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Effects Of Greenhouse & Global Warming On Environment And Uses The Hydrogen As An Alternative Fuel

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Abstract:

The paper considers the greenhouse effect and global warming and discusses the development of hydrogen as alternative fuels.

"Over the past ten years or so, the world and the public have increased their awareness of the problems associated with global warming, caused by such as "greenhouse effect" in which carbon dioxide, the byproduct of burning fossil fuels like coal and oil, prevents the earth from increasing the temperature the presence of CO2 in the atmosphere. Within recent times, many scientists have concluded that this "greenhouse effect" is heating up the planet to the point where ice caps and glaciers in Antarctica and the North Pole are melting at uncontrolled rates, thus making it feasible by controlled the melting water. In the future, causing huge numbers of people found higher ground."

Key words: *Fossil-fuels, Carbon-dioxide, Hydrogen.*

1.Introduction

Between 2002 and 2006, the U.S. and European Union devoted $1.8 billion to hydrogen fuel cell research. Leaders in the U.S. government and other countries around the world believe that hydrogen will eventually replace petroleum as the fuel that powers cars and reduce the environmental impact of burning fossil fuels.

A 2002 future energy "road map" called for 90 percent of hydrogen to come from fossil fuels. This means that current hydrogen production still contributes carbon pollution to the atmosphere.

As of 2006, about half of the entire world's carbon pollution comes from cars and other modes of transportation, according to the U.S. Environmental Protection Agency. Eliminating most of this would help stop global temperatures from increasing.

Hydrogen can be "packaged" in several ways, as a fuel gas in a H2/02 powered engine or the newly devised solid state pellet of hydrogen isotopes that contains about the equivalent of 5000 cubic. Feet of hydrogen and is broken down and releases gas into the second chamber where it goes to the engine for use. There are many ways to get pure hydrogen out of many compounds using methods such as electrolysis and chemical reactions. One of the easiest ways is using a chemical reaction. Simple chemicals (aluminum, sodium hydroxide, and water) can be reacted in the home to produce heavy hydrogen to power your furnace or your hot water heater. No electrical power at all is required.[1] The reaction also gives off a tremendous amount of heat. Even the waste heat could be captured for heating the house. The resulting sodium aluminates are harmless and could be collected at recoiling centers for complete acid/base neutralization. This way is a simpler way than electrolysis produce hydrogen for heating the home, because in a automobile it would be harder to do.

2.What Is Greenhouse Effect

In order to understand greenhouse effect, firstly we need to understand that "infrared radiation"

The main source of life of earth is depending upon the sun. About 30% of sun light that come from the sun is reflected by the outer atmosphere and scattered back into space. And remaining reached to the plant’s surface and is reflected upward again as a type of slow-moving energy called infrared radiation.

The heat caused by infrared radiation is absorbed by "greenhouse gases" such as water vapor, carbon dioxide, ozone and methane, which slows its escape from the atmosphere. Although greenhouse gases make up only about 1 percent of the Earth's atmosphere, they regulate our climate by trapping heat and holding it in a kind of warm-air blanket that surrounds the planet.

This phenomenon is what scientists call the "greenhouse effect." Without it, scientists estimate that the average temperature on Earth would be colder by approximately 30 degrees Celsius (54 degrees Fahrenheit), far too cold to sustain our current ecosystem.

It is the carbon dioxide concentration that is increasing, due to the burning of fossil fuels. This is the man-made portion of the greenhouse effect, and it is believed by many scientists to be responsible for the global warming of the last 150 years.

3.How Do Humans Contribute To The Greenhouse Effect?

We know that greenhouse effect is an essential environmental prerequisite for long life of Earth, there really can be too much of a good thing.

The problems begin when human activities distort and accelerate the natural process by creating more greenhouse gases in the atmosphere than are necessary to warm the planet to an ideal temperature.

- Burning natural gas, coal and oil -including gasoline for automobile engines- raises the level of carbon dioxide in the atmosphere.
- Some farming practices and land-use changes increase the levels of methane and nitrous oxide.
- Many factories produce long-lasting industrial gases that do not occur naturally, yet contribute significantly to the enhanced greenhouse effect and "global warming" that is currently under way.
- Deforestation also contributes to global warming. Trees use carbon dioxide and give off oxygen in its place, which helps to create the optimal balance of gases in the atmosphere. As more forests are logged for timber or cut down to make way for farming, however, there are fewer trees to perform this critical function.

Population growth is another factor in global warming, because as more people use fossil fuels for heat, transportation and manufacturing the level of greenhouse gases continues to increase. As more farming occurs to feed millions of new people, more greenhouse gases enter the atmosphere.

4.What Is Global Warming?

The U.S. Environmental Protection Agency definition of global warming:
"Global warming is an average increase in the temperature of the atmosphere near the Earth's surface and in the troposphere, which can contribute to changes in global climate patterns. Global warming can occur from a variety of causes, both natural and human induced. In common usage, "global warming" often refers to the warming that can occur as a result of increased emissions of greenhouse.
In general way we can say that" Global warming is when the earth the temperature rises up. It happens when greenhouse gases (carbon dioxide, water vapor, nitrous oxide, and methane) trap heat and light from the sun in the earth's atmosphere, which increases the temperature. This hurts many people, animals, and plants. Many cannot take the change, so they die."

5.What Is Global Warming Doing To The Environment?

Due to the Global warming makes the sea rise, and when the sea rises up, and then the water covers many low land islands completely. That is a main problem for many of the plants, animals, and people on islands which are lived. The water covers the plants and causes some of them to die. When plants die, the sources of food for animals are destroy, along with their habitat. Although animals have a better ability to adapt to what happens than plants do, they may die also. When the plants and animals die, people lose two sources of food, plant food and animal food. They may also lose their homes. As a result, they would also have to leave the area or die. This would be called a break in the food chain, or a chain reaction, one thing happening that leads to another and so on. Its means that Entire world is effected by global warming.
Global warming is also affected the ocean in many ways. Anything which are happening in the inside the ocean are linked to global warming. One thing that is happening is warm water, caused from global warming, is harming and killing algae in the ocean. Algae are a producer that you can see floating on the top of the water. These floating green algae are food to many consumers in the ocean. (A consumer is something that eats the producers) One kind of a consumer is small fish. There are many others like

crabs, some whales, and many other animals. Fewer algae are a problem because there is less food for us and many animals in the sea.

Global warming is doing many things to people as well as animals and plants. It is killing algae, but it is also destroying many huge forests. The pollution that causes global warming is linked to acid rain. Acid rain gradually destroys almost everything it touches. Global warming is also causing many more fires that wipe out whole forests. This happens because global warming can make the earth very hot. In forests, some plants and trees leaves can be so dry that they catch on fire.

6.What Cause The Global Warming?

Global warming is caused by many things. One thing that causes global warming is electrical pollution. Electricity causes pollution in many ways. In most cases, electricity is also produced by burning the fossil fuel. Fossil fuels are made of dead plants and animals. Some examples of fossil fuels are oil and petroleum.

- Turning on a light
- Watching TV.
- Listening to a stereo
- Washing and drying cloths
- Using a hair dryer
- Riding in a Car

7.What Are People Doing To Stop Global Warming?

People are doing many things to try to stop global warming. One thing people are doing is carpooling. Carpooling is driving with someone to a place that you are both going to. This minimizes the amount of greenhouse gases put into the air by a car.

Another thing that people are doing is being more careful about leaving things turned on like the television, computer, and the lights. A lot of people are taking time away from the television, and instead, they are spending more time outdoors. This helps our planet out a lot. Now, more people are even riding busses, walking to school, and riding their bikes to lower the amount of greenhouse gases in the air. Planting trees and recycling also helps. If you recycle, less trash goes to the dump, and less trash gets burned. As a result, there are fewer greenhouse gasses in our atmosphere.

Watch what you buy. Many things, such as hairspray and deodorant, now are made to have less of an impact on the atmosphere. Less greenhouse gasses will rise into the air, and global warming will slow down.

8.The Hydrogen As An Alternative Fuel

Hydrogen is the ideal alternative fuel for Army after Next (AAN) platforms. However, while hydrogen offers many benefits, there are two drawbacks to using it as a fuel with current technology. Liquid hydrogen, the preferred form of hydrogen, requires four times the storage space of conventional petroleum-based fuels. The other problem is that hydrogen production depends on the availability of a nonrenewable resource, petroleum. Currently, hydrogen is produced from raw petroleum for industrial use, but petroleum supplies may become limited in the near future. Liquid hydrogen is the best alternative fuel for AAN platforms; however, further research is needed to move the hydrogen fuel technologies from prototypes to usable military hardware and to optimize power outputs from internal combustion engines (Ice’s), gas turbine engines, and fuel cells. Petroleum production is expected to decrease significantly by 2025, the year that AAN concepts and force structures are scheduled to be operational. Current oil production is 25 billion barrels of oil per year; by 2025, annual oil production most likely will be between 18 and 19 billion barrels—less than the annual production during the oil shortages of the 1970's. The predicted decrease, as well as possible interruption of imported oil due to political instability in the Middle East, will result in increased petroleum prices. On the other hand, high speed and high mobility will characterize the AAN battle force, and speed and mobility mean high fuel consumption. The 1998 AAN Annual Report states, "An absolute imperative exists to develop alternative fuels (no fossil) . . . for AAN-era forces." The report goes on to say that there are numerous alternatives to fossil fuels but does not specify what those fuels are. In the January-February 1999 issue of Army Logistician, Lieutenant Colonel Allen Forte recommends " new systems [ought] to examine alternatives to fossil fuels as their first option for a power source." Other writers have recommended that AAN planners develop hydrogen as the fuel for AAN platforms; one unequivocally states, "The development of hydrogen-based vehicles is a national imperative." [2-3]

9.Technical Aspects of Hydrogen Energy

9.1.Hydrogen Production

Although hydrogen is the universe's most abundant element, it is present in the atmosphere only in concentrations of less than one part per million. Most of the Earth's hydrogen is bound up in chemical compounds. Hydrogen for large-scale use should therefore be extracted from a source such as water, coal, natural gas, or plant matter. It cannot simply be produced from a mine or a well. Since considerable energy is consumed in the extraction process, hydrogen should properly be considered an energy carrier rather than an energy source; the energy released when it is finally used is just the energy that was invested in its original manufacture (minus any losses). Recognizing this fact is of critical importance. Any analysis of how hydrogen is to be used must also consider how the hydrogen is to be produced. A variety of alternative hydrogen energy production technologies is available in practice, including [1,20]:

- Steam reforming: Steam reforming is a chemical process that makes hydrogen from a mixture of water and a hydrocarbon feedstock, usually a fossil fuel. The most common feedstock is natural gas, consisting primarily of methane. When steam and methane are combined at high pressure and temperature, a chemical reaction converts them into hydrogen and carbon dioxide. The energy content of the hydrogen produced is actually higher than that of the natural gas consumed, but considerable energy is required to operate the reformer, so the net conversion efficiency may typically be only about 65-70%. Hydrogen produced by this technique may cost as little as 65¢/kg.
- Off-gas cleanup: After steam reforming, the next most common source of hydrogen at present is the cleanup of industrial off-gases. Numerous industries give off high concentrations of hydrogen in their waste streams

Petroleum refineries, blast furnaces, and some chemical plants, for example. Collecting and purifying these gases is often cost-effective, with costs typically

Ranging between 80 and 120 ¢/kg. Most off-gas hydrogen is used on-site by the industry that produces it, so although off-gas cleanup is an important feature of today's market, it seems unlikely that it could be expanded enough to meet the increased demand that would result from widespread use of hydrogen as a fuel.

- Electrolysis: Electrolysis means passing an electrical current through water to split individual water molecules into their constituent hydrogen and oxygen. Energy losses during this process are relatively modest:

65% energy efficiency is common, and state-of-the-art large electrolyzes can be 80 to 85% efficient. Electrolysis has captured considerable attention, even though it accounts for only a small fraction of current hydrogen production, because it is a clean process and water is abundant. At present, however, the technique is only used at relatively small plants, with a cost of 2.40-3.60 $/kg of hydrogen produced. This high cost is expected to limit electrolysis to niche markets in the near and mid term. In the long term, could electrolysis become more competitive? At present, natural gas reforming is more than three times more energy efficient than electrolysis if fossil-source electricity is used.

- Photo process: Photo processes use the energy and other special properties of light (usually sunlight) to produce hydrogen from either water or biomass. There are three broad categories of photo process. Photo biological techniques are based on the photosynthesis cycle used by plants and by some bacteria and algae. The efficiency of photo biological hydrogen production is only 1 to 5%, but researchers hope to increase it to 10% or more. Photochemical processes mimic natural photosynthesis using synthetic molecules. This technique is only about 0.1% efficient now, but it can be improved. Photo electrochemical techniques use layers of semiconductor material separated by water. When exposed to light, the semiconductor layers produce an electrical voltage that splits the water into hydrogen and oxygen. The best prototypes yet demonstrated in the laboratory are about 13% efficient, but the maximum theoretical efficiency is believed to be more than 35%. It has been estimated that efficiency in the field of 10 to 15% may be economical, but such estimates depend strongly on projections of equipment costs. Note that since all these photo processes use light as their primary energy source, their efficiencies should not be used directly in cost comparisons with processes that use hydrocarbon fuels or electricity. Photo processes are a major component of current hydrogen research programs.

- Thermo chemical process: This process uses heat to split water into hydrogen and oxygen. The conceptually simplest version of this technique is direct thermal conversion, i.e. heating water to extreme temperatures, perhaps 3400 K. Because of the high temperatures required, however, direct thermal conversion is yet impractical outside the laboratory. Chemical reactions can be employed to reduce the required temperature.[4]

Various alternatives have been studied, often involving complex multistep processes. Hybrid techniques that incorporate electrolysis into one or more of the reaction steps are under investigation. There has been little recent work available on thermo chemical techniques.

- Radiolysis: This process is the splitting of water molecules by collisions with high-energy particles produced in a nuclear reactor. Since the hydrogen and oxygen atoms thus produced quickly recombine to produce water again, radiolysis would probably be only about 1% efficient. Most experts agree that radiolysis is less promising than other techniques.
- Solar hydrogen: In this original and simplest form of hydrogen energy production, the solar hydrogen scenario envisions producing electricity from sunlight using photovoltaic cells, electrolyzing water to produce hydrogen, and substituting this hydrogen for the oil and other fossil fuels in general use today. The term is now often used more broadly to include electrolysis based on other renewable sources of electricity, such as wind. This idea has received considerable attention largely because of the environmental benefits of using hydrogen instead of fossil fuels. It also addresses two barriers to the ultimate achievement of large-scale use of solar energy: that solar electricity cannot be used directly for non-electric applications, such as combustion engines, and that electricity is difficult and expensive to store.
- Partial oxidation of hydrocarbons: Hydrogen may be formed from the no catalytic partial oxidation (i.e., gasification) of hydrocarbons such as residual oil. Any hydrocarbon feedstock that can be compressed or pumped may be used in this technology. However, the overall efficiency of the process is about 50% and pure oxygen is required. Two commercial technologies for this conversion are available: the Texaco gasification process and the Shell gasification process.

There are also some other hydrogen production technologies, such as:

- Thermal decomposition of hydrocarbon fuels
- Thermo catalytic CO_2-free production of hydrogen from hydrocarbon fuels
- Super adiabatic decomposition of hydrogen sulfide
- Auto thermal reforming (combining partial oxidation and steam reforming)
- Sorption Enhanced Reaction Process (SERP)
- Production of hydrogen from biomass-derived liquids
- Photo electrochemical hydrogen production
- Biological H_2 from fuel gases and from H_2O
- Two-phase photo biological algal H_2-production

system

- H_2 Production from Glucose-6-Phosphate
- Most of the above listed methods are under heavy

investigation for implementation and commercialization. The findings show that there is still much to do for achieving those.

9.2. Hydrogen Storage

9.2.1. Bulk Storage In Distribution System

It is expected that any large-scale hydrogen distribution system should address the problem of bulk storage, to provide a buffer between production facilities and fluctuations in demand. Low-cost and efficient bulk storage techniques are a major research goal. One can store hydrogen as either gas or a liquid. The most widely studied options for storing gaseous hydrogen are underground caverns and depleted underground natural gas formations. Although hydrogen is more prone to leak than most other gases, leakage is shown not to be a problem for these techniques. For example, town gas mixture containing hydrogen) has been stored successfully in a cavern in France, and helium, which is even more leak- prone than hydrogen, has been stored in a depleted natural gas field near Amarillo, Texas. The energy consumed in pumping gas in and out of such storage facilities may be significant, however. Aboveground storage tanks at high pressure are another option.

A certain amount of gaseous storage can be achieved by allowing modest pressure changes in the distribution pipeline system. In the case of natural gas, this technique is used to help manage transient demand fluctuations, such as the morning and evening peaks in residential demand in urban areas. Though the same technique might be useful for hydrogen, its potential is limited, particularly if the hydrogen is to be produced from intermittent sources such as solar or wind.

Storage in liquid form uses tanks similar to those used for liquid hydrogen distribution. For example, Kennedy Space Center uses a 3217 m^3 sphere near the launch pad, and can transfer fuel from this tank to the space shuttle at up to 38 m^3 per minute. Storage at liquefier plants is in vacuum-insulated spherical tanks that usually hold about 1514 m^3[20]. The energy required for liquefaction may not be a barrier if the hydrogen is to be transported as a liquid anyway, or if the end-use application requires its fuel to be in liquid form.

9.2.2. Hydrogen Storage in End Use

- The difficulty of onboard storage is the main barrier to fueling vehicles with hydrogen. Because it is a gas, hydrogen at room temperature and pressure takes up about 3,000 times more space than an energy- equivalent amount of gasoline. This obviously means that compression, liquefaction, or some other technique is essential for a practical vehicle. So far, storage requirements tend to limit range severely. During the past two decades, several techniques were examined to overcome this problem. The four main contenders are compressed gas, cryogenic liquid, metal hydride, and carbon adsorption. Of these, the first two appear most promising for the short-term. Metal hydrides are also relatively mature, but require further research to be competitive. Carbon adsorption is not yet a mature technique, but it appears very promising if the research goals may be met. Glass micro spheres and onboard partial oxidation reactors are currently under investigation, but as yet are "insufficiently characterized for evaluation at the systems level." It is likely that different techniques will turn out to be most appropriate for different applications, for example buses are less size-sensitive than cars [20].
- Compressed gaseous hydrogen storage is at room temperature in a high-strength pressure tank. Including the weight of the tank, compressed gas storage holds about 1 to 7% hydrogen by weight, depending on the type of tank used. Lighter, stronger tanks, capable of holding more hydrogen with less weight, are more expensive. Compressing the hydrogen gas at the filling station requires about 20% as much energy as is contained in the fuel.
- Cryogenic liquid storage is at 20K in a heavily insulated tank at ordinary atmospheric pressure. As a liquid, hydrogen contains almost three times more energy than an equal weight of gasoline, and takes up only about 2.7 times as much space for an equal energy content. Including the tank and insulation, this technique can hold as much as 16% hydrogen by weight. Furthermore, liquefaction at the filling station requires about 40% as much energy as is contained in the fuel. Another disadvantage is the so-called "dormancy problem": despite the insulation, some heat leaks into the tank, eventually boiling off the hydrogen. A "cry pressure" system stores liquid hydrogen in a pressure vessel like that used for compressed gaseous storage, allowing containment of the boiled-off gas. This helps with dormancy, but increases weight and size.
- Metal hydride systems store hydrogen in the integrator spaces of a granular metal.

Various metals can be used. The hydrogen is released by heating. Metal hydride systems are reliable and compact, but can be heavy and expensive. Varieties now under development can store about 7% hydrogen by weight. Unlike the compressed gas and cryogenic liquid techniques, metal hydrides require little or no "overhead" energy when refueling. They do require energy to release the fuel, however.

For low-temperature varieties, this energy may be available as waste heat from the fuel cell or engine. For high-temperature varieties, which tend to be the less expensive ones, as much as half of the vehicle's energy consumption may go to releasing the fuel from the metal.

- The carbon adsorption technique stores hydrogen under pressure on the surface of highly porous super activated graphite. Some varieties are cooled; others are operated at room temperature. Current systems store as much as 4% hydrogen by weight. It is hoped to increase this efficiency to about 8%, even for the room temperature variety. Carbon adsorption is very similar to compressed gas storage except that the pressure tank is filled with graphite; the graphite adds some weight but allows more hydrogen to be stored at the same pressure and tank size.
- Glass micro spheres are small, hollow, glass micro- balloons whose diameters vary from about 25 microns to 500 microns, and whose wall thicknesses are about 1 micron. They can be used in large beds to store hydrogen at high pressures. The micro spheres are filled with hydrogen gas at temperatures of 200 to 400°C. The high temperature makes the glass walls permeable, and the gas fills the spheres. Once the glass is cooled to room temperature, the hydrogen is trapped inside the spheres. The hydrogen can be released as needed by heating the spheres. The spheres may also be crushed to release hydrogen. This option precludes sphere recycling, but is desirable for applications where weight is important.
- Onboard partial oxidation reactor is a concept proposed to help bring about a transition from conventional automobiles to cars powered by hydrogen fuel cells. First, a shift would be made from the internal combustion engine to the fuel cell using a conventional hydrocarbon fuel such as gasoline or diesel coupled to an onboard partial oxidation process and a water gas shift reaction process. The partial oxidation process yields 30% hydrogen gas directly and 20% carbon monoxide. Then, the carbon monoxide is chemically reacted with steam to produce additional hydrogen and carbon dioxide gas, which is readily usable by a hydrogen fuel cell. This fossil-to-hydrogen fuel system would be used as a "bridge" until research yields a commercially ready advanced

hydrogen storage system or a suitable hydrogen carrier.

- Other techniques are still in the early stages of development. One uses powdered iron and water. At high temperatures, these react to produce rust and hydrogen. Other methods are similar to the metal hydride option, but substitute certain liquid hydrocarbons (also known as "recyclable liquid carriers") or other chemicals for the metal.[5-6]

9.3. Hydrogen Safety

Hydrogen is intrinsically no more dangerous than many other fuels. Its different characteristics require different safety equipment and procedures, but all fuels have some potential for accidents; if they did not burn, they would not be much use as a fuel. Hydrogen is used worldwide in the petroleum and chemical industries and elsewhere. It was also routinely used in the USA as a fuel (a component of "town gas") before natural gas became widely available. Town gas is still used in some countries. Moreover, hydrogen ranks between propane and methane (natural gas) in safety.

The physical properties of hydrogen make its safety characteristics rather different from those of other fuels. Its low density means that it tends to rise and disperse into the atmosphere in the event of a leak, rather than remaining in a "puddle" near the ground. This increases safety in well- ventilated applications. Its low density also means that a hydrogen explosion releases less energy in a given volume than an explosion of other fuels, and compared to gasoline or natural gas, hydrogen requires much higher concentrations in the air to produce an explosion rather than just a flame. Furthermore, hydrogen's low ignition temperature and flammability over a wide range of concentrations make leaks a significant fire hazard, especially in confined spaces such as a garage. Because it is clear and odorless, leaking hydrogen is more likely to go undetected than a leak of gasoline or most other fuels. Even the flame of burning hydrogen is invisible. Techniques of leak detection have been and continue to be a research priority. A simple approach is to add an odorant like that added to natural gas, or possibly a colorant, or both. Any addition may detract somewhat from the environmental cleanliness inherent to pure hydrogen, however, and additives would need to be chosen with care to avoid destroying other important features. For example, contaminants may reduce the efficiency and/or lifetime of a fuel cell.

As with most fuels, the fire and explosion hazards discussed above are the main safety concerns. In some situations, there may be other safety issues, such as, in applications that involve hydrogen storage under high pressure or at extreme low temperatures. These problems can be minimized with proper equipment design and operating procedures, however, and are generally agreed to be of less concern than hydrogen's flammability.

9.4. Economics Of Hydrogen

Hydrogen is currently more expensive than other fuel options, so it is likely to play a major role in the economy only in the long term, if technology improvements succeed in bringing down costs. Higher prices for fossil fuels would not necessarily make hydrogen more cost- competitive in the short term. Since fossil fuels are currently the main source of heat, feedstock, and electricity for hydrogen production plants, rising prices for gas, oil, or coal would also drive up the price of hydrogen. Since hydrogen is produced in many different ways, from many different sources, most hydrogen-related international commerce is likely to be not of fuel but of technology: plant components, engineering services, construction expertise, and so on. These areas could potentially represent new export markets.

9.5. Environmental Aspects Of Hydrogen Energy

The use of hydrogen as a fuel is inherently very clean. Hydrogen consumed by either combustion or a fuel cell produces only water as a product. The high temperatures involved in combustion may stimulate some NOx production from nitrogen and oxygen in the air, but this problem is familiar from other fuels and can be controlled. Unlike other fuels, hydrogen contains no other pollutant- producing elements, so it has no potential to produce SO_2, CO, CO_2, volatile organic chemicals, etc. The environmental consequences of hydrogen production should also be considered, however. As mentioned above, production from fossil fuel feed stocks by steam reforming leads to carbon dioxide emissions greater than production from feedstock by itself.. Steam reformers should also somehow dispose of feedstock impurities such as sulfur. Electrolysis is responsible for the emissions of whatever power plants are used to generate the needed electricity. Production of hydrogen from sustainable harvested biomass, solar energy, or other renewable sources might considerably reduce production emissions, but (as described above) such techniques are being fully developed for commercialization. For example, the U.S. Department of Energy (has examined the full-cycle environmental effects of various scenarios for hydrogen production and use. It concludes, "Substantial emissions can be generated when hydrogen is produced from certain energy sources," namely fossil fuels. Thus, the technique of hydrogen production remains crucial.

9.6. Standards And Regulations

Countries have different regulations for hydrogen energy and these regulations are still under development. Area of regulation may include but not limited to commercial truck, bus, passenger plane, pipeline, tunnel, portable fuel container, stationary fuel cell, safety training for operators, and fueling station.

It is obvious that some key, harmonized regulations, codes, and standards are necessary in this regard. Worsted [21] has given the published and draft standards for hydrogen and fuel cells. Some published standards are currently available as follows:

- ISO 13984 Liquid hydrogen – Land vehicle fuelling system interface
- ISO 14687 Hydrogen fuel – Product specification

9.7. Publications And Patents

- Financial and fiscal incentive schemes: The government can give awards for the outstanding and successful projects. Tax incentives, such as depreciation allowance might encourage investments in some new equipment.

The main concern of the industry switching to hydrogen economy may be given as follows:

- The top managers resist investing in new technology because they want to acquire large profits in the short term.
- Some managers think that investing largely in new technology might lead to higher selling prices of their products. Hence, their competitiveness in the market will decrease.
- Others may have lack of knowledge about this new technology or they do not know how to implement it systematically.

9.8. Scientific And Technical Challenges

The scientific and technical challenges for the hydrogen economy may be given as follows [23]:

- Lowering the cost of hydrogen production to a level comparable to the energy cost of petrol.

- Development of a CO_2-free route for the mass production of sustainable hydrogen at a competitive cost Improvement in the durability of fuel cell systems.

The pathway for the transition from current energy economies to hydrogen economy has some scientific,

9.9. Influence of Government and Industry

Two parties may influence the implementation of energy conservation problem. These are hydrogen and fuel cell technologies at the industrial sector, namely the government and the top managers of the industrial organizations. The most important measures that a government can take to implement energy conservation include [22]:

- Pricing policy: In the short term, energy prices influence the way of use of existing equipment and in the long-term energy prices effect the choice of equipment.
- Regulation and legislation: The government can enact a Heat Management Law. For such a law, the companies using more than a certain amount of oil equivalent must submit an annual plan for energy conservation and must employ a manager to monitor its execution for such a plan.
- Publicity campaigns: Government can hold seminars, training workshops for the qualified workers including managers, engineers, and technicians of different companies.[7]

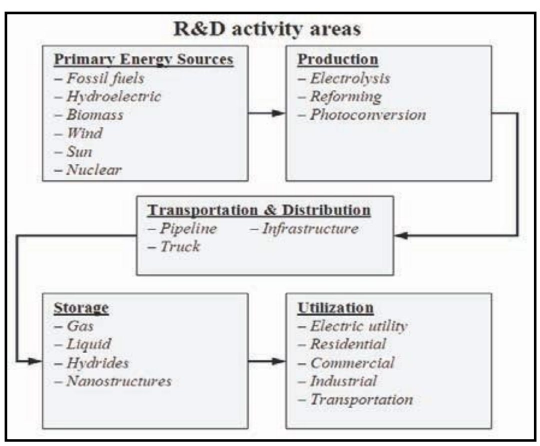

Figure 1

Major R&D activity areas for the pathway to hydrogen economy [31]

It should be noted that universities play an important role in providing the sustainable development of hydrogen and fuel cells through some partnership programs with the relevant industry and government organizations. The output of research conducted in universities is open to other researchers. Hence, being aware of the previous studies and getting benefit of them, new methodologies are developed for better design, analysis, and operation of these technologies. Some challenges to the universities in this issue may be summarized as follows:

- funding challenges,
- coordination of research efforts within and between academic/research institutions, and
- Collaboration between researchers and governmental institutions.

9.10. Priorities That Jordan Should Consider

Jordan has limited energy sources such as oil shale deposits, tar sands, a small hydropower potential, a few low geothermal sources, and biogas [24]. It is mainly dependent on imported oil from neighboring countries to cover main portion of its energy demand. In year 2000, 94% of total energy requirement was supplied from imported oil [22]. The major sector of energy consumption is transportation, which is around 41%. Industrial sector, household, and others, which include service and agricultural sectors, follow it, respectively.

Since the oil reserves deplete in the world, alternative energy sources are required to provide the energy need of the world. In the case of Jordan, the transition to the new energy forms should be accelerated since this country is highly dependent on import oil. The priority should be given to the alternative energy sources that could be used in transportation sector since it has the biggest share among the different sectors. For this purpose, renewable energy such as befoul or hydrogen to be used in fuel cells may be considered. Since the main objective of this paper is to discuss hydrogen and fuel cell technologies, the latter one is discussed below.

For vehicle applications, fuel cells are not only preferable since they use hydrogen as fuel but also they have higher efficiency than internal combustion engines (ICEs), which is not restricted with Carnot efficiency; quieter than ICEs; and reduce environmental pollution. Among different types of fuel cells, Proton Exchange Membrane Fuel Cells (PEMFC), also known as Polymer Electrolyte Membrane Fuel Cells has proven to be the most attractive option. This type of fuel cell consists of a proton conducting membrane, such as Nation, which is chemically highly resistant, mechanically strong, acidic, good proton conductor and water absorbent. Main advantages of this fuel cell may be given as:

Fast startup capability since it works at low temperatures, compact since thin Membrane Electrode Assemblies (MEAs) can be made, and no corrosive fluid hazards because the only liquid present in the cell is water. The main disadvantage of this type of fuel cell is the need for expensive catalysts as promoters for the electrochemical reaction. Additionally, carbon monoxide cannot be used as a fuel since it poisons the cell. On the other hand, the main challenge for PEMFC is the water management, which may be summarized as follows: The proton conductivity of the electrolyte is directly proportional to the water content and high enough water content is necessary to avoid membrane dehydration. Contrarily, low enough water should be present in the electrolyte to avoid flooding the electrodes. Hence, a balance between the production of water by oxidation of the hydrogen and its evaporation has to be controlled.

PEMFCs may conquer the market of structured mobility (city buses, postal services, taxis, city cars etc.) where hydrogen can be supplied to the vehicles from central tanks at scheduled intervals. Nevertheless, they may not succeed in the much broader market sector of random mobility (private cars, trucks, tour busses, military vehicles etc.). Some claim that for that market the SOFC is more attractive. These fuel cells may operate between 600°C and 1000°C, respectively. The most common material used for electrolyte is yttrium-stabilized zirconium. The main advantages of this fuel cell are as follows: its fuel flexibility, which means fuel such as methane, propane, butane, JP-8, may be used as fuel, direct reforming at the anode catalyst, and no need for precious metal electro catalysts. The main disadvantage of this fuel cell may be given as the challenges for construction and durability due to its high temperature. Additionally, carbon deposition may be a problem.

In conclusion, the priority for Jordan should be considering fuel cells for transportation applications since it covers the biggest portion among the sectors. Among different fuel cell types, PEMFCs and SOFCs are the most promising ones for this sector.[8-9]

10.Case Study

Here a life cycle assessment of a PEMFC vehicle, which includes not only operation of the vehicle on the road but also the manufacture and distribution of both the vehicle and the fuel during the vehicle's entire lifetime (Figure 6), is conducted and compared with the one for a conventional gasoline vehicle [25].

As illustrated in Figure 6, the fuel section of the life cycle begins with the primary energy source, e.g., crude oil or natural gas in underground reservoirs. This primary energy is then transported to a manufacturing site, in this case a reforming plant/oil refinery, where it is converted to the fuel suitable for a vehicle, e.g., gasoline or hydrogen. And this fuel has to be distributed from the central reforming plants/refinery by various means to the retail service station where it is deposited in the tanks of vehicles. This sequence constitutes the 'fuel cycle' part of the total automobile technology life cycle.

The vehicle part of life cycle starts with metal ores and other primary materials that eventually converted to components of the vehicle. These primary materials are transported to the vehicle manufacturer (includes manufacture of parts, metals, assembly, and other vehicle constituents). The vehicle itself is fabricated and assembled from these inputs and transported to distributors. Finally, vehicle and fuel cycles come together, which represent the purchaser (user) of both vehicle and fuel. At the end of its lifetime, the vehicle is scrapped or recycled.

The assessment of energy consumption, and greenhouse gases (GHGs) emissions associated with the production and distribution of hydrogen are based on the data published in the literature. Published data are also used to assess the energy consumption, and greenhouse gases (GHGs) emissions associated with producing, manufacturing, and assembling the materials and parts making up the PEMFC vehicle. The assessments of all the phases of each life cycle are then combined to make integrated comparisons with the conventional automobile technology i.e. ICE vehicle.[10]

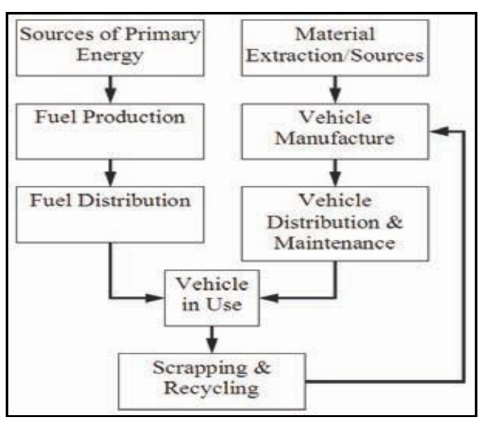

Figure 2

11.Conclusion

The benefits of hydrogen and fuel cell systems is highlighted of using the principles of thermodynamics (particularly energy) and life cycle assessment to evaluate their key roles in sustainable development. The following concluding remarks, which will likely be useful to scientists, researchers and engineers as well as policy and decision makers, can be drawn from this study:

• Moving towards sustainable development requires that environmental problems be resolved. These problems cover a continuously growing range of air pollution, water pollution, solid wastes, pollutants, ecosystem degradation, and extend over ever-wider areas.

• Sustainable development requires a sustainable supply of energy resources that, in the long term, is sustainable available at reasonable cost and can be utilized for all required tasks without causing negative societal impacts. Energy resources such as solar, wind, hydro, and biomass are generally considered renewable and therefore sustainable over the relatively long term. The use of these sources in hydrogen production will be a key factor in sustainable development.

• Assessments of the sustainability of processes and systems, and efforts to improve sustainability, should be based in part upon thermodynamic principles, and especially the insights revealed through energy analysis.

• For societies to attain or try to attain sustainable development, effort should be devoted to developing hydrogen and fuel cell technologies. Renewable energy utilization in hydrogen production can provide a potential solution to current environmental problems. Advanced hydrogen and fuel cell technologies can provide environmentally responsible alternatives to conventional energy systems, as well as more flexibility and decentralization.

• To realize the energy, energy, economic and environmental benefits of hydrogen and fuel cell technologies, an integrated set of activities should be conducted including research and development, technology assessment, standards development and technology transfer. These can be aimed at improving efficiency, facilitating the substitution of these technologies and other environmentally benign energy currencies for more harmful ones, and improving the performance and implementation characteristics of these technologies.

• As illustrated in the case study, the results of a comprehensive life cycle assessment of PEMFC vehicles are presented based on the published data available in the literature.

The two characteristics, which were assessed, are energy consumption and greenhouse gases (GHGs) emissions during the entire life cycle of an automobile. Moreover, conventional internal combustion engine (ICE) vehicle is also assessed based on the similar characteristics to compare with the PEMFC vehicle. The results will likely be useful to scientists, researchers and engineers as well as policy and decision makers. The case study presented on the hydrogen and fuel cell systems highlights clearly the importance of the topic and show that these can help achieve better environment and sustainability.

12.Reference

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