

RENEWABLE ENERGY

EXPERT REPORT

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Strategy 566

By:

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1.0 DEFINITION

Renewable energies are sources of power derived from natural resources that can be continuously replenished.¹ Natural resources such as sunlight, wind, rain, tides, and geothermal heat are effectively used sources of renewable energy. These natural resources are converted into electricity or other usable forms of energy using renewable energy technologies ranging from solar power, wind power, biomass and biofuels, and hydroelectricity. Renewable technologies can be adapted for use for in large scale energy projects or for small off grid locations in rural areas.

1.1 Wind Power

Wind power is a form of renewable energy generated by wind turbines which are able to convert the kinetic energy of wind into electricity. Typically, three blades are connected to a rotor which faces into the wind. The wind causes the rotor to spin transferring the energy into the generator. The generator converts the energy in the rotating shaft into usable electricity. This electricity is transferred along power lines to consumers. However, wind power is not considered a fully reliable energy source because wind is not always constant. Thus wind power cannot take on high levels of energy demand in a region.²

1.2 Hydroelectric Power

Hydroelectric power relies on running water to rotate a wheel or turbine. In the case of a water wheel, the turning produces mechanical power. To generate electricity, a turbine is connected to a generator which converts the energy into electricity. Hydroelectric power generates no waste and produces no carbon dioxide emissions.²

1.3 Geothermal Power

Geothermal power uses the natural heat of the earth to generate electricity or to heat and cool a building. One type of geothermal plant generates electricity by using geothermal steam to turn turbines. Homes use geothermal systems by running pipes down into the

¹ Janssen, R. (2002). *Renewable Energy into the Mainstream*.

² *Renewable Energy*

earth where the temperature is constant year round. Air is moved from the home to the ground exchanging heat and heating or cooling the home depending on the season.³

1.4 Biofuel

Biofuel is a liquid produced from organic materials (biomass) that can be used as transportation fuel. Forms of biofuel include ethanol which is primarily produced using yeast fermentation of corn or sugarcane. Biodiesel is also a common biofuel and is made from oils and fats. Biodiesel is similar in chemical make up to mineral diesel and can typically be used in a diesel engine when mixed with mineral diesel.⁴

2.0 CURRENT STATUS

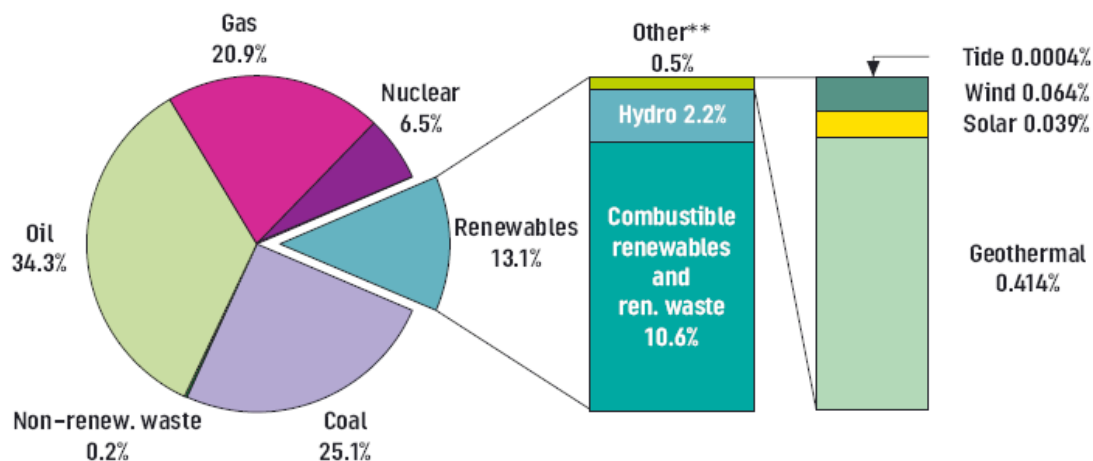
Renewable energy has become a viable option of power generation over the last decade. However, renewable energy is not yet a major source of energy generation worldwide. As of 2005, 13% of the world's primary energy supply results from renewable resources. Primary energy refers to the energy contained in a natural resource before it goes through a man-made process to convert it into useable energy. When a material is processed into useable energy, some energy is lost in the form of heat.⁵ A majority of the renewable primary energy supply comes from biomass sources such as wood. Hydropower generates approximately 2% of the world's energy supply, and energy generated from wind power, geothermal, and solar power account for less than 1% of the world energy supply.⁶ Figure 1 shows the sources of the world's primary energy supply.

³ *About Geothermal Energy.*

⁴ National Biodiesel Board. (2008). *Biodiesel Basics.*

⁵ Kydes, A. (2007). *Primary Energy.*

⁶ International Energy Agency. (2007). *Renewables in Global Energy Supply An IEA Fact Sheet.*

Figure 1. Breakdown of Primary Energy Supply Worldwide**Adapted from IEA Fact Sheet⁶

All types of primary energy must be processed before they become useable forms of energy. Renewable energies are primarily converted into electricity and have had the biggest impact as alternative energy sources in this regard. Renewable sources account for 18% of the electricity generated in the world behind coal and natural gas at 40% and 20% respectively.

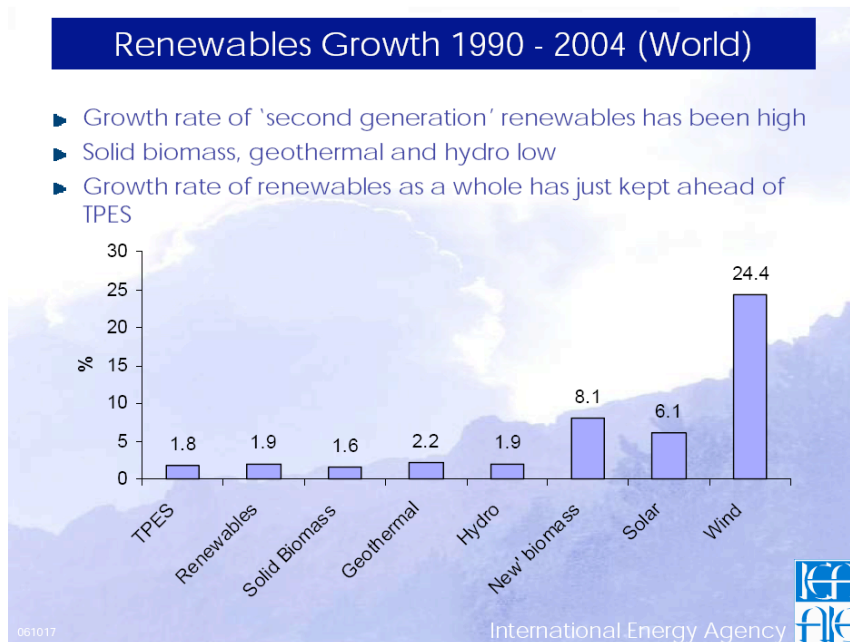
3.0 TRENDS TO DATE

It is clear that renewable energy sources are gaining a larger share in the market place as we progress into the future. This once called alternative energy has now become a mainstream topic in the energy industry. With this, investment capital is growing at double digit percentages each year. With \$80 billion in investment capital in 2005, we have seen investment capital reach \$100 billion in 2006. This is a 25% increase from the previous year's investments.⁷ These large growths in capital investment can be largely contributed to companies like BP, GE, Sharp, and Shell who have a large market share in the energy market and therefore have a large desire to take hold of the renewable energy sector. In Figure 2 below, the overall growth of certain renewable energy generation

⁷ United Nations Environment Program and New Energy Finance Ltd. (2007). *Global Trends in Sustainable Energy Investment 2007: Analysis of Trends and Issues in the Financing of Renewable Energy and Energy Efficiency in OECD and Developing Countries* (PDF), p. 3.

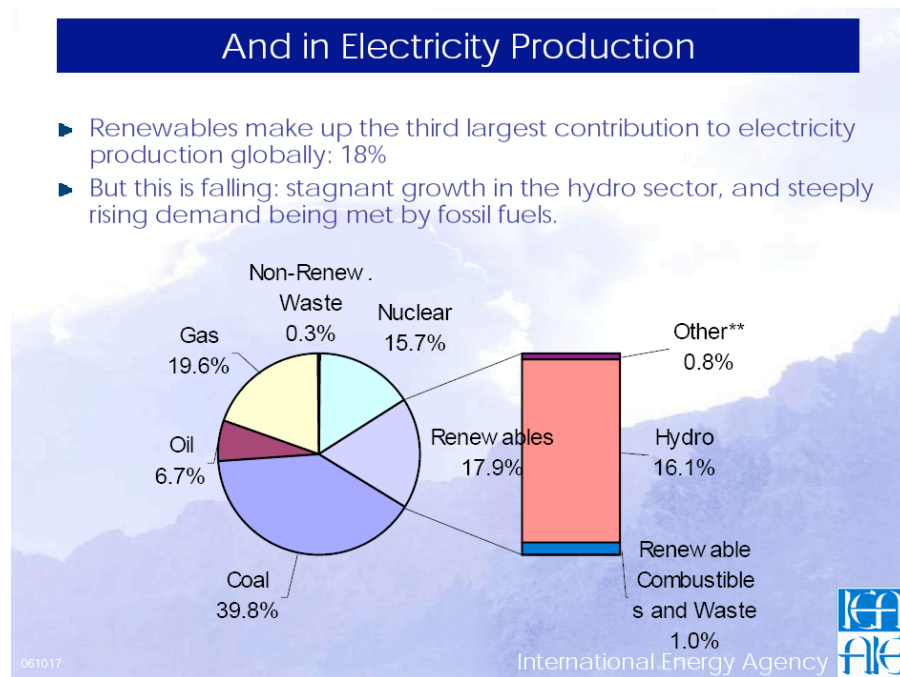
sources from 1990 through 2004 can be observed. This trend has been continuously increasing thus allowing for an overall decrease in the cost of these energies in the process.

Figure 2. IEA: World Renewable Energy Sources Growth from 1990 through 2004⁸



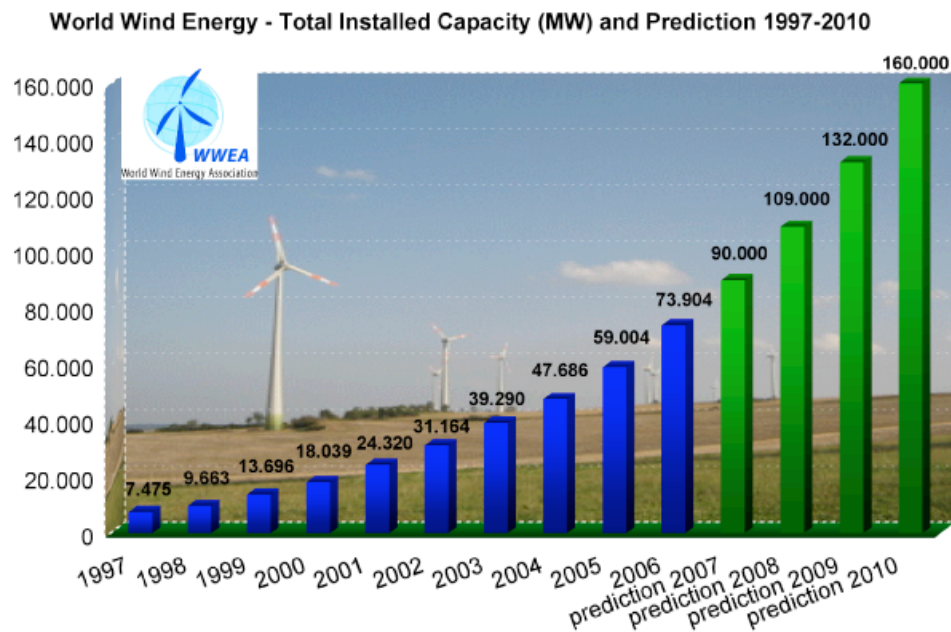
The International Energy Agency has also released data about the current sources of electricity production on a global scale. As can be seen from Figure 3 below, renewable energy sources carry about 18% of the electricity production market. These values, however, are declining slowly due to the rise in demand of oil and due to the slow growth of renewable energy technology within the industry.

⁸ Chandler, H. (2006) *Renewable Energy: Status and Outlook*.

Figure 3. IEA: Global Electricity Production Percentages⁹

We know that overall renewable energy sources are increasing their global capacity and that over time certain areas of the world are adapting to these methods. The area that is growing the fastest is the wind energy sector. Wind is abundant in the world and we can almost guarantee that we will always have wind, depending on the geographic location. With this, certain areas are very well suited for wind energy, mostly comprising of areas either surrounded by water or those near water because of the increased wind speeds over the body of water. The figure below shows the increasing trend over the past ten years of wind energy capacity.

⁹Chandler, H. (2006) *Renewable Energy: Status and Outlook*. /

Figure 4. Wind Energy Capacity Predictions (WWEA)

Even with supply chain difficulty in 2006, companies were still able to exceed their expectations for the year with a 32% growth in wind energy from that of 2005.¹⁰ This is a surprise to the industry which faced difficulty with the wind turbine companies not being able to supply the necessary equipment to the desired locations.

4.0 PROJECTIONS

Renewable energy will hold a large share of the energy market in the not too distant future. The European Union stated in March of 2007 that 20% of their energy usage will be produced from renewable energy sources by the year 2020. This is a common projection for many places around the world. These bold predictions depend on our ability to adapt more efficient ways of harnessing this energy and to also lean away from the traditional coal or fossil fuel burning methods used today.

¹⁰ Global Wind Energy Council. (2007).

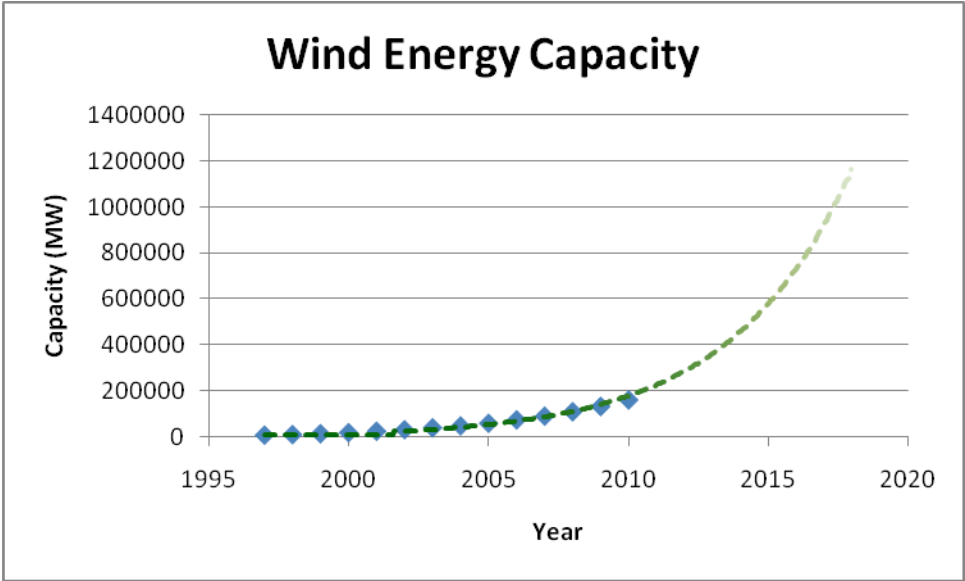
A report sent out by the American Solar Energy Society (ASES) has laid out several scenarios for the future that help us see where renewable energy could take us.¹¹ Renewable energy and energy efficiency could produce up to \$4.5 trillion in revenue for the US while also creating jobs for over 40 million people by the year 2030. These jobs would not be easily outsourced and would also account for nearly one out of every four jobs in the US. In their “business as usual” scenario, they predict that renewable energy related jobs will increase by 190%. “Business as usual” would mean there is no change in current policies and no major renewable energy initiatives until 2030. Their “moderate” scenario predicts renewable energy jobs would increase 7-fold and their “advanced” scenario predicts a 17-fold increase in available jobs. The “moderate” scenario would entail some small policy changes and initiatives but would also entail a continuation of the positive policies already in place. Also, the “advanced” scenario would push us to our limits thus allowing us to grow and expand as much as humanly possible.

Part of the projection process to is determine which renewable energy sources are the most cost effective as well as efficient in their energy production. One of the most limitless areas for renewable energy is wind energy. Worldwide, the long-term potential for wind energy is five times the current energy production and 40 times greater than the total current electricity demand.¹² Offshore areas also have ~90% greater wind speeds than that on land and thus increasing the demand for offshore wind turbines. You can also see in Figure 5 from above that the predicted capacity of wind energy in 2010 is increasing at an exponential rate. We are currently around 90,000 MW capacity level but these numbers are expected to reach as high as 160,000 MW by the year 2010. If we were to expand the projection of the capacity of wind energy further into the future we would see that theoretically we could reach 1,000,000 MW by the year 2018 as can be seen by Figure 5 below.

¹¹ Roger Bezdek (2007). *Renewable Energy and Energy Efficiency: Economic Drivers for the 21st Century (PDF)*. American Solar Energy Society.

¹² Archer, C. and Jacobson, M. (2005). *Evaluation of Global Wind Power*.

Figure 5. Further Wind Energy Capacity Projections*



*Adapted from Wind Energy Capacity Predictions (WWEA)

It is obvious that the cost for renewable energy is a major concern to society. If renewable energy is more expensive to produce than current methods, then this would deter the interest of society to renewable energy technologies thus extending the length of time until we adapt these new energy production methods. The good news is that the potential future energy costs are projected to be equal or less than that of current energy for the most part. In Table 1 below produced by World Energy Assessment in 2004, you can see the comparison of costs of energy in 2001 to that expected potential future costs

Table 1. Current and Potential Future Energy Costs (World Energy Assessment)¹³

	2001 energy costs	Potential future energy cost
Electricity		
Wind	4–8 ¢/kWh	3–10 ¢/kWh
Solar photovoltaic	25–160 ¢/kWh	5–25 ¢/kWh
Solar thermal	12–34 ¢/kWh	4–20 ¢/kWh
Large hydropower	2–10 ¢/kWh	2–10 ¢/kWh
Small hydropower	2–12 ¢/kWh	2–10 ¢/kWh
Geothermal	2–10 ¢/kWh	1–8 ¢/kWh
Biomass	3–12 ¢/kWh	4–10 ¢/kWh
Coal (comparison)	4 ¢/kWh	
Heat		
Geothermal heat	0.5–5 ¢/kWh	0.5–5 ¢/kWh
Biomass — heat	1–6 ¢/kWh	1–5 ¢/kWh
Low temp solar heat	2–25 ¢/kWh	2–10 ¢/kWh
All costs are in 2001 US\$-cent per kilowatt-hour.		
Source: World Energy Assessment, 2004 update		

A great example of the movement towards renewable energy can be seen in California. Governor Schwarzenegger has created the California Solar Initiative.¹⁴ He has set a goal to create 3,000 megawatts of new, solar-produced electricity by 2017. This initiative would give those with a solar power system on their house to receive cash incentives to lower the cost of electricity as well as give them a federal tax incentive which could cover over 50% of the total cost of such a system.

The World Energy Assessment has also released a small table displaying the resource base of certain types of renewable energy as can be seen in Table 2 below.

¹³ World Wind Energy Association. (2006).

¹⁴ State of California. *California Solar Initiative*. (2007)

Table 2. Renewable Energy Resource Base Potential (World Energy Assessment)

The Renewable Energy Resource Base (Exajoules per year)			
	Current use (2001)	Technical potential	Theoretical potential
Hydropower	9	50	147
Biomass energy	50	>276	2,900
Wind energy	0.12	640	6,000
Solar energy	0.1	>1,575	3,900,000
Geothermal energy	0.6	5,000	140,000,000
Ocean energy	not estimated	not estimated	7,400
Total	60	>7,600	>144,000,000
Current use is in primary energy equivalent. For comparison, the global primary energy use was 402 EJ per year in 2001. Source: World Energy Assessment 2001			

As the above figures and tables created by various organizations show, the potential for renewable energy is tremendous. Not only will these energy sources lower the cost of energy, they will also create extremely large amount of jobs for the US and other various countries. This can be very important in a world with an ever increasing population. Not only will these possibilities help our growing world population find work, it will also help make this earth a better place to live for us. The easily availability of fossil fuel resources is diminishing and the use of these is also very harmful to our environment in which we live. Because of this, it is also paramount that we shift our focus on other environmentally friendly energy sources such as renewable energies. Not only for their environmental friendliness but also because there is no limit to their energy source. We will also have wind and flowing water to help us produce these energies. The future is bright for renewable energies and it should be our mission to reach the projections that have been mentioned.

5.0 GLOBAL VARIATION

In 2005, 13% of the world's primary energy supply resulted from renewable resources. By comparison, in the United States only 7% of the country's energy supply is provided by renewable energy¹⁵. Biomass again makes up for half of the renewable energy with hydroelectric power being the other major source of renewable energy. China currently has the highest existing primary renewable energy capacity followed by Germany, the United States, and Spain.¹⁶ The type of renewable energy used by a particular country largely depends on what natural resources are available. Hydro power is used worldwide and the most commonly used source of renewable energy. Wind power is predominantly used in the United States and Europe. Over 20 countries make use of geothermal power including the United States, the U.K., Mexico, and Japan. Iceland leads the world in renewable energy consumed as a percentage of the country's energy demand. In Iceland where there is easy access to geothermal energy, 86% of all homes use geothermal energy for heating and hot water. Geothermal energy is used to produce 20% of the nation's electricity with the remaining 80% produced by hydropower.¹⁷

In the United States and much of Europe and Asia, renewable energy is produced at large energy plants tied into the electricity distribution system. However, renewable energy is widely used in developing countries in the form of small off grid systems. These systems only provide electricity or heat for an individual house or other small building. Small solar panels, wind turbines, and geothermal heating and cooling are prime examples of this technology. Kenya boasts the highest ownership rate of individual home solar systems with 30,000 small photovoltaic systems sold each year.¹⁸

Ethanol fuel has been embraced globally as a renewable energy source for automotive fuel. Brazil boasts a strong ethanol production program and provides ethanol as 18% of its automotive fuel. The United States produces roughly the same amount of ethanol per

¹⁵ Energy Information Administration. (July 2007). *Renewable Energy Trends in Consumption and Electricity*. (2005).

¹⁶ Martinot, E. (2006). *Renewables Global Status Report*. Retrieved on January 23, 2008

¹⁷ National Energy Association of Iceland.

¹⁸ Kammen, D. M. (2007). *What Solar Power Needs Now*.

year as Brazil, but it accounts for only 3% of the United States' automotive fuel.¹⁹ In Europe, biodiesel is far more common than ethanol. A 5% biodiesel to 95% mineral diesel mix is widely available throughout Europe with mixes up to 15% available. The U.K. is currently in negotiations to make a 5% biodiesel to mineral diesel mix mandatory for all diesel transportation.²⁰

6.0 PRIMARY CAUSES

6.1 Climate Change

Global warming has become one of the main driving factors behind renewable energy research and implementation. The major existing energy sources - fossil fuels such as coal, petroleum (or oil), and natural gas - are burned for exothermic energy. These energy sources are carbon based, resulting in the release of carbon dioxide (CO₂) into the atmosphere during combustion. Since the widespread use of fossil fuels began during the Industrial Revolution, CO₂ levels in the atmosphere have risen by 35%. In the United States, 94% of all CO₂ emissions result from fossil fuel combustion.²¹ This percentage is similar for all industrial countries that release CO₂ emissions into the atmosphere. The rising CO₂ level prevents heat from solar radiation entering into the atmosphere from dissipating. This phenomenon is commonly known as global warming, and until recently, has been dismissed by the majority of the scientific community and the general population. Now, the acceptance of the global warming concept has helped cause an influx of research into sources of renewable energy, and moreover, sources of energy that do not release CO₂ as a byproduct.

6.2 Escalating Oil Prices

Recent increases in fossil fuel prices have caused a public outcry for alternative, cheaper sources of electricity. Fossil fuels are mined or extracted from layers and reservoirs underground. These sources have formed from plant and animal matter that has decayed

¹⁹ Lugar, R and Abdenur, R. (2006). *America and Brazil Intersect on Ethanol*.

²⁰ Biodiesel Filling Stations.

²¹ U.S. Environmental Protection Agency. (2007). *Renewables Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2005*.

over thousands and/or millions of years. Consequently, due to the finite time span in which life has existed, there is a finite amount of fossil fuels. While large and untapped fossil fuel sources remain, most of the easily extractable sources have begun to run out. As these cheap sources of petroleum and natural gas disappear, fuel prices are increasing due to higher extraction and production costs of new sources.²² Now, these price increases are causing a public desire to shift to consistent and cheaper sources of energy, i.e. renewable energy.

6.3 Dependency on Foreign Oil

Most countries have some access to fossil fuels within their boundaries, but only a few countries have access to very large quantities of possibly the most influential fossil fuel - petroleum. Petroleum is the main fuel for vehicular transport, from cars to boats to aircraft. As the number of vehicles has increased worldwide over the last century, most countries, such as the United States, China, and most countries in Europe, have become increasingly dependent on petroleum, allowing countries with large petroleum reserves, such as Venezuela and some countries in the Middle East, to become very influential in the pricing of petroleum on the world market. Due to their dependency on petroleum, most countries have no choice in the price they pay for it. For this reason, many countries are looking for new, cheaper fuel sources within their own boundaries, most of which are renewable.²³

6.4 Lack of Infrastructure in Rural Areas

While most of the developed countries have an electricity delivery system in place, many developing countries lack the infrastructure to deliver electricity to rural areas, and do not have the funds to build or maintain it. Also, even in the developed countries, the cost of delivering electricity increases with distance, due to declining efficiency and an increasing amount of maintenance.²⁴ Due to the lack of electricity infrastructure in rural areas of developing countries, and the costs associated with delivering electricity to rural areas of developed countries, many people in rural areas have found, or are looking for,

²² Webb, S. (2008) *Solid Reasons for High Oil Prices-BP's Former CEO*

²³ Miller, G. (2004). *Reducing U.S. Dependence on Foreign Oil*.

²⁴ Liu, L. and Zobian, A. (2002). *The Importance of Marginal Loss Pricing in an RTO Environment*.

ways to locally produce electricity. The most common and effective methods usually make use of renewable sources such as sunlight.²⁵

6.5 Damage to Ecosystems

Worldwide, nature has paid a price for our current methods of power generation. Mining coal and drilling for petroleum and natural gas ruin natural landscapes. Petroleum refineries release air and water pollution. Petroleum spills can destroy marine habitats. Air pollution released from the combustion of fossil fuels includes nitrogen oxides, sulfur dioxide, volatile organic compounds, and even radioactive metals like uranium. These air pollution factors result in smog and acid rain. Other power generation techniques like nuclear energy and hydroelectric dams have environmental hazards as well. Nuclear energy carries the potential risk of the release of radiation from the uranium fuel both during operation and in the disposal of waste. Hydroelectric dams create large reservoirs that flood and destroy river habitats. The ecological consequences of current power generation methods provide for a strong reason to develop clean, renewable, and less invasive sources of energy.

7.0 PRIMARY CONSEQUENCES

7.1 Stabilized Climate

As the use of renewable energy increases, globally reducing the usage of fossil fuels, the rate at which we produce CO₂ will decrease gradually. Eventually, once the production rate of CO₂ falls below the rate at which the earth can absorb it, the overall CO₂ levels in the atmosphere will finally begin to decrease. As CO₂ levels in the atmosphere decrease, the rate of global warming will slow and eventually the average global temperature will lower. This is a process that will take centuries, but will only start with a switch to renewable energy.

²⁵ Kammen, D. M. (2007). *What Solar Power Needs Now*.

7.2 Stabilized Energy Prices

With the switch to renewable energy sources, the cost of producing electricity will stabilize - depending on the costs of construction and maintenance rather than a fuel source (with the exception of biomass). Stabilized production costs will lead to stabilized, or possibly decreasing, energy prices, as opposed to fossil fuel prices that will only continue to increase.

7.3 Secure Sources of Energy

As countries shift to using renewable energy, they will have the ability to generate their electricity locally and will no longer depend on other countries for fuel. This will eliminate the risk of conflicts developing over decreasing fossil fuel supplies. Also, it will eliminate the costs associated with transporting fossil fuels.

7.4 Localized Power Generation

The use of renewable energy sources in rural areas will allow for developing countries to spend less money on building electricity infrastructures. Developed countries will not have to spend money on building or maintaining long distance power lines. Also, the inefficiency costs associated with delivering electricity over long distances will disappear.

7.5 Damage to Ecosystems

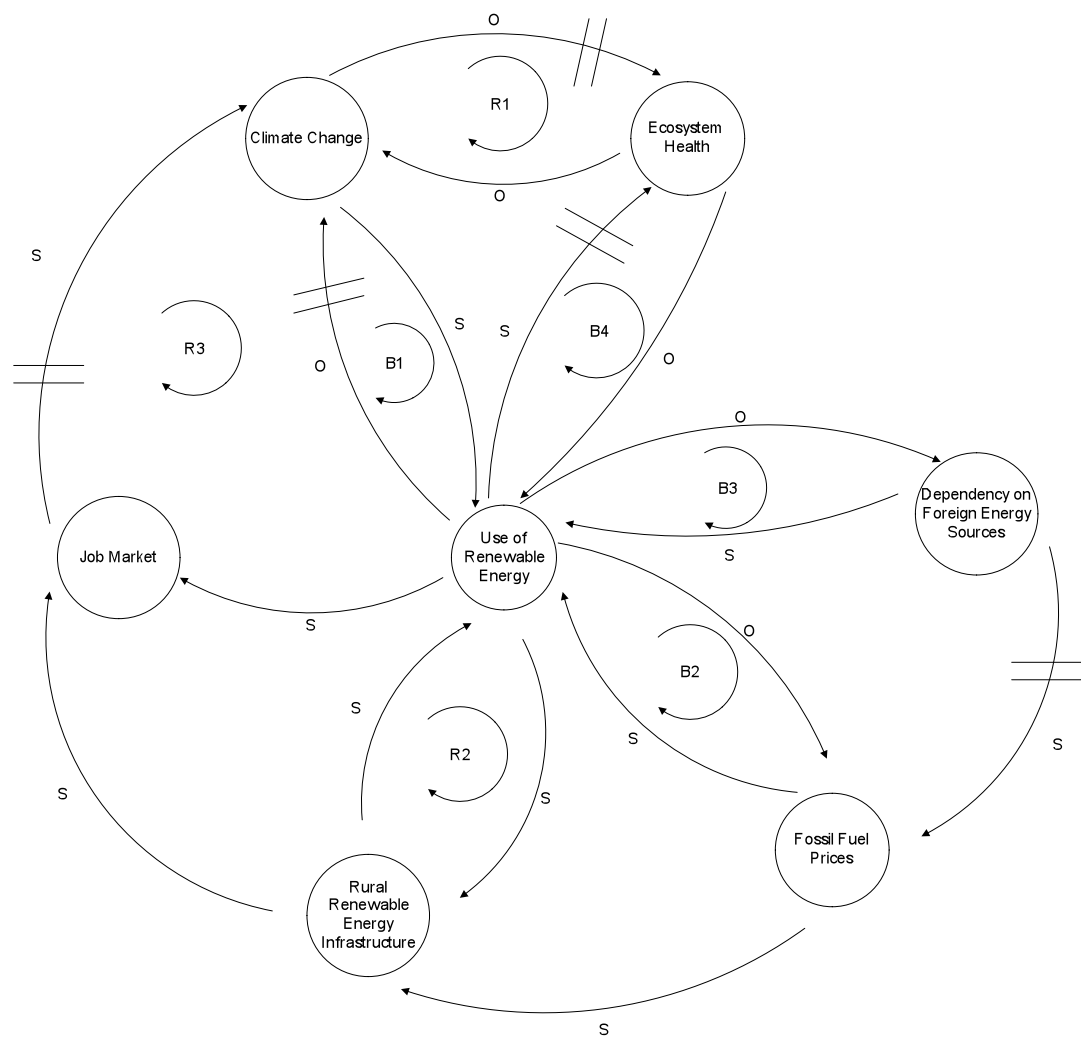
The switch to renewable energy does have some possible negative environmental effects, depending on the type of energy used. For instance, hydroelectric dams ruin river ecosystems as mentioned before. Burning biomass, like trees or garbage, releases the same types of air pollutants as burning fossil fuels and if used in large amounts will have similar effects (acid rain and smog). Wind and solar power stations require large areas of land and can ruin natural habitats as well as the aesthetic of the land itself. Despite the possible negative effects of renewable energy sources, the consequences of continuing fossil fuel use far outweigh them.

7.6 Job Market Created by Industry Expansion

As the world makes a switch to renewable energy, many new jobs will be created in an expanding industry. Job markets will open or expand in all aspects of renewable energy systems - research, testing, design, construction, and maintenance. This will also allow for all of the people who currently work in the fossil fuel industries to continue to work as their job markets shrink.

8.0 CAUSAL MAP

Figure 6. Causal Map for Renewable Energy



8.1 Reinforcing Loops

R1: Climate Change and Ecosystem Health (O-O)

As climate change increases, the health of the ecosystem will decline over time due to the increasing temperatures and the greater occurrence of stronger storm systems. As the ecosystem health deteriorates, (i.e. loss of foliage, and glacial ice) the more CO₂ will remain in our atmosphere. Glacial ice will release great amounts of CO₂ and the reduction of trees will decrease the amount of CO₂ absorbed by the ecosystem.

R2: Use of Renewable Energy and Rural Renewable Energy Infrastructure (S-S)

As the use of renewable energy increases, the rural renewable energy infrastructure will increase with it. In order to keep up with the new sources of energy, these rural areas will be forced to construct their own infrastructure.

R3: Use of Renewable Energy, Job Market, and Climate Change (S-S-S)

The increase in use of renewable energy will create many jobs throughout the world. There will be a strong need for jobs for the construction of such sites and also the maintenance of these technologies. As the job market increases, with a time lag, climate change will also increase with the added amount of employment. This may come from the increased number of cars used by the working class as well as increased wealth that would lead to an increase in population. This is another reinforcing loop that has dire consequences that are not even part of this report.

8.2 Balancing Loops

B1: Use of Renewable Energy and Climate Change (O-S)

As the use of renewable energy increases, the hope is that climate change will decrease due to less CO₂ emissions, after a large time lag. As climate change continues to decrease, we would also see a decrease in the use of renewable energy because our focus would now turn to other issues at hand once the climate change issue has been handled. This can more easily be understood by an increase in climate change will lead to an

increase in the use of renewable energy, labeling this part of the loop “S”. This would then become a balanced system in which we have a certain amount of renewable energy use in which we are no longer causing climate change from our energy consumption.

B2: Use of Renewable Energy and Fossil Fuel Prices (O-S)

An increase in use of renewable energies will lead to a decrease in demand for fossil fuels and at a given quantity of supply for fossil fuels this will lead to a decrease in price. On the other side of things, as fossil fuel prices increase, the use of renewable energies will also increase as we try to stay away from the use of expensive fuel options. This leads to a balancing out of this system with fossil fuel prices finding their equilibrium point with an increase in renewable energy use.

B3: Use of Renewable Energy and Dependency on Foreign Energy Sources (O-S)

It is clear to see that as we increase our use of renewable energies, we are decreasing our dependency on foreign energy sources because we are now harnessing the energy on our own in a more localized setting. Conversely, if we were to see a rise in our dependency on foreign energy sources, we would surely look to increase our use of renewable energy to shy away from the increasing dependency on foreign energy. This would then create a yet another balancing situation between these two occurrences.

B4: Use of Renewable Energy and Ecosystem Health (O-S)

With a large time lag, an increase in the use of renewable energy would increase the overall health of the ecosystem due to less CO₂ emissions and the less harmful extraction of other sourced of energy from our earth. On the other side of things, a decrease in ecosystem health would then lead to the desire for an increase in the use of renewable energies. This too creates a balancing loop which aims to keep ecosystem health as healthy as possible.

8.3 Other Trends

Dependency on Foreign Energy Sources and Fossil Fuel Prices (S)

If our dependency on foreign energy sources were to increase, we would be unable to control the prices that they would charge for their energy. They could charge whatever they would like because we would have less and less of an option. So an increase or decrease in our dependency would lead to an increase or decrease in fossil fuel prices respectively.

Fossil Fuel Prices and Rural Renewable Energy Infrastructure (S)

As fossil fuel prices increase, there would be a stronger desire to use renewable energy and thus creating an increase in rural renewable energy infrastructures to help these rural communities to harness their own energy.

Rural Renewable Energy Infrastructure and Job Market (S)

As the infrastructure for renewable energy in rural areas increases, the need for jobs to build and maintain these facilities will also increase thus creating a similar trend between the two.

9.0 INDUSTRY ROLES/IMPACTS

Industry is directly involved in the causal mapping, sometimes as a direct cause for some of the actions on the map. Industry is the main consumer of the energy produced whether it is from renewable or non-renewable sources as it needs transportation and power to operate. Consuming power generated from fossil fuels, promotes the increased production in fossil fuel energy. The energy generation from fossil fuels releases vast amounts of air and water pollution into the environment lowering the ecosystem health. Also the carbon dioxide released from the combustion of fossil fuels directly contributes to global warming, increasing the amount of climate change. Increasing pressure from the public regarding these adverse effects to the global environment has created a need to switch to cleaner sources of energy. According to the causal loop diagram, as the

ecosystem health decreases renewable energy increases. Over time as renewable energy increases, the ecosystem can recover and increase thus creating a balancing loop between renewable energy and ecosystem health. A similar loop exists between renewable energy and climate change. Most of all, the oil business is very profitable and as long as consumers are willing to buy oil, the industry will continue to sell it at a high price. Until renewable energy becomes more prevalent, increasing oil prices will be the norm. Once renewable energy is widely available, the demand for oil will decrease which will lower the price.

The industry will be greatly affected by the consequences of renewable energy both positively and negatively. The industry will be impacted positively at first by the boom in necessity for renewable energy sources. This will create wide spread increase in the job market for both the constructing and maintaining of these newly developed facilities. After some time however, this may lead to a decrease in the use of other energy source facilities which could lead to the laying off of the employees at these sites. Even though this is a negative impact on the industry, it needs to be seen that renewable energy will both create jobs as well as impact many other areas of the world in numerous ways.

Industry also plays a large role in how energy is bought. If renewable energy becomes more widely available and cheaper than other sources of energy, then this will force industries to buy renewable energy thus increasing the demand for renewable energy. This will create a reinforcing loop for the development of renewable energies. The industry sector of the world accounts for a significant amount of the world's total energy consumption. If this sector slowly switches over to renewable energy, the impact on the renewable energy market would be tremendous, forcing more and more companies to invest in these new technologies allowing them to grow to heights that we could have only dreamed about a decade ago. The key to a successful transition from current energy sources to renewable energy sources lies with the industries role in the matter. The rest of society will "follow the leader."

10.0 SUSTAINABILITY RECOMMENDATIONS

Although renewable energies are gaining support worldwide, fossil fuels are still the most relied on source of energy. In order for renewable energy to make a substantial impact on reducing pollutants and reducing damage to the ecosystem, renewable energies must replace traditional fossil fuel resources as the primary source of energy generation in the world. Federal and local governments across the world must take steps to promote, support, and encourage growth in renewable energies. Likewise, industry must take the necessary steps to switch from primarily using fossil fuels sources of energy to renewable energies in order for renewable energy to be part of a sustainable world.

Ideally, industry sees the damage to the environment that results from the production of energy from fossil fuels and switches to cleaner, renewable sources of energy. However, the probability of this happening is next to zero. Industry as a whole is not likely to make this switch unless it is financially beneficial. The energy industry is in a prime position to lead this change. Rather than invest more money into finding the remaining oil reserves and drilling further out to sea to find oil, this money could be spend developing renewable energy technologies and making them more efficient. Already the price of some renewable energy is cheaper than the traditional sources. In a study performed by the Rocky Mountain Institute in the electricity market, wind cost 4.2 cents per kilowatt hour compared with 4 cents for coal and 9.1 cents for oil.²⁶ Industry as a whole would use wind energy since it is cheaper assuming that there is enough energy to fulfill the industry's need. It is up to the energy companies to expand wind energy capacity and renewable energy capacity as a whole so renewable energy can be more widely used by industry. Even though the price of traditional energy is increasing, oil and energy companies are still recording record profit. In 2006, Exxon reported \$36.13 billion in profit, a record in U.S. history.²⁷ Thus, the energy industry will not be prone to change over to renewable energy unless given extra incentives.

²⁶ Chea, T. (2004). *Rising Fossil Fuel Costs Boost Renewable Energy*.

²⁷ *Exxon Mobil Post Record Profit*.

The government can play a role in encouraging companies to invest and expand the use of renewable energies. Since most of the energy industry is heavily invested in oil, the government can offer rebates and incentives for growth in renewable energy. Incentives can be given for growth in the capacity of renewable energy or by subsidizing research or initial construction costs for renewable energy. Both federal and local governments have a role to play. The State of California has launched the Million Solar Roofs Initiative. This initiative would give those with a solar power system on their house a cash incentive to lower the cost of electricity as well as give them federal tax incentives which could cover over 50% of the total cost of such a system.²⁸ The Federal government could also similar incentives or it could establish programs to build new renewable energy plants. Regardless of the method used to increase the use renewable energy worldwide, the government, private industry, and individual must have a commitment to uses renewable energy to create a more sustainable world.

²⁸ State of California. *California Solar Initiative*.

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