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Power Up: Live Solar

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Section One

Background

Thesis Proposal

BACKGROUND

Most of the energy in the United States comes from fossil fuels — coal, oil, and natural gas supply approximately 85% of all our energy needs. This accounts for nearly two-thirds of our electricity and virtually all of our transportation fuels. It is likely that the United States reliance on fossil fuels to power our expanding economy will continue to increase over the next two decades. The U.S. Department of Energy estimates that residential energy use in the United States will increase 25% by the year 2025. Unfortunately, the process of creating energy generates significant and dangerous levels of pollutants: 10.3 million tons of sulfur dioxide, 3.9 million tons of nitrogen oxides, 2.4 billion tons of carbon dioxide, and over 50 tons of mercury each year. These pollutants are dangerous to our environment, our public health, and our economy.

Global Warming

Among the gases emitted when fossil fuels are burned, one of the most significant is carbon dioxide, a gas that traps heat in the earth's atmosphere. Over the last 150 years, burning fossil fuels have resulted in more than a 25% increase in the amount of carbon dioxide in our atmosphere. Carbon stored over millions of years is being released in a matter of decades, disrupting the earth's carbon cycle in unpredictable ways.

Since reliable records began in the late 1800s, the global average surface temperature has risen 0.5-1.1 degrees Fahrenheit. Scientists with the Intergovernmental Panel on Climate Change concluded in a 1995 report that the observed increase in global average temperature over the last century "is unlikely to be entirely natural in origin" and that "the balance of evidence suggests that there is a discernible human influence on global climate."

Climate scientists predict that if carbon dioxide levels continue to increase, the planet will become warmer through the 21st century. Projected temperature increases will most likely result in a variety of impacts. In coastal areas, sea-level rise due to the warming of the oceans and the melting of glaciers may lead to the inundation of wetlands, river deltas, and populated areas. Altered weather patterns may also result in more extreme weather events, and inland agricultural regions could suffer an increase in the frequency of droughts.

Health Issues

Not only are these emissions toxic to the planet, they constitute serious public health problems. In a recent report produced in association with the Environmental Protection Agency, Abt Associates concluded that fine particle emissions from fossil fuel electricity generation leads to severe health problems for many Americans each year.

Similarly, the Center for Disease Control found the effects of air pollution on human health and the environment also have economic impacts. For example:

1. The health costs of exposure to outdoor air pollutants range from \$40 to \$50 billion.
2. People with asthma experience more than 100 million days of restricted activity, costs for asthma exceed \$4 billion, and about 4,000 people die of asthma.
3. An estimated 50,000 to 120,000 deaths are associated with exposure to air pollutants.

Limited Supply of Fossil Fuels

There is a limited supply of fossil fuels simply because there are no sources being created. As a result, estimates suggest that oil reserves will be depleted in 30 to 80 years. Coal supplies will be gone with in 150 years while natural gas deposits are projected to last slightly longer at 80-200 years. Although these are estimates, it is inevitable that the rate of consumption will increase in future years making it impossible to keep up with demand. As fossil fuel supplies diminish and demand increases, it will be essential to utilize other fuel resources.

Political Problems

Our country's fossil fuel dependence means that, in order to ensure our supply, we may be forced to secure access to foreign sources of oil. The first Persian Gulf War is a prime example: U.S. troops were sent to Iraq to guard against a possible cutoff of our oil supply. Through taxes, billions of dollars are spent protecting oil supplies with our armed forces. Reliance on Middle East oil also creates a danger of fuel price spikes or shortages if supply is disrupted. Today, approximately one-third of our oil comes from the Middle East. By 2030, if the United States does not change its energy policy, we may be relying on Middle East oil for more than two-thirds of our supply.(1)

Renewable Energy

Fossil fuels are not the only source of energy, and burning fuel is not the only way to produce electricity; however, reducing the U.S.'s dependence on fossil fuels is a challenge. Renewable energy, often classed as clean alternative energy, progress has been slowed by technological and governmental difficulties. As global energy consumption grows each year, development of certain alternative energy sources becomes increasingly important. The main benefit to utilizing these sources is that over time they replenish themselves, therefore, unlike fossil fuels, renewable energy sources can provide an endless source of power. Renewable energy sources also have much smaller environmental impacts than fossil fuels.

Most everyone understands that fossil fuels are finite and will eventually run out, so preparing for the inevitable is essential. The question people do not understand is what can replace fossil fuels and meet modern society's high energy demands? The solution is unlikely to be a single solution and will in all likelihood involve a mix of sources and technologies. Renewable energy industries, such as hydroelectric, solar, wind, and geothermal energy exist, but these energy sources currently only account for a combined 14% of energy consumed worldwide. Many of the technologies needed to harness these sources are still in their infancy, but they are technically improving all the time and will become cheaper to install as they become more common.

Currently, the five main renewable energy technologies are:

1. Wind
2. Water
3. Solar
4. Biofuel
5. Geothermal

All five of these renewable energy technologies must be further integrated into mainstream use in order to meet the global appetite for power and electricity. However within this group, solar energy has the greatest potential.

In fact, solar radiation provides the greatest amount of available energy of all renewable energy resources. The earth receives more energy from the sun in just 1 hour than the world uses in 1 year. It is estimated that photovoltaic panels covering an area of approximately 110 miles by 110 miles—or one-third of the land area currently covered by roadways—could supply our nation's total annual electricity needs (2).

In addition, it is clean. So clean in fact, energy obtained from the sun has zero pollutants. Solar energy systems can reduce the impact of global warming and other environmental externalities by reducing fossil fuel consumption and related pollution. [Get more information regarding pollutants from PV manufacturing from Liam]

In comparison to the other leading resources, solar panels need little maintenance and last over 30 years. [This will be an information graphic]

- » Wind turbines, being mechanical devices, require some maintenance throughout their lifetime. Most modern turbines require minimal maintenance and are designed for long-term reliable service. Depending on the machine, it can be as simple as performing an annual visual inspection and possibly replacing the blade leading edge tape every three to five years.
- » Hydroelectric dams also have many moving parts involved in the hydroelectric power process, the lifespan of a hydroelectric plant is about 50 – 100 years. These moving parts wear out easily and must be replaced.
- » Geothermal sites are capable of providing heat for many decades. However, eventually locations may cool down because there is only so much energy that can be stored and replenished in a given volume of earth.
- » Biofuel requires developing crops to burn for energy. There are multiple factors in the process of making energy from biofuels, such as burning of biomass produces greenhouse gases. Also, collection, harvesting, and storing raw biomass materials is expensive, especially considering the large volumes required compared to fossil fuels. If biofuels are to replace fossil fuels, these crops will take up huge amounts of land that might be necessary for growing food. (3)

Another advantage of solar energy is it allows for use off grid in remote areas that do not have access to power grids. Power travels from the power plant to your house through a system called the power distribution grid. Grid energy storage lets electric energy producers send excess electricity over the electricity transmission grid to temporary electricity storage sites that become energy producers when electricity demand is greater, optimizing the production by storing off-peak power for use during peak times. Photovoltaic users can avoid the necessity of having battery storage by connecting to the grid, which effectively becomes a giant battery. Photovoltaic operations can store electricity for night time use.

Obstacles to Solar Energy Implementation

With all these benefits, why is solar energy producing less than 1% of the U.S. energy supply? First, it is expensive to build solar power stations, largely because of the high cost of the semi-conducting materials used in building one. The cost of solar energy is also high compared to non-renewable utility supplied electricity. Solar cells cost a great deal when compared to the amount of electricity they can produce over their life cycle. Secondly, there is a lack of government support. This includes the lack of policies and regulations supporting development of a renewable energy infrastructure for energy storage and distribution. Another obstacle, according to the National Renewable Energy Laboratory, is a lack of information dissemination and consumer awareness about the advances in solar energy technology.

Argument for More Research

Photovoltaics (PV) are a solar power technology that uses solar cells to convert light from the sun directly into electricity. Because solar cells are semiconductor devices, they share many of the same processing and manufacturing techniques as computer and memory chips. Single crystalline wafers, which are used in the semiconductor industry, can be made into excellent high efficiency solar cells, but they are generally considered to be too expensive for large-scale mass production.

The most important issue with solar panels is installation and materials. Because of increased demand, the price of silicon has risen and shortages occurred in 2005 and 2006. As of early 2006, the average cost per installed watt for a residential sized system was about \$6.50 to \$7.50, including panels, inverters, mounts, and electrical items.(4) [Comparison chart with costs of nonrenewable costs per watt]. In order for PV cell costs to become competitive, scientists need to develop less expensive and more efficient manufacturing techniques. However, scientists can not accomplish that goal without greater financial support and recognition for their research.

Among the American public, solar power must overcome a general lack of awareness of the benefits and availability of solar photovoltaic systems. Part of this awareness problem stems from the fact that solar power is not offered as an alternative to natural gas and coal by local utilities in many areas of the country. Because it is not offered, it is not something that many customers know about, thus is not in high demand. The PV market will grow faster through customer education of the benefits that solar energy provides, which will in turn, increase the number of customers who choose to generate portions of their electricity from solar power.

In fact, research has uncovered many reasons for new consumer interest in solar power. In a study of Colorado homeowners, some of the identified motivations for adopting solar energy include a desire to replace the use of fossil fuels for electricity production, that sunlight is a particularly good renewable source in the state, concerns over sustainability for future generations, and the belief that a solar energy system would be a good investment. Significantly increasing investments in solar energy research is important for the United States in a number of ways. For example, more funding can bring solar power into the American mainstream market faster, which will be critically important in helping transition away from an economy dependent on fossil fuels. (5)(6)

According to a survey conducted on behalf of Energy Future Coalition, American voters support a new, bolder energy policy, even if it might cost billions of dollars more. Nine out of ten voters (91%) support the view that "the country is facing an energy crisis. Having reliable energy is fundamental to economic prosperity, our national security, and protecting the environment. We need more ambitious and creative thinking behind a new energy policy for the future." Just nine percent (9%) of voters agree with the statement, "There is no energy crisis facing this country. We are meeting our energy needs and prices have stabilized. Radically changing our energy policy would require billions of dollars, and there are simply too many other priorities right now." (7)

How Can Design Help?

Design can help increase the American public's understanding of solar energy research. This understanding can lead to public support — support that can influence lawmakers to make investments in solar energy research.

Advertising and mass media campaigns are a proven, tested vehicle for:

1. Raising awareness of a public problem (ex: the current crisis in funding solar energy research)
2. Provoking the public to take action (ex: write your congressman in support of solar energy)

A secondary benefit would be promoting science research in general at a time when the American public is falling behind the rest of the world. There is consensus that science is poorly understood and often misrepresented to the public, the news media, and to political decision-makers. Informed understanding of the nature and value of science is necessary in order to gain public endorsement of scientific endeavors and public support for more government funded research. (8)

How Advertising/Mass Media Campaigns Work

The primary application for persuasive campaigns is through the mass media. According to University of California-Santa Cruz Professors of Psychology, Anthony Pratkanis and Elliot Aronson, "A successful persuasion agent can use any number of influence tactics capable of inducing the target to think positively about an issue or course of action. However maximum influence is most likely to occur when four main stratagems of influence or general maneuvers for obtaining compliance are accomplished."

1. Pre-persuasion: Take control of the situation and establish a favorable climate for your message. This refers to how the issue is structured and how the decision is framed. If done successfully, it establishes "what everyone knows" and "what everyone takes for granted"
2. Source Credibility: The communicator needs to appear like authoritative, likable, and possess attributes that could persuade an audience.
3. Message: The message that focuses the audience's attention on powerful information or imagery.
4. Emotions: Arouse and emotion and then offer the audience a way of responding to that emotion that happens to be positively towards the desired course of action.

These strategies date back to Aristotle's Art of Rhetoric theory of Ethos, Pathos, and Logos. (9)

1. *Ethos* is an appeal to authority. It is how well the speaker convinces the audience that he or she is qualified to speak on the particular subject.
2. *Pathos* is an appeal to the audience's emotions.
3. *Logos* is logical appeal. It is normally used to describe facts and figures that support the speaker's topic.

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Case Studies

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Section Two

Design Brief

DESIGN BRIEF**Primary objective**

The goal of this project is to educate the general non-science American public about the need for, economic importance of, and the benefits of funding solar energy research.

Secondary objectives

To generate public support for solar power

To educate the general public, especially the science apathetic public, about the value of scientific research and development

AUDIENCE**Primary**

Because this campaign will target the general adult population, it is important to attract US citizens that can vote in order to influence their elected officials regarding solar energy research funding. This audience will be familiar with some current issues in renewable energy, and therefore likely respond positively and actively to the campaign. They are well educated, financially secure, and consider themselves active in the community.

Secondary

The secondary audience will be the public who is new to the idea of renewable energy sources. This campaign will give them tools to become proactive in the current debate over solar energy research and development.

DESIRED OUTCOMES

People take a more proactive role in supporting science research

1. Public signs online petitions that are sent to their congressman
2. Encourage science education throughout their community

CAMPAIGN PERSONALITY

Intellectual and entertaining — a balance between smart and fun

Proactive and community oriented

Forward thinking, welcoming, engaging, and inspiring

Contemporary

Professional and credible

APPLICATIONS/VEHICLES

This project is a public educational campaign which will consist of a series of traditional print advertisements. Because this project should be seen by as many people as possible, a portion of the campaign will be focused on the Seattle Metro bus system. This blanket approach is likely to reach 20% of the daily 216,588 Seattle bus riders on a daily basis. Also, exterior bus boards will travel across a 2,100 square mile area and be seen by many of Seattle area's 1 million residents.

A series of posters that visualize solar energy information that target public libraries, community centers, and other appropriate locations to drive interest in solar energy research.

A series of small information postcards that can be distributed at museums, newsstands, coffee shops throughout Seattle which can be directed towards the primary audience. These cards will provide a teaser information to encourage further investigation via the campaign website.

Nontraditional advertising might include kiosks that feature solar based materials. Placed in high density areas, these kiosks would give additional information regarding the benefits of solar energy. They would also be a venue to see photovoltaic cells in operation.