achieve mass-market success by then. Neither government policy nor business investment should be based on the belief that hydrogen cars will have meaningful commercial success in the near or medium term. Romm was acting assistant secretary of energy for energy efficiency and renewable energy during the Clinton administration. This article is based on material from his book The Hype about Hydrogen: For more information about the book, go to www. Be the leader your company needs. Join us at EmTech Digital

Chapter 4 : The Hype about Hydrogen : Fact and Fiction in the Race to Save the Climate | eBay

Offering an explanation of hydrogen and fuel cell technologies, this book takes a hard look at the practical difficulties of transitioning to a hydrogen economy. It provides a provocative primer on the politics, business, and technology of hydrogen and climate protection.

Chapter 5 : The Hype About Hydrogen: Fact and Fiction in the Race to Save the Climate by Joseph J. Rom

Hydrogen cracking in ferritic steels only occurs when a critical combination of the four basic factors involved is exceeded. These factors are: Hydrogen content, susceptible microstructure, stress, and; temperature. Atomic Hydrogen. First off, let me start with an explanation of the term "hydrogen." When we think of hydrogen, we think of molecular H2.

Chapter 6 : Talk:The Hype about Hydrogen - Wikipedia

The Hype about Hydrogen: Fact and Fiction in the Race to Save the Climate is a book by Joseph J. Romm, published in by Island Press and updated in

Chapter 7 : Hype about Hydrogen - MIT Technology Review

In his State of the Union address, President Bush seized the nation's attention with his advocacy of a "hydrogen economy," with fuel cells that produce energy and water taking the place of.

Chapter 8 : The Hype about Hydrogen - Wikipedia

Hydrogen as a fuel in fuel cell vehicles are all hype and neve going to be a viable solution without massive, massive investment in hydrogen infrastructure.