Increasing Alternative Fuel Development and the Global Response of the Chemical and Automotive Industries

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Section I - Alternative Fuel Development: An Increasing Global Trend

Over the past decade, many aspects of human activity changed in response to a growing global crisis. Our globalized and advancing world today is highly based around the use of quickly depleting non-renewable fuels, two examples being oil and coal. Another global crisis that is generally accepted is the acceleration of global climate change due to emissions of carbon dioxide from these unclean non-renewable fuels. Due to these potentially disastrous problems, interest in alternative energies increased over the past decade and are now a real solution to a global dependence on non-renewable fuels and an environmental catastrophe. However, for many people, environmental concerns are not a primary motivator to incorporate alternative fuels as a realistic option in their society. In this section, I will argue that innovations in alternative fuels are increasing globally in order to decelerate global climate change and reduce the use of non-renewable fossil fuels, not only as an environmental concern, but as a result of global economic, social, and behavioral factors in a world with quickly decreasing supplies of fossil fuels.

The global alternative fuel movement started across the world in the early 1970s, with the first Earth Day, due to increased awareness of environmental concerns such as elevated greenhouse gas concentrations in the Earth’s atmosphere and the threat of global climate change (Heussner 1). Subsequently, the alternative fuel industry evolved, not restricted to any particular geographical region, but common to all areas that utilize fossil fuels. For clarification, conventional fossil fuels include petroleum, coal, propane, and natural gas, while alternative fuels, comprise various renewable materials or substances that can be used as fuel (Reed 1). This movement was repressed for many years due to political and economic self-interest from oil companies and others that would feel the effects of a more diverse market (Reut 1). A historical
example of the resistance to the development and adoption of alternative fuel technology was explored in the 2006 documentary film *Who Killed the Electric Car?*. This film describes how General Motors developed a battery electric vehicle in the 1990s that was only in production ten years and then discontinued and the technology destroyed. The film showed the complex roles between automobile manufactures, oil industry, United States government and consumers (Vonder Haar 1). This example shows how throughout history special interest groups and companies manipulated the automotive industry and the progression of alternative fuel development. There has been a historical opposition to the development of these alternative fuel options, but through all of this, alternative fuel popularity has increased over the past few decades, even though there is still resistance by some major political and economic powers.

Energy is one of the biggest aspects in economic development. The amount of energy consumed correlates directly with the standard of living within the society (Lindberg, Korpi and Vinha 6-7). According to the United Nations Industrial Development Organization’s 2009 General Conference Report, modern forms of energy are not utilized by more than fifty percent of the world’s population living in both rural and semi-urban areas. This population comprises approximately 2.5 billion people mainly located in underdeveloped countries of the world (3). New alternative energies are being explored for their use to give more opportunities to developing countries (7). Alternative fuels can provide energy to areas that once lacked access to modern forms of energy in order to stimulate the economy and in turn, increase economic development of the area. These points support my argument that there is an economic benefit for alternative fuels, specifically, in this example, in developing countries.

There are also economic benefits for developed countries in their use of alternative fuel sources, such as the implementation of new vehicle technologies. Many developed countries
around the world agreed to the Kyoto Protocol in 1997 to lower greenhouse gas emissions (UNFCCC 1). One method in which these participating countries are complying with this agreement is the implementation of alternatively fueled vehicles such as hybrid, flex fueled, hydrogen powered, and electric vehicles. It is predicted that by the year 2030 sixty-four to eighty-six percent of the sales of passenger vehicles will be electric cars (Becker, Sidhu, and Tenderich 2). This statistic is based upon the price of oil and the cost of conventional vehicles. This trend towards alternatively powered vehicles will have economic benefits for developed countries in which these new vehicles and their technologies will be implemented. This will open a new market sector along with new jobs in manufacturing and maintenance. In today’s world, with the increasing use of alternative fuels, their introduction into developed countries has economic benefits.

Even though the economic benefits outweigh the disadvantages there are some arguments against implementing alternative fuels. Cost has been a major inhibitor to the widespread adoption of renewable energy. Most conventional gas-powered vehicles cost three thousand to eight thousand dollars less than similar hybrid vehicles (Hybrid Cars 2). The price of alternative fuels and alternative fuel technology is high, but with better production techniques and a bigger market it could be possible to produce the technology at a more reasonable cost. This is not well accepted by people that have investments in fossil fuels, such as oil or coal. There is great resistance because opening a new market and increasing competition would decrease the profits of fossil fuel companies (Vonder Haar 1). Everyone does not accept alternative fuels, but they are an increasing global trend of the future.

Another economic concern revolves around the increased use of ethanol. Ethanol is an alternative fuel derived from plants such as corn or switchgrass. The world production of
ethanol is predicted to pass twenty billion gallons in 2012 with more than half coming from Brazil and the United States (World’s Ethanol Production 1). With this large demand for ethanol, agricultural products used to produce the fuel will increase in price. According to the Congressional Budget Office of the United States, the 2008 total United States ethanol production contributed between 0.5 and 0.8 percent of the overall increase in food prices, which was reported by the Consumer Price Index to be a total 5.1 percent increase (6). This is a concern, but in my opinion the implementation of other alternative fuels and not the reliance of just one, the food prices should stabilize. This may not concern many people in developed countries that have the means to buy produce at a slightly higher price, but does affect people in developing countries with little money that rely on corn or another single product as a staple in their diet.

Through efforts to find affordable replacements to current fuel choices, biodiesel quickly became one of the leading alternatives due to its usefulness and social impacts on societies. Biodiesel, produced from vegetable oils and processed animal fats, is a recycled energy source. In many developing countries, such as the Philippines and African countries, the jatropha plant is being utilized to produce biodiesel fuel. This plant is being considered as a new biodiesel source due to its resistance to drought and pests along with a high oil yield. Impoverished villages can refine the jatropha seed into biodiesel and use it to operate generators to power lights or pump clean water (Shekhawat 1). This has social impacts on many lives, especially women, who in many non-industrialized societies are the primary caregivers and providers of basic necessities including water, fuel, and food. Providing women with this technology improves the entire community’s quality of life and their opportunities as women (Yih and Brower 2). This
exemplifies how alternative fuels can help to progress and change the social structure of culture especially in developing countries.

Also, in developing countries, solar power is providing available energy and creating changes in social culture. This technology is very effective in underdeveloped areas such as Africa and the certain areas of the Middle East. Some areas cannot grow crops for biofuels, but solar power is a great renewable energy source that works well in desert conditions. Within six hours the deserts of the world receive more energy from the sun than the entire world uses in a year (Desertec 3). If a portion of this energy could be harnessed by local cities the social dynamics will change since more energy would be available and would increase the quality of life in terms of healthcare, education, and nutrition (Reddy 43-44). This shows how the increased implementation of alternative fuels, such as biodiesel and solar power, have social benefits in developing countries of the world. Alternative fuels are not limited to the progress of technology in scope, but rather aid in the progression in human rights as well.

The increased use of alternative fuels promotes behavioral changes within developed and developing nations. Some of these changes can scare many people that are used to an oil-gasoline-based society. The most effective and cleanest method of alternative fuel is hydrogen, which does not combusted to create energy, but rather combines hydrogen gas with oxygen gas to create an electrical charge. The only emission from this combination is pure water (Brus and Hotek 21). If countries want to incorporate this technology they will have to make social and infrastructure changes to accommodate this technology, including storage, handling, and distribution (Brus and Hotek 22). Hydrogen fuel-celled automobiles are gaining popularity around the world, but in order to be implemented, behavioral changes will have to be accepted for the consumer to utilize this technology to its fullest extent. One change would be not having
the convenience of numerous refueling stations as seen with gas stations in many developed countries.

A large social issue, especially among developed countries, is the reduction of greenhouse gas emissions attributed with the implementation of alternative fuels. For developed countries to reduce their greenhouse gas emissions many behavioral and lifestyle changes need to be addressed, including transportation, energy consumption, and human culture. In my opinion there will need to be a cultural movement away from the high consumption of fossil fuels towards an alternatively fueled society in order to fully achieve global sustainable development. These examples support my argument that social and behavioral impacts have an effect on alternative fuels use in both developed and developing contemporary societies.

The environmental factors based around the implementation of alternative fuels are truly a global issue. We all live in one world with one environment that we all share. The pollution of one country affects all countries. The environment in which we live is intertwined together and a large issue facing our global community is global climate change. Some people debate whether this phenomenon is occurring or if it is human caused, but the fact is many scientists and countries around the world believe it is occurring and are developing national and international programs to address the issue, one of the largest being the United Nation’s Intergovernmental Panel on Climate Change (IPPC 1). Many countries see the implementation of alternative fuels as a solution to environmental pollution, but also to economic and social struggles. Fossil fuels, consisting of oil, coal, and natural gas, comprise 96.8 percent of the total carbon dioxide released by the United States (U.S. Department of Energy 1-5). The implementation of alternative fuels greatly decreases these environmentally harmful emissions. Alternative fuels have very low emissions, if any, and would lower the dependency upon fossil fuels, which are very dirty forms
of fuel. Implementing clean alternative fuels benefits the environment and is one part of why alternative fuel innovation is increasing.

Alternative fuels are here to stay. With increased research and development, this area of products will soon become more efficient, readily available, and economical for the entire global marketplace. This increasing global trend is in response to ever increasing oil prices, demand, and also global climate change. Many countries around the world, mainly developed, can visualize how soon oil supplies will become overwhelmingly depleted based on current consumption rates. Now is the time to develop sustainable and renewable ways to run our societies (Victor and Yueh 1). For the poor of the world more energy and more energy services can mean a better quality of life. Energy use can allow services that improve healthcare, education, and nutrition in less developed nations. In an ever-growing world with ever depleting resources alternative renewable energy sources must be developed and implemented.
Section II - Alternative Fuel Development: The Global Response of Chemists

The trend of the increasing use and development of alternative fuel sources affects many people and professions across the globe, but one of the major professions responding to this trend is the global chemical industry. Chemical development and the roles of chemists have a larger impact than people may realize on alternative fuels. Chemists are the backbone of innovative developments that major industries implement in their production lines. The role of the chemist has grown significantly over the past two decades due to the increasing global trend toward the implementation and development of alternative fuels. I will prove that the global chemical industry is responding to the increasing need for alternative fuels by advancing their technological developments to fit the culture and need in both developed and developing countries, therefore linking science and business.

Many countries around the world study chemistry and its impact on different aspects of physical life and each have a unique agenda on how it affects their funding of research and development. One of the leading areas in which alternative fuels are being researched is the development of alternatively fueled vehicles. Again, some countries find this research more essential than others, depending on their economy and their political and environmental agenda. Unlike the United States, other countries around the world normally aid their automotive industries through tax incentives and reimbursements for research and development (Murphy 1). France is an interesting example since their government supports the automotive industry’s research with a new tax credit system that reimburses fifty percent of the cost of research and development in the first year (Murphy 2). Another example found in a developing country is how Brazil’s governmentally owned national bank finances different biodiesel and flex-fuel research initiatives at lower interest rates (Murphy 2). Across the world alternative fuels and
chemists are affected by how a government views the importance of this research and how it fits into their national agenda.

Globally, chemists are becoming more involved with research to develop alternative fuels. Developed countries are the leaders in the research of alternative fuels and their implementation into society. Publications in notable chemistry journals are now including more and more articles addressing alternative fuel research. One example is an article entitled “Electrochemistry and the Future of the Automobile” published in *The Journal of Physical Chemistry Letters* (Wagner, Lakshmanan and Mathias 2204) where the scientists discuss a new energy solution to powering a vehicle with lithium ion batteries. Another example is from Europe where the implementation of alternatively fueled vehicles is prevalent in the culture. Iceland has often been used as a test market for the implementation of alternatively fueled vehicles. Iceland installed their first hydrogen fueling station in 2003 and has been testing hydrogen-powered vehicles and their effectiveness as an alternative fuel source (Moody 25). In more recent years, Iceland has worked with Japan making Iceland the first nation in Europe to drive electric cars developed by Mitsubishi (Moody 25). Chemists are looking at these tests and seeing how the technology is fitting in with society. In my opinion, the role of chemists when dealing with alternative fuels is creating practical options for people that do not remove them too far from their comfort zones, but still creates a positive environmental change.

Chemists across the world in the automotive industry are working to develop various prototype vehicles based around alternative fuels, such as ethanol, hydrogen, battery, electric, and biodiesel. These prototype vehicles are implementing new processes developed by chemists to make alternative, more sustainable materials. The automotive manufactures in Europe have been using more sustainable plastics in the development of new automotive parts. These parts are
lighter in weight, making the vehicle more energy efficient and also able to withstand environmental factors and corrosion. This use of these new alternative plastics, which are lighter in weight, reduce fuel consumption and make the implementation of new safety systems possible as well (EuPC 1). Japan has also been looking into alternative parts for vehicles including plastic exterior body panels and carbon fiber reinforced plastic frames (MCHG 2). Chemists developed all of these synthetic materials in an attempt to lower the weight of vehicles and in turn increase the fuel efficiency of the vehicles. This may not be a direct correlation to alternative fuels, but it is a method of implementing alternative technologies and recycling resources in order to reduce consumption and the environmental effects of the overuse of traditional metals and fossil fuels.

Even though alternative fuel research is highly studied in developed countries, it is also researched in developing nations as well. Chemists in developing nations are motivated mainly for the economic gain of their country (RSC 1). With the increase in chemistry and other sciences comes increased development. Alternative fuels are not at the top of the priorities in developing countries due to their desire to grow and use inexpensive technological advances (RSC 1). One example of how alternative fuels are researched in developing countries comes from a journal published by the Chemical Society of Ethiopia. This article entitled “Biodiesel Fuels From Palm Oil, Palm Oil Methylester, and Ester-Diesel Blends” addresses how the researchers found a biodiesel fuel to run diesel engines due to the increasing costs and environmental detriment of non-renewable fossil fuels (Ajiwe, Ajibola and Martins 19-26). This case study is one of many more that show how developing countries are also focusing on alternative fuel sources. The researchers realize the problems and drawbacks of using fossil fuels. This example also shows how chemists in developing countries are reacting to the
increased global trend toward alternative fuel sources. Although similar in their endeavor and research for alternative fuels, their motives are different to fit the culture tied around a developing country. The researcher’s focus is not upon high technology alternative fueled vehicles, but rather a more practical use and implementation into a developing country’s culture and lifestyle. Agriculture is often a major component in the economic structure of a developing country. The chemical researchers use what natural resources are available, in this case, palm oil from plants, to derive a fuel to run on already existing diesel engines. This ties back to the point that the role of chemists should be to develop an alternative fuel that is practical and applicable to people and the culture of the specific area.

Another key example to investigate on a global level in terms of alternative fuels is the developing country of India and how as the country develops, more and more people will have accessibility to vehicles, thereby continuing to decrease air quality and create a huge environmental impact. India is developing quickly not just economically, but more importantly, population wise with currently almost 1.2 billion people (CIA India 3). This large population is of concern since a large portion of these people will purchase and drive vehicles in their lifetime. V. K. Saraswat, the scientific advisor to the Defense Minister in New Delhi, stated that most of the air pollution in India is caused by vehicle emissions and industrial smog (Times of India 1). Saraswat has been urging India to move towards alternative fuels especially within the automotive sector due to the foreboding environmental concern. To address this environmental issue, research is being performed to look at the effectiveness of biodiesel and hydrogen power. India consumes diesel fuel at a rate of forty million tons a year, but in 2003 the government of India began projects to replace approximately five percent of the diesel with biodiesel from jatropha plants (Reuters 1). Chemists in India have been working with emerging new
technologies for energy sources including fuel cells and hydrogen energy. Saraswat suggested to the Indian government that a large investment needed to be funded in biodiesel and hydrogen power and make a move to a hydrogen based economy by 2030 (Times of India 1). If not already, due to their enormous population, the chemists in India will have to respond to the global trend toward alternative fuels especially in vehicles to prevent an environmental disaster.

As a response to the increasing global trend of alternative fuel development, chemical corporations are beginning to create their own prototype, alternatively fueled engines and vehicles. At the 2010 North American International Auto Show in Detroit, the DOW Chemical Company was involved more than one would think. The company had an area showcasing its new alternative energy solutions. This was the first time that a chemical company not related directly to the automotive industry was a main contributor to an Auto Show Showcase (Winder 1). This event shows DOW Chemical Company’s creativity in terms of research and development of innovative renewable and alternative energy solutions. The more important aspect is that this innovation and inclusion came from the chemical industry. When this showcase opened it affirmed to the world market that chemistry is an intricate part of alternative fuel technologies in the automotive industry. This is a prime example of a chemical industry’s response to the global trend toward the future of energy and sustainable energy consumption.

The future of our society will be determined by people, governments, and businesses working together to create innovative solutions for the world’s need for clean, affordable, and sustainable energy. Energy is the catalyst for global economic growth in both developing and developed countries. The future of economic growth, sustainable action, and popular culture revolve around the need for innovative technologies and materials developed by chemists.
Section III – Alternative Fuel Development: Impact on Chemistry and Japan’s Automotive Industry

Japan, even though small in area size in comparison to other countries, has a large industrial capacity, as it is one of the world’s largest and technologically advanced producers of electronic equipment and motor vehicles (CIA Japan 10). The automobile industry in Japan is a vital source to the economic prosperity of the country. Automobile production is Japan is a key part of the economy comprising approximately thirty-seven percent of the manufacturing industry exports (JAMA 1). Japan is headquarters to eleven automobile manufacturers with the top five being Toyota, Honda, Nissan, Mitsubishi, and Mazda (Hays 4). These automakers comprise 95.8 percent of the market in Japan leaving 4.2 percent available for foreign automobile manufacturers (Hays 1). This shows that the Japanese prefer their cars whether fuel-efficient or not to other foreign manufactured cars such as American or German vehicles. The automobile industry along with the chemical industry in Japan has always been on the cusp of new sustainable technology and currently, with the research of engineers and chemists, is among the leaders in the innovation and development of alternatively fueled vehicles toward the goal of a sustainable society.

Japan is an island country located in the Pacific Ocean off the East Coast of China, Korea, and Russia. Its four islands comprise an area of 377,915 square kilometers, which is slightly smaller than the state of California, but many smaller islands also surround these four main islands (National Tourism Organization 1). Japan’s population is estimated at approximately 126,804,433 people as of July 2010 (CIA Japan 3). Most of Japan’s population occupies crowded urban areas. Tokyo, Japan’s capital city, along with its suburbs comprise approximately twelve million people (Japan National Tourism Organization 2). The Japanese economy is the fourth largest economy in the world after the European Union, The United States,
and China with a Gross Domestic Product of approximately 4.15 trillion dollars (CIA Japan 8). All of these facts about Japan show how this small island nation is in need of alternative fuels due to its small geographical size, large population and lack of natural resources.

Japan has a strong incentive to research alternative fuels, due to its size and minimal natural resources. A major energy importer, Japan is the largest importer of coal and liquid natural gas along with being the second largest importer of crude oil (CIA Japan 2). Japan is greatly dependent on outside sources for fossil fuels due to its lack of natural resources. To diminish the environmental impact of fossil fuel pollution, Japan’s major automotive manufacturer, Toyota Motor Corporation, is expanding their chemical research, their development of renewable and less polluting alternative powered vehicles, and their involvement in biotechnology initiatives (Energy Research Toyota 2). In analyzing this move towards these alternative technologies, Japan is pushing the development of new technologies forward in order to implement them into their society to decrease the dependence on foreign oil and reduce the carbon dioxide emissions helping to slow the effects of global climate change.

Chemists in Japan are becoming highly involved in the research and development in these areas as a result of the increasing national agenda towards an alternatively fueled society. Chemists are employees of all of the major corporations since they conduct the research and development behind all of the alternatively powered vehicles that are eventually produced on the global market. This means that the alternative fuel developments of the Japanese automotive industry come from the innovations of chemists and other scientists. Japan, due to its environmental and natural resource limitations, is pushing forward these alternative fuel technologies in order to develop a sustainable lifestyle. One example of how chemists are working within the automotive industry to develop cleaner technologies is found in Honda’s
introduction and development of new technologies to reduce carbon dioxide emissions. New hybrid vehicles such as the CR-Z have been introduced into the automotive market and had a profound effect on the lifestyles of Japanese citizens. Honda is also conducting research into the manufacturing of bio-ethanol technology at its Kazusa laboratory. The goal is to effectively design this fuel and eventually find a preparation for large-scale commercial production (Honda 37). This shows how one new chemical development can make a huge progression in terms of the effects and implementation of alternative fuels and their technology.

Another example of how Japanese chemists are involved in alternative energy is through a recent development of catalysts that turn natural gas into plastic and alternative fuel. This new development uses a cheaper catalyst to produce plastic and methanol. The methanol can be used as an alternative fuel and burns very cleanly, reducing harmful carbon dioxide emissions from automobiles (Maeda 1). This exemplifies the resourcefulness of Japanese chemists in response to multiple needs. People use both plastics and fuel and these chemists developed a method of producing two useful resources out of one chemical process. This is almost a way of implementing a “nothing-goes-to-waste” policy, all a part of a sustainable society. Also, another important aspect is that the production of this resource through this method is inexpensive, which is a positive incentive, opposite of the normal controversy that alternative fuels are expensive. In the end this example shows how chemists from Japan are developing new chemical techniques to create a sustainable society around the implementation of alternative fuel technology.

A new development originating in Japan is the development of hydrogen powered vehicles. Chemists are deeply rooted into this technology since the production of hydrogen gas and implementation of hydrogen gas to create energy involves chemical processes and mechanisms (Green Car Congress 1). In Japan, at Tokyo City University, scientists are
developing a multi-cylinder direct-injection spark-ignition hydrogen internal combustion engine (Green Car Congress 1). This development shows again how chemists are highly involved with new vehicle and alternative fuel technology. This process of developing a hydrogen-powered vehicle that works in everyday applications is difficult and much different than traditional fossil fuel engines. With the development of this technology would come the concept of a net zero emission vehicle where the only emission would be pure water and no harmful greenhouse gases. Hydrogen vehicles do not use hydrogen in a combustion reaction, but rather an electrolysis reaction or electrochemical reaction. This means that an explosion is not produced, but rather an electric current (Brus and Hotek 1-2). The increased development of this technology is necessary and a priceless technology in Japan’s goal of becoming a sustainable society through the implementation of alternative fuel technology.

One of the most successful Japanese automobile manufacturers is the Toyota Motor Corporation. Toyota is producing a large number of alternatively fueled vehicles and performs extensive research and development into new technologies. Toyota’s success in developing a hybrid vehicle was based around the fact that the research and development maintained a wide variety of technological innovations and not just focusing on one area of a vehicle (Yarime, Shiroyama, and Kuroki 195). The latest Toyota innovation is a solar powered ventilation system that utilizes the sun’s rays as the car sits in the daylight. This technology involves using solar panels on a moonroof to capture the energy from the sun and use it to power a fan that circulates cool air from outside the car inward (Solar Powered Toyota 1). Toyota is taking many steps to produce new and alternative technology that does not just focus on the engine, but rather the entire vehicle making sustainable changes in every aspect of the way people act.
In summation, the focus of chemists on alternative fuel technology is impacting the automotive industry, along with the economic, cultural, and environmental conditions within the country of Japan. This in turn then spreads globally to affect any country that imports or produces Japanese automobiles. These Japanese automobile manufacturers market their vehicles to many countries across the globe including the United States, China, European countries, and Russia (Hays 5). The use of alternative fuels is not just limited to the Japanese automotive industry since many United States based and European based automotive manufacturers are conducting research and development of alternatively fueled vehicles. Through these examples given in this section, it can be seen how chemistry is changing the face of the global automobile industry through the increased development through alternative fuel technologies. Since the research and development of new technologies involving the automotive industry is ever expanding to meet the public demand, chemists will continue to be involved in these research and development processes for decades to come.

This global trend toward the implementation and development of alternative fuel technology is here to stay and chemists have a major role to fill. Chemists will need to develop new sustainable fuels from new fuel sources along with mechanisms to produce large quantities of these fuels at a cheaper rate. Keeping the price down will make these innovations more marketable and accessible to the general public as viable alternatives to unclean conventional fossil fuels. The global implication of this trend needs to be addressed because the overuse of fossil fuels is creating an environmental disaster waiting to happen. This environmental disaster will affect everyone no matter what country. The world needs to take a step forward and continue researching these options to offset or even reverse environmental dangers to the atmosphere and ecology of the biosphere.


<http://www.jama-english.jp/about/intro.html>.


