A photograph of a pond with many green lily pads. A single white lily flower is in bloom in the middle-right area. The background is a soft-focus forest with trees and foliage.

# Innovation Space:

Creating Sustainable Solutions with Nanotechnology, Energy, &  
Equity for  
Native Americans Living Off the Electricity Grid

**Fall 2008**

**Center for Nanotechnology in Society  
(CNS)**

**Innovation Space**

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Solstice is a cooking appliance that utilizes free energy to conveniently, cleanly, and efficiently cook food. This green product enables off-the grid individuals to cook home-made meals without the high cost of natural gas (or propane/butane) and the environmental/personal harm of open-fire cooking. This cooking device also decreases a great deal of the labor individuals without electricity must endure in cooking, providing a fuel source available right to the doorstep. Solstice is a small device, resembling an outdoor grill. The product holds a dual function and can also be conveniently folded up for inside cooking. Along with side solar panels, glass will cover the “stove top” to ensure the high amount of heat needed in cooking is available within a short amount of time. A turn dial on the front of the device will allow the user to adjust heat for different cooking needs. The “stove top” will be coated with non-stick nano-coating so that food may be “grilled” directly on the glass screen like a typical barbeque. This non-stick coating also ensures that no raw meat particles remain on the device, providing a sanitary cooking device at all times. The light-weight glass screen can also be pulled up to place food inside for traditional oven-baked goods. An energy storage device utilizing nanotechnology will allow unused energy to be gathered and used later in the evening. The appliance sits on a stand that can be adjusted to the user’s comfortable cooking height, and can be easily folded up when the user desires to cook inside his or her kitchen. Handles on both sides make it as easy for users of all ages to carry the lightweight product as they would a lunchbox.

Solstice will free both rural and urban cookers from fossil fuel dependence. The appliance will significantly lower basic costs of living by utilizing free energy. The firm and the appliance are both designed to bring energy independence and financial stability to rural users living off the electric grid. The product is also designed to liberate urban dwellers from not only fossil fuel dependence, but also from an electricity mindset. The product will significantly decrease the urban resident’s energy utility bill. It will return the natural beauty to the rural dweller’s land (as fewer fossil fuel plants in rural areas will be used to supply urban electricity), thus decreasing climate change for everyone. Focusing on the triple bottom line (social, environmental, and economic profit) Solstice proves that technology should equal progress, in terms of convenience, quality, and eco-friendliness for all users. Using Solstice enables users to reverse climate change one person at a time.

Roughly a quarter of the world’s population is without electricity. Something as basic as cooking often becomes an extremely labor intensive process. Whether it is driving twenty miles to fill up a gas tank, chopping logs by hand, or gathering biofuels, simple cooking is anything from simple. Pinpoint will compete with other renewable energy capturing devices, most specifically the basic solar oven and any other cooking devices that utilize renewable energy and enter the consumer market. Solstice will experience its greatest

profit growth within a few years, when the general public realizes the countless benefits their eco-friendly acquaintances receive from using Solstice and decide to purchase the product as well. Pinpoint's business strategy with Solstice includes dual market penetration. The original device will be developed to meet the daily needs of off-the grid rural individuals. However, an adaptation of the original product will be marketed as a convenient and green product to the secondary market-upper-middle class city dwellers. The business strategy involves making Solstice accessible to lower-income rural individuals by selling it at a loss to individuals in this market. This step will not only increase brand recognition and greatly assist these populations in economically meeting a need, but will also improve the positive image of the firm. Pinpoint will be able to sell products at a loss to the primary market by using revenue from sales to the secondary market. The benefits Solstice provides to rural individuals will be promoted through strategically formulated advertising campaign (appearing in online newspapers and green magazines) marketed toward eco-friendly and equity conscious city dwellers. Ten percent of the revenue obtained from this secondary market will go toward providing rural, off the grid individuals with the product, an aspect that will be heavily advertised.

The design of Solstice will be slightly adapted to specifically target the upper-middle class eco-friendly market niche and will be sold at a relatively high price-point to these individuals to make up for small profits in the primary market. The original product will be sold through trading posts and other small-town shops to the original target market. It will be sold online and through a select few outdoor-gear retailers to the secondary market. Having minimal retail presence for the product will increase the green as well as the commodity image of the good and will minimize resources needed for facility maintenance, thus reducing overhead costs. Once ordered online, the product will be shipped in minimal packaging to reduce raw materials and fuel costs needed in transport. The firm will also enter into transport agreements with other firms to ensure that product "carpooling" is maximized. After Solstice's initial dual-market presence, slight design innovations and customization options such as color personalization will take place annually, creating greater demand in the secondary market.

Mantra: "Energy independence"

Tagline: "Stop paying for free energy" "Let Mother Nature Do the Cooking"



Loop reduces waste and eliminates the need to transport organic waste to landfills. Loop utilizes every scrap of organic waste and circles it through a “looped” process to turn trash into treasure- a usable energy source. With over 1.6 billion people, (or one quarter of the global population) worldwide without electricity (Global Issues), Loop is designed to provide rural dwellers with a clean source of energy that can be used in daily household tasks. Studies have shown the direct correlation between electricity in homes and education levels. Loop will therefore bring not only energy independence, but will increase opportunity, enabling those currently without electricity to enjoy night-time leisure and educational activities such as reading. To eliminate potential for toxicity, Loop is designed to function with only organic waste and will reject any non-organic products put into the appliance. The product will also cut down on the amount of waste in landfills, as a substantial amount of the earth’s surface is now covered with trash. Loop is an easy-to use product that encourages the re-use of resources and makes disposing of waste significantly less labor intensive. To create a clean energy source, the user simply turns on Loop and inserts organic waste into the device. The organic waste is then dehydrated and passed through a cycle to produce a clean energy source. The clean energy source produced by Loops will be similar to wood chip but will be clean-burning and non-hazardous. The device is designed to not only decrease the labor-intensive life individuals without electricity face, but to also decrease the burden of not having sanitary services (many resort to burning their own trash or must let trash pile up outside until an opportunity arises to travel to the distant landfill). Loop will also make the lives of urban individuals more convenient while simultaneously promote the recycling of many non-organic but recyclable materials that cannot be put into Loop. The device is also designed to discourage the burning of waste by placing a value on organic waste that cannot be traditionally recycled but rather re-used to produce household energy using Loop.

Loop will not only free individuals all over the globe from a dependence on fossil fuels, but empower households to become self-reliant and self-sustainable as well. Rather than having the burden and cost of relying on a utility company, each home will be able to sustainably produce its own energy using Loop. This personal energy provider will also spark the beginning of an entirely new mindset toward thinking about a sustainable future. The device will use renewable and readily abundant sources of energy (such as solar power), and will produce no harmful by-product. Aside from its clean energy output, the device’s only by-product will be clean water that can, when passed through the optional filter attachment, become potable water.

The rising cost of fossil fuels as well as new governmental regulation on CO2 emissions will create great demand for this device. Also, as individuals all around the world become more environmentally conscious as a result of the “Go Green” movement, and an increasing awareness of the negative effects of climate change, consumers will see the

countless benefits of using Loop. Our primary market, off-the grid individuals living on American Indian reservations, will see the practical and immediate benefits of using Loop: In a manner respectful of the land, the device conveniently and economical produces energy and disposes of organic waste. Our secondary market, urban city dwellers, will see these same benefits, but will also desire the product because of its convenience factor. Roughly the size of a trash bin, the device will save users the time they must dedicate to frequently take out the garbage. Because of the scientifically tested nano-coating on the interior of the device, it will emit no odor and will therefore allow crowded city dwellers a more relaxed life as they no longer have to choose between taking the trash out daily, giving up valuable cabinet space, and a smelly kitchen. An educational program would also be implemented with the product, encouraging residents to dedicate this saved space to a recycling bin. City dwellers will likely be more trend-conscious, and the product's design for this market will reflect this. Because of the design up-grade, Loop will be sold at a higher price point to urban residents than to rural individuals. This taste difference will allow Pinpoint to sell Loop at a low price point to rural dwellers and recover from this low profit by high sales margins from the urban market. After a significant amount of sales in the secondly market, profit will be used to donate a number of low price-point Loop to lower-income rural dwellers as part of a push marketing campaign to promote user awareness and brand recognition. These users will voluntarily serve as a test market for the product and will frequently take part in customer satisfaction surveys to continually improve Loop for its market launch into the global urban marketplace. The product's success in the rural marketplace will be strategically advertised to build brand-image through print-based and online media such as "green" magazines, a select few technology magazines, and leading business newspapers such as The Wall Street Journal and The Economist. Advertising in The Economist will be targeted to the European consumer, as tight space restrictions and high fossil fuel prices make this a promising aspect of the secondary market.

In rural areas such as Indian reservations, small towns, and eventually global villages, the original product will be distributed through local stores and trading posts (on reservations). However, the more upscale product designed for city-dwellers will be initially be sold exclusively at high-end home improvement stores such as Lowe's to experience the profit-growth necessary to offer the product to the primary market. Eventually, product awareness will reach the mainstream market and will be available in stores such as Target and Wal-Mart, where the product will be strategically placed with other renewable energy devices and traditional appliances as well.

Mantra: "Energy independence"

Tagline: "Trash to Treasure"

EVERWELL



Everwell is designed to keep individuals healthy by providing them with a constant source of purified drinking water. Everwell is an outside device that utilizes internal and external temperature differences to create water for individuals living in rural settings with no in-door plumbing. The nanocoating on the product will allow it to maintain a constant temperature well below the atmospheric temperature. This temperature difference creates dew on the exterior of the product's surface, which is then brought inside the device where it is filtered into pure drinking water. The nanoparticles on the surface's exterior follow the Lotus effect, keeping the device clean without the need for any artificial cleaning materials. This same coating also prevents the growth of mold or other bacteria. The actual structure of the device will be made up of carbon nanotubes to ensure that the product is lightweight enough to be transported and sturdy enough to withstand rain, storms, and other environmental wear and tear. Collapsible water bottles are attached to the sides of the device and can be removed and brought into the home when desired. The bottles are automatically filled as collected water is filtered and available for use. As the bottles are being removed, the hole automatically closes so not a drop of water is wasted in the process.

Roughly twenty percent of the world's population does not have access to clean drinking water (Ethos 2008). Everwell will serve the needs of rural dwellers who must endure long, labor-intensive commutes to obtain water for drinking and other household purposes. Many members of the target market (American Indians living on reservations) must drive upwards of thirty minutes to fill up barrels of water for household and livestock use. Thus, Everwell will convert water-retrieval into a simple and economical task, simultaneously eliminating the fossil fuels consumed by vehicles in water commutes. After initial success in the target market, Pinpoint will pursue global expansion, targeting the product to rural inhabitants in developing nations. With increasingly long drought seasons, a likely negative effect of climate change, many people around the world struggle to obtain daily rations of water. Furthermore, the combination of a nonexistent water infrastructure (as seen on Indian reservations) with a lack of transportation means causes certain individuals to bear the burden of retrieving and delivering water to others, often carrying it on their backs).

Everwell will ensure that no individual with this product will lack basic water needs. It will also provide the convenience of readily available water that residents in industrial nations take for granted when turning on the faucet. Because of the basic need that the product meets, it is designed for practical use and blends in well with the natural environment of its outside surroundings. Therefore, the design of Everwell will never go out of style and the product will constantly see high demand. The nanomaterials utilized

in the product are materials that are already available in consumer goods and have therefore already undergone extensive safety and health testing, ensuring that the water produced is completely sanitary. Upon request, Pinpoint will disclose any available information concerning these materials to the public and will ensure that concerns for or lack of knowledge about nanotechnology do not hinder any individual from having fresh drinking water.

The product will be marketed differently in its different markets. For the American Indian population, the product will be advertised through local newspapers as bringing a gift of nature right to the home. This reliable, life-bringing device will be sold at an extremely low price-point in all markets in order to profit from “the fortune at the bottom of the pyramid,” rather than profiting from the wealthiest elite of the global population. However, the product will be marketed differently in developing nations, especially those where drought is prevalent and humidity is high. This product will meet the most immediate needs of the poorest individuals in the world and therefore will not partake in many traditional marketing approaches. Instead, the product will be advertised in a select set of magazines and newspapers aimed at the purchaser rather than the end-user. These advertisements will show the product’s benefits and past success in providing a basic human need. Pinpoint will establish working relationships with charity organizations who will advertise Everwell by urging organization members and donors to purchase the product for individuals in the country of their choice. Since the initial profit from selling a product at an extremely low price-point is low, Pinpoint will petition start-up funding from Ethos Water because of the firm’s relevance, as a supplier of sanitary water to Africa. Everwell will be distributed directly through humanitarian aid distribution partners that have direct contact with the target user. A few years after the product’s initial run in the marketplace, Pinpoint will unveil complementary products to the U.S. market that attach to Everwell, including a heavy-duty hose that would bring the filtered water directly into the user’s home. As a not-for-profit company, these convenience accessories will enable Pinpoint to gain revenue, investing all assets directly toward further product distribution to impoverished regions.

Mantra: “Small Solutions to Big Problems” (Pinpoint Mantra)

Tagline: “EverWater, Everwell” “End World Thirst”



## **Executive Summary**

### ***Political and Legal Environment***

The Preliminary Strategic Business Plan was written before the results of the 2008 presidential election. However, because of the election results, only Barack Obama's energy policy will be implemented into governmental policy. Obama's major energy changes include: reducing federal energy consumption, increasing energy efficiency for all governmental buildings by 40 percent in 5 years, implementing programs so that all of these buildings create zero emissions by 2025, investing in "low emissions coal plants," promoting domestic energy production, and encouraging development of "clean coal" technology. He also plans on creating financial incentives to improve energy efficiency, creating a digital Smart Grid, re-engaging in the U.N. Framework Convention on Climate Change, promoting the green industry, improving automobile efficiency, and lastly, reducing America's energy consumption.

### ***Economic Environment***

The economic recession is aiding the sustainability movement on a corporate level as companies are finding the financial benefits in "going green." However, on an individual level, the economic recession may hinder consumers from purchasing more eco-friendly products due to tight budget restrictions. As a result of the economic crisis, Pinpoint must work to cut costs at all steps of the innovation process, offering practical solutions to global problems.

### ***Sociocultural Environment***

The movement to "go green" will have a large impact on Pinpoint's environmentally friendly products. As these products utilize nanotechnology to create new solutions to current human and environmental problems, societal concern regarding the health and safety of nanotechnology becomes a crucial factor to be considered. Educational campaigns are essential in informing consumers about nanotechnology so that if consumers do hold moral opposition toward the science, it has at least been formed in an educated manner. Thus, it is essential that Pinpoint educate consumers on nanotechnology's ability to clean toxicity from materials and create more green ways of producing energy and solving basic human needs. The hope is that this will reduce societal opposition to the introduction of solutions that have the ability to sustain life through nanotechnology.

### ***Industry/Competitive Environment***

Increasing scientific research in nanotechnology is causing the industry to grow and become more prevalent in consumer goods. The demand for green products is growing, causing great potential for nanotechnology products that increase the energy efficiency of components used in alternative energy sources. This provides Pinpoint with great

business opportunities in meeting the needs of this market niche. Pinpoint competitors are companies currently utilizing nanotechnology in consumer goods and specifically those companies utilizing nanomaterials in renewable energy sources.

### *Technology*

Nanotechnology is “the understanding and control of matter at dimensions between approximately 1 and 100 nanometers, where unique phenomena enable novel applications” (NNI 2008). Due to the different properties that elements exhibit on the nanoscale, this technology provides many revolutionary solutions ranging from lighter, more durable products in consumer goods, enhanced health care solutions, the extraction of toxic elements from materials, and enhanced extraction and storage capabilities for energy obtained from renewable sources. Lastly, and perhaps the greatest potential benefit nanotechnology holds, is its role in solving global issues related to social inequity by providing energy and resource access to a greater number of individuals.

### *Suppliers*

The main product suppliers will be firms that create nanomaterials needed in Pinpoint products. Start-up nanotechnology firms will utilize outsourcing capability to produce nanomaterials and also to create a lean supply chain to ensure that products quickly reach the users in need. Pinpoint will use local distributors to reach rural, off-the grid American Indians living on reservations, selling the products at small stores and trading posts. To encourage local economic growth, these distributors may become regional product dealers, creating an inter-connected group of regional dealers around the country. However, in order to cut overhead costs, no central headquarters will exist. Instead, supply chain communication and strategic planning will take place virtually. For certain products, humanitarian organizations will act as product distributors to ensure that Pinpoint products enable individuals in natural or human-made disasters to meet basic needs.

### *Market Opportunity Analysis*

Pinpoint’s primary marketing strategy involves profiting “from the fortune at the bottom of the pyramid.” This business strategy, as explained by C.K. Prahalad in his book of this title, involves creating profit by targeting consumers in developing regions. Pinpoint will finance these operations by dually targeting a variety of its products to the upper-middle class market niche. By employing a dual market strategy of selling products at a low price-point to the primary target market and at a higher margin to the secondary market, Pinpoint will reach a larger customer base and build brand recognition as well as recognition for the nanotechnology and energy industry.

### *Mission Statement*

Pinpoint's overall objective is to utilize nanotechnology to solve large-scale global inequity in the energy sector by "bringing small solution to big problems." Pinpoint is in the business of bringing practical, easy to use products to rural individuals to meet daily needs in eco-friendly ways that will simultaneously improve living conditions. Pinpoint's green products are innovative and revolutionary- both in concept and in product design. Utilizing state of the art nanotechnology, Pinpoint products will create solutions previously unheard of by utilizing nanotechnology and biomimicry, all while focusing on creating hope and freedom from fossil fuel reliance. Pinpoint will partner with humanitarian aid organizations, working together to create solutions for a sustainable future.

### *Objectives*

Pinpoint will ensure that product advertisements accurately depict the product's benefits without creating false promises in the eyes of the consumer. Marketing standards must be recognized at all times, keeping in mind the Pinpoint mission statement even when targeting the secondary market. Sales to the primary market should be in high-volume/low-cost ratios to ensure that a low price-point is implemented for this user group. The primary market will follow a push strategy to ensure that the product is available in all times of need. For the secondary market however, Pinpoint product sales will follow a pull operational strategy, providing users with the product as demanded. Cutting costs in the secondary market through this pull strategy will ensure that Pinpoint makes the revenue necessary to distribute its products to the primary market. Marketing campaigns will highlight past "success stories" of the product's advantages, personalizing these benefits so that the viewer sees the true value of the product and feels good about his or her purchase.

### *Strategies and Tactics*

Pinpoint's strategies and tactics are consistent with the firm's mission statement at all times. While each product will require different materials, the firm will undergo complete life-cycle analyses for each product, ensuring that all of the materials and components are ecologically neutral and of the utmost quality. Pinpoint's product strategy also includes creating more sustainable goods by enabling products to be assembled in parts, allowing for replacement with damage and/or technological innovations. Pinpoint products will be priced low for individuals in need, and higher for more privileged individuals, circling profit made from this market to create greater global equity.

## *External Environment*

### *Political/Legal Environment*

With the 2008 presidential election drawing near, many rumors have arisen about each candidate, including the hot topic of energy, often claiming that one candidate does or does not support a certain influential energy source or process. However, both candidates have clearly outlined specific energy plans for the nation's future. This leaves only the uncertainty of who will win and if he will truly implement all promised energy modifications.

Both of the presidential candidates have agreed that the United States is currently facing two major energy challenges: a dependence on foreign oil, and global climate change, both of which are due to a reliance on fossil fuels for energy. Though accounting for only five percent of the world's population, Americans consume about twenty six percent of the world's energy (Global Issues). On Obama's campaign website, he states that Americans consume far more energy than necessary due to lifestyle choices and the way that the communities have been constructed. He continues on, saying that the U.S. is only the twenty second most energy efficient country among the other major world economies as proof that the U.S.'s energy consumption is disproportionate. Furthermore, the average amount of electricity that an individual American uses has tripled since 1973. To combat energy waste, Senator Obama calls to reduce federal energy consumption and increase energy efficiency of all governmental buildings by forty percent in five years, implementing programs to ensure that all of these buildings create zero emissions by 2025. His plan includes ensuring that a fifteen percent reduction is achieved by 2015. (change.gov 2008)

Senator Obama's energy plan, "New Energy for America" addresses "...the moral, economic and environmental challenge of global climate change, and building a clean energy future that benefits all Americans" (change.gov 2008). One aspect of Obama's energy plan calls for investing in "low emissions coal plants" and working with the Department of Energy (DOE) and other partnerships to create five "first of-a-kind" commercial sized coal-fired plants, complete with carbon capture and sequestration, a process called "clean coal" technology. This is one aspect of Obama's plan that calls on investing \$150 billion over ten years to promote renewable energy, energy efficiency, biofuels, commercial plug-in hybrids, create a new digital electricity grid, and develop low emissions or clean coal power plants. Obama also plans on giving incentives to utility companies to improve energy efficiency that will result in reduced monthly energy bills for families and businesses. He plans to achieve this by changing the profit structure of utility companies so that, rather than profiting from increased energy consumption, they profit from performance based on increased efficiency. Obama's energy plan calls on the U.S. to be a leader in combating climate change, admitting that a solution to climate change will not come until all major carbon-emitting countries unite for a global solution. He plans to do this by re-engaging in the U.N. Framework Convention on Climate Change (UNFCCC- the primary international forum dedicated to addressing global warming) (change.gov).

Senator McCain notes that the federal government is the world's largest single consumer of energy in the world, estimated to spend approximately \$14.5 billion in energy consumption for the fiscal year of 2008. McCain wants the U.S. government, as the largest electricity consumer on earth, to lead by example by creating higher efficiency standards on new and existing buildings and by moving construction toward green technology. McCain, like Obama, also sees it necessary to end America's dependence on foreign fossil fuels and clean up carbon emissions to combat climate change. Both candidates' energy plans involve improving the nation's carbon footprint to become a leader in global green technology. Some key elements of both presidential candidates' energy policies include the smart grid, a cap and trade, promoting the green industry, improving automobile efficiency, and diversifying energy sources (The Lexington Project).

### *Smart Grid*

Smart Meter technologies enable programs to monitor and manage energy peaks and reduce energy consumption through increased efficiency. The Smart Meter utilizes new technologies to power and control electricity flow in order to more efficiently manage the grid. The Smart Meter also uses technology to analyze energy transmission and make this information available to the consumer, encouraging greater energy efficiency on an individual or household scale as users see the impact of their actions. Both candidates' energy plans involve investing in the Smart Meter grid, ensuring that it has the capacity to withstand plug-in hybrid vehicles as well. Senator McCain's energy plan also calls on reimbursing a quarter of qualifying Smart Grid investments (The Lexington Project).

### *Clean Coal*

Clean coal is a system in which carbon gas emitted from coal-burning energy plants is captured and transported to a storage site and then pumped underground for permanent storage. However, it is expected that this currently being developed technology may not be available for some time. The clean coal carbon capture and storage technique holds the potential to reduce greenhouse gas emissions and supply the nation with locally produced energy by means already being performed, such as coal mining. If done properly, the clean coal method could create carbon neutral coal facilities. Certainly however, the method of pumping greenhouse gases into the earth may prove to be a controversial topic.

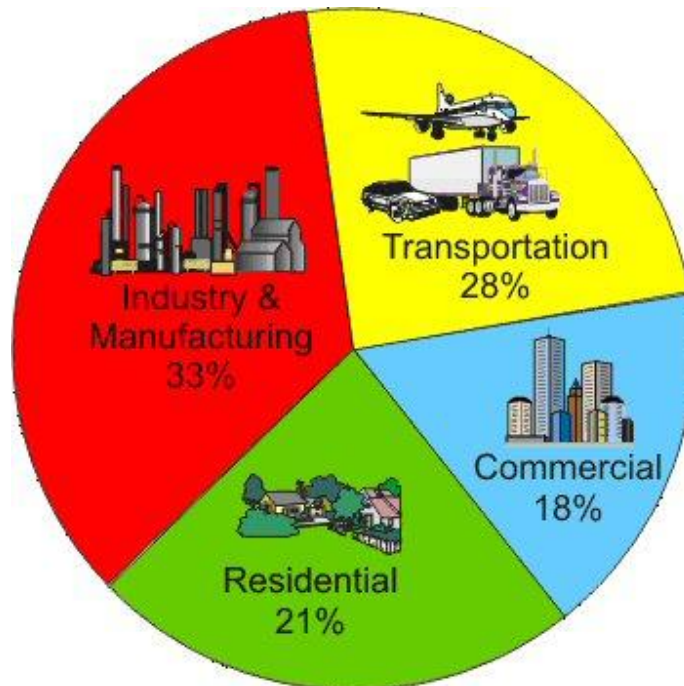
McCain's energy plan involves investing \$2 billion annually through federal funding to advance clean coal technologies. McCain hopes that these technological investments can later be exported to growing nations currently using large amounts of coal, such as China. McCain also sees these investments as a way to potentially create more jobs for the United States economy (The Lexington Project). Obama also promotes using enhanced oil recovery (EOR) to produce more oil from existing fields that is currently not able to be used, including the technology as one element of the cap-and-trade bill (change.gov 2008)

*Promote the Supply of Domestic Energy*

Obama promotes increased production of domestic oil and gas with a “Use it or lose it” approach that will require oil companies to either begin drilling in currently-owned locations or allow another company to do so. Obama has also identified some specific locations in the U.S. to be exploited for oil and/or natural gas. Obama wants to re-start construction on the Alaska natural gas pipeline (proposed to congress in 1976 and authorized up to \$18 in loan promises) (change.gov.).

Like Obama, McCain’s energy plan also supports increased domestic oil drilling as well as resource exploration, primarily for the same reason, which is to end the United States’ reliance on foreign fossil fuels. McCain would especially like to exploit the natural resources in the Outer Continental Shelf that have an estimated seventy seven trillion cubic feet of recoverable natural gas. His energy plan includes working with each individual state as well as the Department of Defense to develop federal oil reserves in order to decrease the nation’s trade deficit (currently at negative forty one percent, due primarily to oil imports, says McCain). McCain also promises to construct the infrastructure throughout the United States needed to transport the fuel produced from this increased oil drilling. Furthermore, McCain promotes increasing market transparency of fossil fuels in an effort to lower oil prices for Americans (The Lexington Project).

Obama also wants to give Americans short-term financial relief from the increasing gas prices by requiring that oil companies share profits through financial aid, \$500 for an individual and \$1,000 for a married couple. This money would be paid for by five years of taxes on the oil companies who have produced record profits in the past year. Obama also proposes energy rebates that would either offset a working family’s gas costs, with the price increase in gas, or pay for their whole winter heating bill (for those living in cold-weather regions). The Obama plan also proposes setting aside some of a second round of “fiscal stimulus to ensure sufficient funding for home heating...” Both candidates propose using oil from the Strategic Petroleum Reserve to relieve increasing oil prices and utilize domestic resources (Change).



U.S. Energy Usage by Sector for 2006. (Carnegie Endowment 2008)

### *Cap and Trade Program*

Obama's mid to long term goals in his "New Energy for America" plan include implementing a nation-wide cap-and-trade system to reduce carbon emissions by eighty percent below 1990 levels by the year 2050 (the eighty percent emission decrease is based on the necessary amount as estimated by scientists). His cap and trade program requires that all pollution credits to be auctioned, which guarantees that every industry pay for each ton of emissions that they release instead of simply giving the emission rights away to companies based on their past pollution performance, says the energy plan. Under Obama's plan, a small part of the receipts generated by the auctioning (an estimated \$15 billion per year) will go to support the development of clean energy. This includes investing in energy efficiency improvements and developing the next generation of biofuels and clean energy vehicles, all of which will help the U.S. meet its emissions reductions goals. Furthermore, money from the "pollution" auctions will go toward funding state and federal land to restore habitat, create wildlife migration corridors, and aid fish and wildlife adapt to the environmental effects of global warming. The remaining money generated from the auction receipts will be used to assist families and communities to ensure that they are not financially burdened from the change to a "low carbon economy" (change.gov 2008).

McCain promotes a cap-and-trade program that would limit greenhouse gas emissions, allowing entities to buy and/or sell rights to emit carbon. The program works by granting

firms, including electric power, transportation, and commercial and industrial businesses, (the areas responsible for nearly ninety percent of all emissions) the limited amount of carbon emissions and allowing them to sell any remaining “carbon permits” for cash. This provides firms with a motive to reduce carbon emissions. McCain has set out specific target timetables of: returning emissions to 2005 levels by 2012, returning emissions to 1990 levels by 2020, bringing emissions twenty two percent below 1990 levels by 2030, and ultimately, bringing emissions sixty six percent below 1990 levels by 2050 (The Lexington Project).

### *Promoting the Green Industry*

Obama’s plan includes investing in green manufacturing, by helping current manufacturing centers become more modern. He also promotes teaching Americans the skills needed to produce “green products.” Obama proposes a plan called the “Green Vet Initiative” that would specifically aid war veterans, through counseling, educational programs, and job placement, enter the “new energy economy” (which totaled over \$2.6 billion in 2007 from private investment in venture capital). Obama hopes that plans serve as an incentive for small to mid-sized companies to become more environmentally friendly and operate with higher efficiency. This investment of \$1 billion per year will also assist R&D of new “green” technologies and speed up economic growth in sustainable fields across the nation as well. The Obama plan also includes a job program for “disconnected and disadvantaged youth,” focusing them on the clean-energy sector (Change).

McCain’s energy plan will encourage “green” technology by creating a permanent tax credit equivalent to ten percent of employee wages that were used by the company for R&D. McCain proposes this tax plan as a means to simplify the U.S. tax code and make the U.S.’s manufacturing and R&D sector more competitive with other countries by serving as an incentive for companies to innovate (The Lexington Project).

### *Improved Automobile Efficiency*

Obama declared it “an economic, national security, and environmental imperative” that the U.S.’s oil dependence end (referring to the fact that American vehicles rely on oil for ninety six percent of their energy) (change.gov 2008). One of his goals is to reduce the U.S.’s oil consumption by more than the amount currently being imported from the Middle East and Venezuela combined, within ten years. His plan to achieve this goal calls on increasing the fuel efficiency standards by four percent each year, which will ultimately save almost half a trillion gallons of gas and six billion metric tons of greenhouse gases. This will include continued R&D in advanced vehicle technology and specifically advancing battery technology to make plug-in hybrid cars more accessible to the American consumer. This will contribute to Obama’s goal of putting one million plug-in vehicles on America’s roads by 2015. Furthermore, he will offer \$7,000 tax and other credits to those who purchase hybrids, while also supporting American automakers to produce these vehicles. Obama plans to grant \$4 billion tax credits and guarantee loans



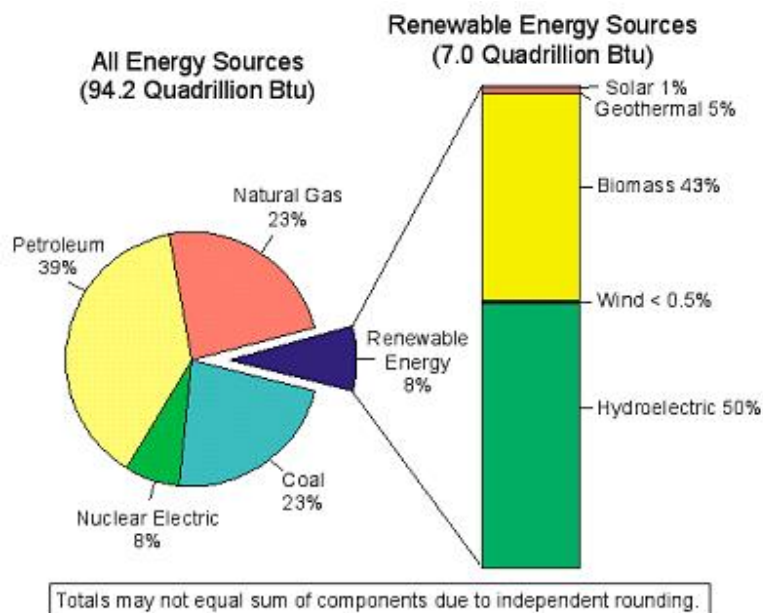
for American auto plants and parts manufactures who participate in these and other fuel-efficient programs, such as flexible fuel vehicles (FFV). Obama's FFV plan includes petitioning both Congress and auto companies to assist in the transition. This will ensure that all new vehicles have the ability to operate with FFVs by the end of Obama's four-year term. Obama's FFV plan is intertwined with his plan to develop and incorporate biofuels (like cellulosic ethanol, biobutenol, and other forms of synthetic, renewable petroleum), initiating programs that require sixty billion gallons of these biofuels by 2030. Obama will also implement tax incentives and government contracts to develop the best technologies for these synthetic biofuels as well as the infrastructure that this will require. Obama's plan establishes a National Low Carbon Fuel Standard (LCFS) to quickly introduce low carbon non-petroleum fuels (including biofuels). This standard would be enacted in 2010 and require fuel suppliers to begin reducing the carbon in their fuel by five percent within five years and ten percent within ten years. His plan is designed to provide incentives for increased private sector investment in advanced low-carbon fuels. A "sustainability provision" is also included in the LCFS plan to ensure that increased biofuels production does not negatively impact the eco-system (Change).

McCain's plan includes issuing the "Clean Car Challenge" to America's automakers. The challenge would consist of a tax credit to consumers to reduce carbon emissions. The tax credit would provide \$5,000 credits to each customer who buys a carbon neutral (zero emissions) car, simultaneously encouraging automakers to be in the market for these in-demand cars. Graduated tax credits will be given for other vehicles, giving a higher tax credit the lower the carbon emissions. McCain's energy plan promotes improving battery technology as well, offering a prize of \$300 million for the creation of a better battery "package." The regulations involve creating a battery with the size, ability, and sufficient power necessary to fully power vehicles, while costing thirty percent less than the batteries currently available, a very likely candidate of nanotechnology. A practical, more functional battery would thus enable plug-in hybrids and electric vehicles to become more feasible and thus more desirable to the consumer. McCain, like Obama, supports flex-fuel vehicles and proposes granting incentives for U.S. auto manufacturers to reduce carbon emissions, calling on the auto companies to make a quicker and complete switch to FFVs than the timeline to which they have currently committed. McCain also supports C.A.F.E. standards, mentioning specifically the standards that set the mileage requirements that must be met by all automobile manufacturers' in vehicle production. McCain plans on increasing the financial penalties faced by car companies who do not meet these requirements so that they may no longer produce non-compliant vehicles and then pass on these non-compliance fees to the consumer. Supporting FFVs, McCain and Obama both see alcohol-based fuels, cellulosic ethanol, and other resources that will not compete with food crops as vital to expanding America's energy options (The Lexington Project).

### *Diversifying Energy Sources*

The Department of Energy estimates that wind could provide one-fifth of all electricity in the U.S. by 2030. The U.S. solar energy industry continued to grow at double digit numbers in 2006. McCain proposes an even system of tax credit for these and other types of renewable energy (such as hydro and solar) as incentives to increase renewable energy generation and to make renewable energy more affordable to consumers. McCain's plan involves continuing these incentives until the market is able to sustain renewable energy on its own. Seventy percent of the United State's "clean" energy (energy that produces zero carbon emissions) and twenty percent of all of the U.S.'s total energy is currently produced from nuclear power. McCain would like to increase this number of "safe and secure nuclear energy" by constructing forty five new nuclear power plants by 2030, ultimately hoping to construct up to one hundred new nuclear plants (The Lexington Project).

Obama likewise calls on expanding nuclear energy-generation. Before calling for expansion of nuclear power plants however, Obama wants to consider "key issues" such as security of nuclear fuel, the waste by-product, the storage of nuclear bi-products (waste storage), and proliferation. Obama's plan also mentions safeguarding nuclear material to prevent it being used in non-energy forms (such as in weapons) (change.gov 2008). Obama's plan includes diversifying America's energy sources for the sake of the nation's security, the economy, and the environment, as stated in his plan "New Energy for America." Obama's energy plan involves creating a ten percent federal Renewable Portfolio Standard (RPS) that requires ten percent of electricity consumed in the U.S. to be derived from sustainable energy sources such as solar, wind and geothermal by 2012 (Change).



Division of energy sources in 2007 for the U.S. (powerhouse engineering 2008)

### *Reduce*

The first of the 3R's (reduce, recycle, and re-use) is not forgotten by Obama in his energy plan. He calls for a reduction of the U.S.'s electricity demand by fifteen percent from the levels projected by DOE for 2020. (This projected demand is based on the estimate that electricity demand will increase by 1.1 percent per year over the upcoming decades.) Obama sees this being achieved by setting reduction targets for utilities and by setting strict building and appliance regulations. This decrease will save consumers \$1,330 billion, reduce carbon emissions by over five billions tons by 2030, and create countless new jobs in the United States. The plan also includes the goal that all new buildings be carbon neutral by 2030. Obama's plan outlines achieving this goal by improving new building efficiency by fifty percent and bettering existing buildings by twenty five percent over the upcoming decades. Obama proposes full funding for LIHEAP to ensure that low-income families have heating for the winter, improved insulation/weatherization, and energy efficient appliances and lighting for one million homes annually. Obama's energy plan states that this will enable families to cut energy bills by 20 to 40 percent in the long run. Lastly, Obama proposes to make American communities more sustainable by repairing roads and bridges and investing in systems that encourage walking, biking and using public transportation (Change).

While both presidential candidates offer claims of what they will do to improve the environmental and energy issues facing our world today, the election results naturally determine which plan the U.S. will follow in the upcoming years. After the election results and presidential inauguration, more waiting will be required to see if the future president will keep all of his energy promises and if they will be approved by Congress.

The passing of the cap-and-trade program, as well as many of the other proposed environmental regulations, (with the exception of the carbon sequestration process, which would likely maintain the current high demand for fossil fuels) should impact the Pinpoint's products in a positive way. Since the Pinpoint will be using nanotechnology to create "clean" sources of energy, it is expected that the products will be more desirable in the market because of the increased environmental regulations and an overall increasing concern for the environment with the "go green" movement. Hopefully, the "go green" movement will not be a passing fad, and governmental regulation and genuine societal concern will bring an increased awareness of, and a demand for, renewable energy sources. Thus, the firm should expect its products to benefit from this increasing market opportunity for clean energy sources. Furthermore, since these new regulations and policies will likely bring the U.S. up to par with other nations in terms of environmental regulations (particularly the European Union), designing products to meet upcoming regulations will enable the products to be easily adapted for the global marketplace.

### *Economic Analysis*

The initial recession faced by the United States over a year ago- attributed to the sub-prime mortgage lending market crash- has now escalated into what many are calling a financial crisis. The U.S. government has taken bold steps to secure the economic future of the country. The controversial “Bush Bailout Plan” is designed to assist, or “bail out,” influential financial institutions from bankruptcy. However, while some financial institutions are being assisted by the government bailout plan, other companies have already officially filed for bankruptcy, and still others have been sold to other, more stable institutions, such as Washington Mutual’s (WaMu’s) recent sale to JP Morgan Chase.

Originally, the bailout plan proposed authorizing the Treasury to borrow a maximum of \$700 billion to buy assets related to distressed mortgages from American financial institutions during the next two years. The plan was designed to assist unstable financial institutions by buying mortgage-related assets from the companies, enabling them resume loaning money to consumers. This plan was designed to put spending money back into the U.S. economy, which is especially important to financial growth as consumer spending currently accounts for seventy percent of the country’s GDP. Furthermore, the plan was intended to stabilize the capital markets and potentially protect individual investment and retirement funds. It is also possible that the bill could have stabilized the ever-declining housing prices. The House version of the bailout bill proposed the release of \$350 billion of the plan for immediate use, with \$350 available later, unless Congress held back the funds at a later date. The bill would have put certain limits on CEO compensation as well. Under the bill, the government would have been able to take ownership stake in firms that benefited from the bill. It was proposed that the bill be executed by hired asset managers who would perform the detailed criteria of purchasing the specified securities. A bi-partisan committee would take oversight of the implementation of the plan (West 2008).

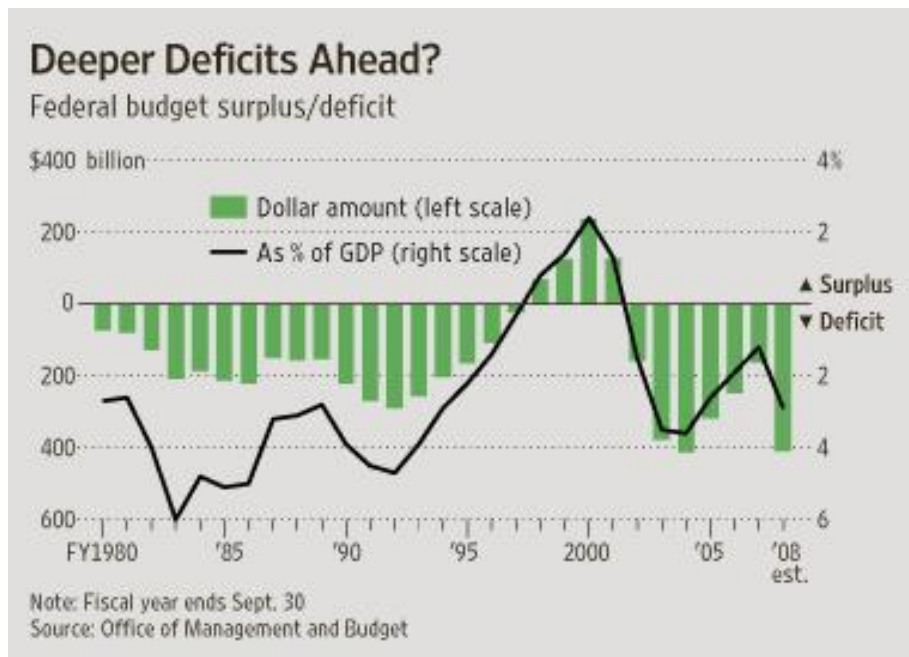
However, the original version of the bailout plan was voted down by the House. The rejection of the bill caused the Dow Jones Industrial average to suffer the largest one-day point drop in its history, losing 777.68 points and \$1.2 trillion in market capital. As speculation continued the following day, the Dow Jones Industrial average was able to recover 485 of the lost points from the previous day’s financial panic (West 2008).

Congress quickly compiled a new version of the bailout bill which included tax credits on state and local tax returns, alternative minimum tax relief, renewable energy tax breaks, and R&D credit for businesses. Clearly, the later two measures could potentially provide large incentives for development and research in the nanotechnology and renewable energy industries.

The new bailout plan would also increase the Federal Deposit Insurance Corporation (FDIC) insurance cap from \$100,000 to \$250,000, and allow the FDIC to borrow money from the U.S. Treasury. Under these new provisions, any net losses after five years from the financial industry would have to be reimbursed to taxpayers. The new bailout bill also

requires that health insurance companies cover mental illness just as they would cover any physical illnesses (West 2008).

This up-dated bailout plan was approved by Congress on October 5, 2008. Even though the bailout plan was approved by Congress, the stock market continues to experience extreme vicissitudes from one day to another. Despite this, many seem optimistic that the United States stock market appears to be stabilizing over time. The economic crisis is greatly affecting the United States and many individuals as they recover from jobs losses. However, it is important to remember that other countries, such as Iceland, are experiencing extreme financial hardship as well, making market expansion of luxury consumer goods especially difficult. Due to the increased financial deficit facing the U.S. from the recently approved bailout, increased governmental assistance to low-income families, renewable energy, or other measures as promised by both presidential candidates should not be relied on. Rather, firms should constantly consider the current situation of the global economy in designing functional, practical, and affordable products for the user that rely on sound and sustainable business



U.S. Federal deficit/surplus from 1980 to 2008 (U.S. Office of Management and Budget 2008).

## *Sociocultural Environment*

### *Consumer Spending*

One sociocultural trend that has emerged from the declining US economic status is decreased consumer spending. In recent months consumer spending has dropped 0.3 percent, which is the lowest it has dropped in four years (Marco 2008). According to Nariman Behravesh, chief economist at IHS Global Insight, “Consumers have thrown in the towel. They have no choice but to cut back on spending in a very big way.” One factor that has contributed to this is unemployment, which increased from 6.1 to 6.5 percent leaving 10.1 million people unemployed in October 2008 (Bureau of Labor Statistics 2008). Another factor is the high cost of consumer products, which has increased by 5 percent over the last year; the largest increase in the last seven years (Jacobe 2008). The combination of these factors has resulted in consumers spending 2.9 percent less on more expensive, durable, long-term goods such as automobiles and furniture while less expensive, nondurable goods, only decreased by 0.8 percent (Marco 2008). Not only are consumers spending less but they are altering their spending habits. They are shopping for the lowest prices, decreasing spending on luxury goods including entertainment and fast food, and paying closer attention to budgets (Jacobe 2008).

This trend will need to be considered as the innovation process takes place. It is unknown how long consumer spending will be down or will continue to decrease. Therefore, it is important to create a product or service that consumers see a clear need for and that they can afford. The company will need to consider market strategy, which may need to be low cost and mass market.

### *Nanotechnology Background*

Richard Feynman gave a lecture in 1959 entitled “There’s Plenty of Room at the Bottom.” This lecture later proved famous, sparking the beginning of the discussion for nanotechnology. However, it was not until 2001 that research for nanotechnology in the U.S. became a federal initiative, becoming known as the National Nanotechnology Initiative (NNI) (Eckelman 2008). The nanotechnology industry has seen tremendous growth recently, with scientific journals dedicated exclusively to the science, and ever-increasing government funding (the U.S. government spent over \$1 billion in 2006 on nanotechnology-related funding) (Eckelman 2008). The phenomenon of nanotechnology lies in its ability to create new properties and capabilities by changing the particle size to a nanoscale. This new nanomaterial then reacts differently than the material or element at its original scale and can be manipulated in new ways.

However, in this property-changing ability lies the controversy of the new technology, as the elements have been chemically tested for some time now at their natural state while the new compounds they form on the nano-scale are yet to be tested for all elements. Furthermore, while the published information concerning the potential effects of nanomaterials and nanoproducts is relatively scarce, this information generally concerns

only one-dimensional nanoproducts, leaving information concerning 2-D and 3-D nanoproducts difficult to find. Further complicating the situation, the information that is available on 2-D and 3-D nanoproducts is largely in the source of numerical data rather than analyzed information concerning environmental impacts of these materials (Sengül 2008). However, literature concerning more benign materials that can be substituted for the more toxic ones currently being used in nanomanufacturing does exist and is being utilized as research continues. Thus, it is only a question of how long it will take for scientists to “green” nanotechnology manufacturing by using less harmful and less energy exhaustive resources (Sengül 2008).

### *Moral opposition*

As nanotechnology advances, more concerns are raised about whether or not these advancements should be taking place. Some people hold a moral opposition toward the development of certain types of nanotechnology because they believe enhancement of humanity when it is not necessary to alleviate pain or for survival, takes away from who and what humans are. They believe that nanotechnology may lead to immortality and that humankind was not meant to be immortal (Gasman 2006). According to a study done by D.A. Scheufele at the Center for Nanotechnology in Society, one major influence that may be contributing to this opposition, especially in the United States, is the influence of religion in the lives of those concerned about the technology. According to a survey he conducted of 1,015 adult Americans, only 29.5 percent of them considered nanotechnology to be morally acceptable. According to Scheufele, “They are rejecting it based on religious beliefs. The issue isn't about informing these people. They are informed” (Scheufele 2008).

However, a random digit-dialing survey performed in 2006 with 1,014 individuals that was also conducted to discover the perceptions Americans have toward the risks of nanotechnology showed contrasting results. The survey showed that overall, respondents believed that the benefits of nanotechnology outweighed the risks. The survey also found that women were more likely to perceive the risks as outweighing the benefits in nanotechnology. The study found that younger people and individuals with higher education levels were more likely to have previously heard about nanotechnology, while 44.3% of men and 55.7% of women overall knew “little or nothing at all about nanotechnology” (Smiley 2008). In this survey, respondents appeared most interested in the new ways nanotechnology can treat human diseases and were most concerned about invasion of privacy and consumer safety (Smiley 2008). However, a later survey on U.S. societal perception of nanotechnology found that while respondents initially had concerns about safety and privacy, they were currently most concerned about environmental and health risks (Karn 2008), possibly due to the recent “go green movement.” Somewhat alarmingly however, a recent poll discovered that scientists actually working in the nanotechnology field were more worried about nanotechnology’s risk than was the general public (Karn 2008). Consequently, while varying research results make it difficult to accurately state current societal perceptions of nanotechnology, it is important to see that all results conclude one thing: that a high number of the society remains both concerned and uninformed about the technology. This makes it crucial that the science and

business communities working to market nanotechnology to consumers integrate the technology in a way that is consistent with individual beliefs, whether they are cultural, religious, moral, or scientific, if they are to succeed commercially with this science.

### *Human and Environmental Implications*

Perhaps catering to the growing concerns about nanotechnology, the U.S. Environmental Protection Agency (EPA) released a draft statement in 2007 that discussed the technology's potential environmental benefits, the potential issues in managing nanotechnology's risk, the challenges in measuring these potential risks, and the need for further research on nanotechnology's environmental impacts. However, more so than nano's implementation into consumer products, the potential use of nanotechnology on human health and the environment has caused a great deal of discussion as well as a call for government regulation of the industry. With the current uncertainty of the moral implications of nanotechnology, Eckelman, Zimmerman, & Anastas cite in "Toward green nano" that revealed health problems exclusive of only one nano product could "essentially wreak havoc on the entire nano industry, causing billions of dollars in economic loss from consumer backlash against all nanotechnology" (Eckelman 2008). To counteract this, many in the nano field advocate increasingly publicizing the benefits of green nanotechnology to improve public perception of the entire nanotechnology industry.

### Pollutants

An important concern for the nanotechnology industry is the potentially harmful consequences that the development of nanotechnology will have, which is largely unknown because it is still an emerging technology. The main concern lies in the nanomaterials, and in what ways the new properties of these materials on the nanometer level will impact consumers and the environment (Gasman 2006). This is a very important and valid concern as pollutants from other technologies have had harmful impacts in the past. Therefore, the firm will need to ensure that a sufficient amount of research is done concerning the impacts of the nanotechnology integrated into the product or service being provided to ensure that consumers do not have to worry whether or not safety regulations have been met.

### Human Health Risk

Lucas Reijnders, in "Hazard Reduction in Nanotechnology" defines hazard as the potential to cause harm, continuing to say that "hazard is a matter of concern for nanotechnology," as nanoparticles may release hazardous substances and cause hazardous reactants (Reijnders 2008). Reijnders states in "Hazard Reduction in Nanotechnology" the several known negative effects nanoparticles may have on human health, including negative effects caused when nanoparticles interact with human lung tissue, which may potentially result in lung inflammation and eventually to cardiovascular disease. Furthermore, nanoparticles can travel from the lungs to the circulatory system (causing increased risk of cardiovascular disease) and can also travel



from the nasal region and eventually to the brain. If nanoparticles are swallowed, they can potentially cause negative effects on the intestines and other organs they contact. Furthermore, many believe that it is highly possible that nanoparticles may be able to penetrate porous materials (such as skin) because of their size similarity with viruses that have evolved to exhibit this ability (Clift 2008). However, it must be understood that these potentially negative human-health effects from nanoparticles only pertain to certain elements. Therefore, it should not be misunderstood that all nanomaterials will display all or even any of these negative side effects.

### Consumer Harm

Nanoparticles found in products can also prove potentially harmful to the consumer. Products that utilize nanoparticles that are “inherently dispersive,” such as those nanoparticles found in drugs, fuels, disinfectants, personal care products, lubricants, and environmental cleaning products have been proven to display greater hazardous potential. However, other products that require fixed nanoparticles can prove equally dangerous depending on the product’s use in its entire life-cycle (especially relevant with regard to its cleaning and recycling process). The degree of hazard in nanomaterials varies widely from one nanomaterial to another, thus making it difficult to specifically chart the potential health hazards of each. Currently no consensus exists on a way to identify and classify the characteristics of nanomaterials and their applicable product functions. Some nanotechnology experts, such as Seager and Linkov believe that benchmarking the toxicity of nanomaterials based on their property characteristics “may be unrealistic” due to the tens of thousands of possible varieties and reactions nanoparticles exhibit under various environments (Seager 2008). However, it is commonly accepted that an entire life cycle analysis (LCA) of the nanomaterials and their usage in the product must be conducted. LCA proves most influential in analyzing the impacts of nanotechnology, as it takes into account the whole product life cycle, investigating the specific stages with potential of causing human health and environmental risk (as opposed to merely analyzing materials at a single state, which is often used in risk analysis).

### Worker Harm

Concern for the safety of those working with nanotechnology and manufacturing must also be addressed. It is believed that inhaling a nanoparticle is the most likely way a worker may become exposed to nanoparticles in the nanomanufacturing production process. Furthermore, the worker can become especially at-risk because not only do the nanoparticles carry a potential health risk, but the chemicals needed to synthetically create nanomaterials are often toxic as well. Because of this, many analyses have been done (and are currently being undertaken) to increase the safety of those working with nanomanufacturing, such as proper ventilation to prevent cross-station contamination (Reijnders 2008).

## Nanotechnology Risk Assessment

Moreover, the nanotechnology field lacks structured, quantitative guidelines used to analyze the environmental and health risks that nanotechnology poses. The lack of this quantitative data makes LCA and RA analysis on nanotechnology particularly costly and time-intensive. Further complicating the process of conducting these analyses comes from data collected using other measurement scales than what is applicable to nanotechnology because of the atypically large surface area characteristic of nanoparticles (the reason why nanoparticles display greater changeable reactivity than particles in their natural state and why they prove such a promising technology). Because of the potential for harm, some argue that until complete data is available on nanomaterials, they should not be allowed into consumer products. Others however argue that nanotechnology's potential benefits outweigh the risk, and that LCA should be tested as nanomaterials are developed, pushing for their continued use in consumer products (Shatkin 2008). Fortunately though, it has been found that increasing the preciseness and efficiency (including waste and bi-product reduction) of nanomaterial production may decrease the risk of hazardous material output. Therefore, it is possible to expect that hazardous risk will decrease as the nanotechnology industry continues to advance.

## Nanomanufacturing

Little has been investigated concerning nano manufacturing (the synthetic process needed to create nanomaterials). Because the requirements for nanomaterial production vary drastically from those required in typical chemical production, it is especially crucial to analyze this novel process. Nanomaterial production requires a very specific and controlled environment that includes a vacuum, completely pure materials, a low tolerance for defects, and process repetition. The production process then produces low yields of the produced material, leading many to question whether nanotechnology should even be used, with such inefficient production requirements, the use of toxic chemicals, greenhouse gas emissions, and a demand for large amounts of energy and water (Sengül 2008). The manufacturing phase of nanomaterials has been identified as potentially the main contributor to the "life cycle impacts" of nanotechnology (Sengül 2008). However, because each nanomaterial differs in its specific manufacturing requirements, little research has been conducted in terms of each step in the production process, making it difficult to pinpoint and modify the most harmful steps. Authors Sengül, Theis & Ghosh of "Toward Sustainable Nanoproducts" write that nanotechnology research is taking two basic routes. One route is the "receptive view," in which the nanotechnology is being utilized for environmental benefits such as creating better chemical catalysts and sensors that can detect toxic materials in substances. The second route researchers are taking (concerning nanotechnology) is a precautionary view, looking to identify nanotechnology's potential risks and negative health effects on both humans and the environment (Sengül 2008).

## Hazard Reduction

Researchers are currently investigating the potential of utilizing nanotechnology in biomimicry- an attempt to mimic superior components found in nature. Currently, nanotechnology is being applied to biomimicry in attempts to mimic the self-cleaning effect of the lotus- a complex structure on the surface of leaves that utilizes nanoscale hair-like structures to create a wax-like water-repellant surface (Fiedeler 2008). If successfully mimicked, this wax-like surface would be used as a coating when working with toxic materials, thus requiring much less energy and resource consumption in the hazardous material clean-up process. Another practical application of nanotechnology's use in biomimicry is using this same method, the lotus effect, to replace the toxic chemicals commonly put on the bottom of large ships to prevent bacterial and organism growth (Fiedeler 2008). Another example of nanotechnology's ability to reduce hazardous chemicals is in the creation of a ceramic-like coating. This ceramic-like coating combines silica nanoparticles with lacquer on the wood, to create a material that can insulate the wood from heat, reducing fume generation, a potentially useful technology for rural off-the grid individuals who rely on wood for heating and cooking (Fiedeler 2008). Another application of nanotechnology's benefits is in stabilizing the separation layer in lithium-ion batteries (which currently consists of an organic compound that is not temperature stable). By making this part of lithium-ion batteries temperature stable, they can now be used in vehicles in place of the current lead-containing batteries (Fiedeler). These examples show the broad scope of nanotechnology's implications as well as the difficulty of defining the technology, as in the battery example only one element of the entire process is changed with nanotechnology. Even so, all three uses show examples of nanotechnology's application as a substitution for hazardous substances. However, due to the high levels of toxic elements (some of which are potentially carcinogenic) needed in nanomaterial production, element leaks, as mentioned previously, are extremely dangerous to workers, and potential worker harm should be thoroughly analyzed before use (Sengül). Like any other product, when looking at nanotechnology's benefits in reducing the environmental impact of hazardous elements, it is essential to conduct a full life-cycle analysis of the manufacturing process used to create nanoparticles or nanomaterials to ensure that the benefits far outweigh the potential risks.

### *Going green*

A 2007 survey of 7,751 people in Brazil, Canada, China, France, Germany, India, the UK, and the U.S. found that 87% of consumers in these nations are concerned about the environmental and social impacts of the products they purchase ("Helping 'green' products grow"). However, the same survey showed that many are merely "talking the talk" rather than "walking the talk" in the "go green" movement, with only about 33% of these consumers purchasing green products. With all the hype to "go green," even big corporations like Wal-Mart are now carrying organic produce and other green items. However, the market share of green products is still relatively insignificant (making up less than 2% of the market in 2006) ("Helping 'green' products grow"). The article, "Helping 'green' products grow" mentions that consumers express a desire to "go green,"

but find it difficult to identify any brands that offer green products, showing a lack of brand awareness. This provides evidence that brands are not properly marketing their eco-friendly products, rather than a mere indifference by the consumer (“Helping ‘green’ products grow”). This stresses the importance of developing strong marketing campaigns that educate the consumer on all of the social and environmental benefits of using green nano products. Furthermore, the Pinpoint must work with distribution channels to ensure that products are available to the consumer, so that it is just as easy to purchase these products as it is to purchase “brown” (not green) products. The supply chain is again essential in creating successful green products to eliminate unnecessary costs in the entire supply chain. Cutting costs is crucial for green products, as high prices are the greatest of the five barriers that keep consumers from purchasing green products (and proves even more essential with the current financial crisis). The five barriers that prevent greater sales of eco-friendly products include: lack of awareness, negative perceptions, distrust, high prices, and low availability, all or one of which contribute to consumers “talking the walk” rather than truly “going green” (“Helping ‘green’ products grow”). Also, as with any product, it is essential to remember that most consumers value performance, reliability, and durability in a product rather than its eco-friendliness. Thus, it is essential that any green product also meet all three of these quality standards in order to be successful in the marketplace. Especially with green products, the entire product innovation process must be executed to bring value to the user group(s), be good for both society and the environment, be desirable from a business standpoint, and of course be possible with technology (including utilizing the most sustainable technology possible). Next, a well-thought out marketing campaign must be developed to educate the consumer about the product’s benefits, especially if the product utilizes nanomaterials, as green nanotechnology remains an even less-known in the public eye than the true motives behind the “go green” sustainability movement.

### *Green Nano*

“The Road to Green Nanotechnology” cites the two goals of nanotechnology: to produce nanomaterials and products that do not harm the environment or human health, and to create solutions to climate change and other environmental issues through nanotechnology (Karn 2008). “Green nano” is described as, “the design of nano-scale substances, materials, and processes through green chemistry and green engineering that results in the development of new performance without adverse consequences to humans and the biosphere”( Karn 2008). Unfortunately, in 2006, less than 1% of all federal funding on nanotechnology was given to green nano, with roughly 95% dedicated for nanomaterial applications and 4% dedicated to nanotechnology implications (Karn 2008). However, even with comparatively little federal funding, Green nano is an emerging field within nanotechnology. Green nano includes green chemistry, applying the synthesis of nanomaterials and engineering principles found in traditional nanotechnology, while aiming for sustainability in the entire process.

As nanotechnology is a relatively new-emerging field, the many environmental implications nano materials hold are still being investigated. A metric, called the E-factor, has been developed to measure the eco-friendliness of green chemistry. The E-

factor metric analyzes the traditional chemical syntheses of various nanomaterials that have already been produced, such as carbon nanotubes, fullerenes, and metal nanoparticles. The E-factor is computed by analyzing how the traditional synthesis of certain nanomaterials is obtained. However, chemists have discovered that some nanomaterials hold E-factor numbers that can vary between several orders of magnitude depending on the methods used to produce the particles, making classification difficult. Even while a relatively ambiguous process, the ability to classify most nanoparticles does bring hope, implying that it will be possible to utilize more environmentally friendly methods in nanomaterial production. This scale also makes it possible to analyze and measure the environmental benefits that nanomaterials may hold. The authors of "Toward Green Nano," say that research is primarily being focused on the effects of nanomaterials and potentially toxic materials in regards to human health and the ecosystem, while the actual artificial synthesis that takes place to create nanomaterials has been very little explored (especially with regards to how this artificial synthesis will impact the environment) (Eckelman 2008). Therefore, many individuals advocate investigation that uses life-cycle analysis to analyze the entire production process used to create nanomaterials. Producing sustainable nanoproducts requires analyzing the entire life cycle before the design process begins. Next, green chemistry and green engineering principles are applied to produce nanoproducts without using toxins, utilizing the lowest temperature and energy as possible, and utilizing as many renewable sources as possible (Karn 2008). Nanotechnology, in the form of using catalysts at the nanoscale in chemistry, can make the process less wasteful and also separate the chemicals necessary in production from the waste. The article gives examples of how nanomaterials can be used to meet the second goal of green nanotechnology, by cleaning hazardous waste, purifying water and pollutants, or identifying harmful elements in the environment (Karn 2008). However, researchers have found that because of the wide array of procedures used in creating these nanomaterials, it is extremely difficult to determine the efficiency from the resources used in nanomaterials production, creating even more barriers to nanotechnology regulation. Many scientists and researchers have come to a consensus that the process of producing nanomaterials is currently not very environmentally friendly. Therefore, scientists are currently working on "greening" nanotechnology by substituting various harmful but necessary elements with more benign materials. However, some materials necessary to produce nanomaterials cannot be easily obtained, and thus must be made synthetically to produce the desired catalyst for nanomaterial production, making substitution a complicated process. As with any green product (whether it utilizes nanotechnology or not), it is important to consider the entire supply chain, from product design to the product's end life, completing an entire life-cycle analysis of the product to determine whether or not the product truly is green.

### *Nanotechnology Industry*

Global demand for nanoscale materials, tools, and devices is expected to reach \$28.8 billion in 2008 and then increase annually at approximately 30.6%, estimated to reach a \$1 trillion market by 2015 (Eckelman 2008). The majority of this spending is focused on utilizing nano technology in consumer products in the form of nanomaterials. Still, a great amount of research is also being done on nanotechnology's potential to aid human health and environmental improvement.

The nanotechnology industry is not so much an industry as it is an enabling technology that can be used across many different industries with many different applications (Gasman 2006). If however, an attempt is made to define nanotechnology as its own industry, John C. Miller, the author of "Handbook of Nanotechnology: Business, Policy, and Intellectual Property Law" states that, "the nanotechnology industry can be roughly defined as the group of companies focused on bringing nanotechnology processes, tools, and first-generation materials, devices, and systems to market" (Miller 2004). He also concludes that there are three general categories that nanotechnology industry companies can be divided into: 1) those that are creating nano-tools 2) those that are marketing basic applications of nanotechnology, and 3) those that are building small nanotechnology devices (Miller 2004).

Companies that are creating nano-tools are developing ways to "synthesize, manipulate, observe, and characterize nanomaterials. Examples of nano-tool companies include NanoInk, Veeco, and Npoint. NanoInk is developing and refining dip-pen lithography, which is one technique that draws nano-scale particles into the desired location, Veeco manufactures devices that provide capabilities in measuring on the nano-scale, and Npoint is working on creating tools that gather and place individual nano-scale particles in precise locations (Miller 2004).

Companies that are marketing the basic applications of nanotechnology are working with the unique capabilities and applications of different materials on the nanoscale. They market "bulk quantities of nanomaterials" including, "novel powders, dispersions, coatings, catalysts, composites, lubricants, chemicals, and textiles" (Miller 2004). Examples of companies in this category of the industry include Nanophase, Inframat, Catalytic Solutions, and Nanotex. Nanophase manufactures nanocrytalline particles that are used in products such as sunscreen. Inframat works to create industrial coatings, Catalytic Solutions provides nanoscale materials that can be used as catalysts, and Nanotex works to improve existing fabrics (Miller 2004).

Companies that build devices on the nanotechnology scale are actually creating marketable products and integrated systems that are enhanced through the incorporation of nanomaterials. Some examples of companies that fall into this category are Nanosphere, Nanomix, and Konarka. Nanosphere uses gold material on the nanoscale to detect genes that contain disease. Nanomix is working to use nanomaterials to create gas sensors and more efficient storage of hydrogen, and Konarka is working to improve the

efficiency of capturing light and converting it into energy by incorporating nanomaterials into photovoltaic cells (Miller 2004).

If the Pinpoint is defined in terms of these three categories, they would be classified as a research and development company that builds small nanotechnology devices and integrated systems. Thus, all of the other companies that fall into this category would be considered industry competitors, even though the solutions created might meet very different needs in different market sectors. Companies that fall into the second category, marketing nanomaterials, would be potential suppliers to the company, as the business strategy will focus on the research and development of the incorporation of nanomaterials into solutions and not the materials themselves.

### *Funding*

Nanotechnology has the ability to provide many opportunities over many different industries but consideration needs to be given to how the development of the technology will be funded, as it requires a considerable amount of start-up capital. According to “Nanotechnology Applications and Markets” by Lawrence Gasman, smaller firms will tend to finance their operations from “angel investors and the personal funds of management and relatives” while larger firms “get their funding from investment banks and venture capitalists” (Gasman 2006). Nanotechnology firms are more likely to receive government funding in comparison to other technological companies. However, there are many additional costs that come with this funding, such as alteration of product strategy, bureaucratic fees, and stiff competition. Start-up nanotechnology firms may have to change the direction of their products to meet requirements, the process may be long and involve excessively complicated administrative procedures, and firms might invest a significant amount of money to apply for funding even though they never held potential to receive funding to begin with (Gasman 60).

### *Barriers to Entry*

The University of Illinois - Springfield recently completed an analysis of nanotechnology commercialization sponsored by the U.S. Department of Commerce Technology Administration and KT Consulting, Inc. Based on the study, they affirm that “no single technology offers more economic and societal promise than nanotechnology. Nanotechnology holds the promise of both incremental improvements of existing products and potential for revolutionary change that could transform entire industries and create entirely new ones.” Although nanotechnology holds great potential, the commercialization of nanotechnology is developing at a rate slower than expected. This is surprising to many considering that the federally funded nanotechnology initiative (NNI) has invested \$5 billion into research since 2001 and is expected to fund \$1.4 billion for research in 2008 alone. In addition to federal governmental investment, local government and non-governmental agencies are continually investing in their own research and development initiatives. It is thought that the reason for the slow rate of commercialization is due to the many barriers to entry that the nanotechnology industry faces (McNeil 2007). Significant barriers to entry include the previously mentioned

health and environmental impacts and public perception of the technology, time and cost factors, intellectual property issues, foreign competition, and a lack of understanding and awareness on the subject.

### Time

Time is a significant barrier to entry for companies entering the nanotechnology industry. Due to the extensive time spent on the research and development of nanoproducts, product development is measured in terms of years rather than months like other industries such as the information technology industry. Companies that are able to develop their products at a faster pace will hold the competitive advantage of being first to market with their specific product. Additionally, once intellectual property is developed, it can take up to three years for patents to be approved, which merely lengthens the time barrier to entry (McNeil 2007).

### Cost

Entry into the nanotechnology industry requires significant investment in research and development. Nanotechnology requires extremely high-tech infrastructure to conduct research. While research infrastructure might be available to those with a large amount of capital or to certain universities, smaller companies who do not have access to infrastructure resources or the required amount of capital to purchase them will have difficulty conducting research. Another costly element to research and development is the need for highly skilled and highly trained researchers who have the knowledge of how to handle materials, properly conduct research, and interpret findings in a way that will be beneficial for commercialization. Additionally, there is a serious gap between the cost of research and actual development of the product. For every dollar that is contributed to research, \$100 is needed for actual production. It is also thought that if the government were to create more favorable research and development tax credits, the barrier to entry would not be as strong and would create incentives for more firms to enter into the nanotechnology industry (McNeil 2007).

### Intellectual Property

Having intellectual property is crucial for businesses entering into the nanotechnology industry because unique intellectual property is what gives businesses a competitive advantage and sets them apart in the eyes of investors who keep the firm functioning and growing. As mentioned previously, nanotechnology intellectual property is difficult to develop because of the cost and time that it requires. Another consequence of the time barrier is that firms may launch into business before their patents are approved only to find out later that they are infringing on another firm's patent. This creates a huge barrier for the firm, as it must cease business until it proves that its intellectual property is distinctly different from that of the other patent. To prevent this, intellectual property protection must be stronger. Currently, companies that want to obtain and effectively utilize intellectual property for commercialization need to have between \$1.5 and \$2 million budgeted to do so. This cost naturally creates a major barrier to entry into the



nanotechnology industry, especially for start up firms, as other legal fees needed to defend intellectual property rights prove costly as well (McNeil 2007).

### Foreign Competition

Foreign Competition in the nanotechnology industry is rapidly expanding. Currently, seventy five percent of the known nanotechnology research and development is being conducted by foreign nations. Furthermore, competition with the United States and other nations will continue to increase because many other countries support greater funding and R&D than does the US. One of the largest foreign competitors in the nanotechnology industry are Chinese nanotechnology firms, who are very aggressive in their business strategies in product commercialization. In addition to direct competition from companies, foreign competition also exists in terms of research experts. Many experts come to the U.S. to receive training and education in the disciplines of mathematics and science as they relate to nanotechnology but due to immigration restrictions, must cease current research and return to their homes. Furthermore, those who are foreign born and have the ability to maintain residency in the U.S. may have issues gaining access to certain, government restricted research laboratories. This proves an extremely relevant issue to the U.S. nanotechnology industry because, if these experts are not able to work without restraints, they may naturally turn to other countries where they can function more freely. Furthermore, as foreign competition expands, barriers to entry will become stronger as it becomes more difficult to obtain the educated researchers as well as differentiate products and services between those of the competition (McNeil 2007).

### Lack of Public Awareness/Understanding

The public's perception of nanotechnology is not completely positive. Some see it as unsafe and/or unethical, and certain studies show that the public perceives the risks to outweigh the benefits. Acceptance of nanotechnology by the general public is subject to influence by different powerful entities such as the media who have the ability to shape public opinion. Efforts to better and more accurately educate the general public on the topic of nanotechnology have the possibility of increasing public support and interest. Increased public perception of nanotechnology may in turn contribute to faster commercialization of nanoproducts. In part due to a lack of complete understanding of nanotechnology and its capabilities, there is not a lot of regulation or policy to govern the technology. Specific methods to evaluate the toxicity of nanomaterials need to be created in the near future to assist with the risk management of potential harm that could affect public health and safety. This lack of public awareness and understanding about nanotechnology creates barriers to entry because firms must deal with negative public opinions and concerns about risk that are still being researched. Clearly, consumers must be convinced that the product is safe for use, creating difficulty due to the lack of knowledge about nanotechnology (McNeil 2007).

### *Strategies of Potential Competitors*

While the strategies of potential competitors vary from company to company, all hold a common theme or company vision. Each potential competitor has well defined goals and objectives that enable them to move forward and measure their success along the way. These goals, objectives, and their implementations can be seen in examples of potential competitors such as, Mitsui & Co. Alternative strategies utilized by nanotechnology firms with a strong vision can be generally outlined by the method used by the National Nanotechnology Institution.

#### Mitsui & Co

Mitsui & Co, associated with Mitsubishi, created a specific division of its company for the sole purpose of researching nanotechnology. In order to realize quick returns on investment, the firm made an effort to integrate nanotechnology into its products as quickly as possible. To do this, the firm implemented a strategy that allowed the nanotechnology division to separate itself physically, as well in its business functions, from the rest of the company. This allowed the nanotechnology division to invest all of its time and effort into research, allowing for more rapid product development. Mitsui & Co currently has five divisions dedicated to the research and development of nanotechnology including Bio Nanotech Research Institute, Carbon Nanotech Research Institute, Device Nanotech Research Institute, Ecology Nanotech Research Institute, and Intelligence Nanotech Research Institute. The nanotechnology division of Mitsui & Co leverages cooperative relationships that have already been established by its parent company. It also utilizes its global network of expertise obtained during the parent company's time working with Mitsubishi. The nanotechnology division's goals and objectives include identifying the technology seed within universities and other organizations, working on patents to secure intellectual property, developing prototypes and product plants, utilizing the firm's global network to bring the product to the market, and hiring experts in globally diverse areas for cultural and educational integration (Mitsui & Co 2008).

#### National Nanotechnology Institution

Another way to look at strategy for nanotechnology innovation is to break it down into four areas of strategic focus, as done by the National Nanotechnology Institution (NNI). The four areas of strategic focus that NNI uses that all nanotechnology firms must incorporate into their strategic plans in some way are research and development, commercialization of new products, education, and supporting responsibility (NNI 2008).

#### Research and Development

NNI focuses most of its efforts on research and development objectives, as many start-up nanotechnology firms must do. To effectively manage these efforts, it has leaders at the forefront of multiple disciplines including physics, chemistry, biology, materials, and engineering. This allows NNI to see where innovation is moving in all different industries. NNI allocates funding to many single investigators with different research

objectives to gain the ability to be involved in a broader range of research topics (NNI 2008).

#### Commercialization of Products

In order to make the transition from research and development to commercialization, NNI partners with firms doing research, and with firms with the proven ability to take new technologies to market, coordinating the two during the process of sharing information, ideas, and each firm's needs. NNI fosters successful transitions by breaking down certain barriers to entry such as time and lack of public awareness. The federal government is currently working to develop a more knowledgeable team of patent examiners specifically for nanotechnology. NNI also works with federal regulation agencies to identify, measure, and reduce safety and health risks of nanotechnology products (NNI 2008).

#### Education

NNI's main focus within education is to encourage curiosity and exploration around nanotechnology. They want a greater number of people to understand nanotechnology more thoroughly so that the acceptance of nanotechnology products comes easier. In order to do this, they are looking to empower youth by awarding funding for students working on nanotechnology projects so that they may be given the flexibility of scientific research. Additionally, NNI wants to bring nanoscience to students that are in middle school and high school. Currently there is a hands-on museum called Nanoworld that is dedicated to educating children on the subject of nanotechnology. NNI is also turning efforts towards working adults who could potentially contribute various skills to the nanotechnology industry by distributing information about nanotechnology at career fairs, developing nanotechnology training centers, and offering training opportunities on its website (NNI 2008).

#### Support Responsibility

Lastly, NNI looks to support responsibility in nanotechnology. NNI is dedicated to conducting large amounts of testing and research on the risks to public safety, risks to public health, and environmental implications. Its results and work in progress will continue to be communicated transparently as it encourages other nanotechnology firms to do the same (NNI 2008). Responsible methods of nanotechnology practices include eliminating or reducing bioavailability and hazardous materials as well as designing the product for the end of its useful life. Furthermore, it is essential that the product or material be designed in such a way that the nanoparticles within the product remain unchanged during the product's use.

#### *Technology Analysis*

In order to understand how nanotechnology applications might be used, it is important to gain a basic understanding of what nanotechnology is. Although there are many different definitions, the U.S. National Nanotechnology Initiative describes it as involving R&D at

the nanometer level to create structures that have unique properties because of the scale they are on.

### *Consumer Products*

Nanomaterials are the different types of structures on the nanometer level that contain unique properties that will be used to enhance current technologies and to construct nanostructures developed during research and development. The benefits to utilizing nanomaterials include smaller and less dense products and product components which can potentially increase product performance. Consumer products currently on the market that utilize nanomaterials include food storage containers, static-proof and stain-resistant clothing, improved sunscreens, cell phones components, tennis racquets, golf clubs and other various sports equipment, as well as certain medical devices. Nanomaterials include elements such as buckyballs, carbon nanotubes, and nanowires.

#### Buckyballs

Buckminsterfullerene, or buckyball for short, is a molecule constructed of 60 carbon atoms that has the ability to bond to a variety of different atom types. Practical applications of this material include more effective antioxidants, improved medical imaging, and more efficient fuel cell membranes (Booker 2005).

#### Carbon Nanotubes

Carbon nanotubes are a collection of buckyballs in the form of a cylinder. Some properties of carbon nanotubes include superior strength, elasticity, lightweight, low density, and high conductivity in comparison to other materials. Practical applications of this material include the development of highly conductive wires, chemical vapor detection systems, and hydrogen fuel tanks (Booker 2005). Carbon nanotubes hold great potential in future technologies to more cleanly and efficiently capture and store energy storage.

#### Nanowires

Nanowires are nanoscaled wires composed of a variety of different metals. Practical applications include memory devices, transistors, and disease sensors (Booker 2005).

### *Global Solutions and Equity Potential*

Consumer goods currently in the marketplace that utilize nanomaterials generally consist of enhanced convenience products, as mentioned above. However, it is important to recognize the potential that nanotechnology has to offer in creating solutions for the many issues concerning global sustainability and resource inequity facing the world today such as, "climate change, energy, food, fresh water, systemic pollution, ecosystem collapse, demographic burdens, economic recession, and new financial and political

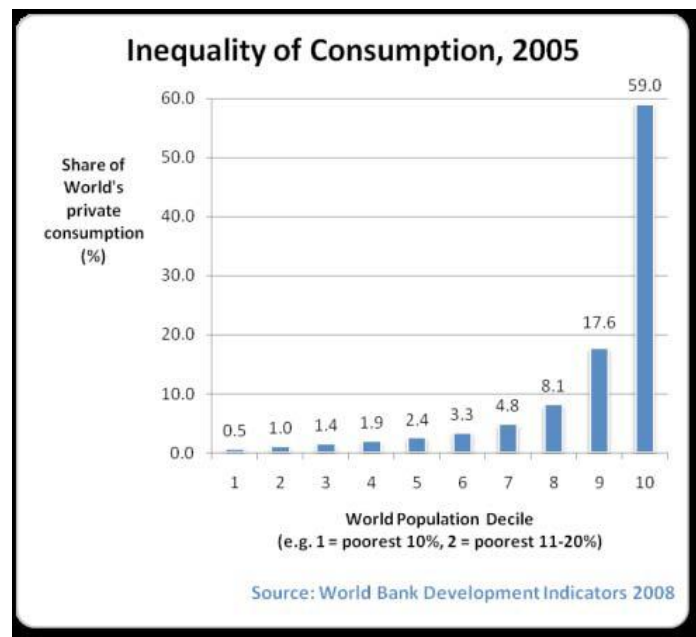
instabilities” (Hunt 2008). Geoffrey Hunt reaffirms this critical point in “Negotiating Global Priorities for Technologies” by saying,

It would be reckless to miss the historical opportunity to address some of the most pressing human needs because of a failure, even an unwillingness, to expand our grasp of context, while nano-trivia (skin creams, car wax, go-faster skis, etc.) proliferate at the shopping mall.

Hunt asserts that “transdisciplinary” debate must occur to provide a global consensus on how and how not to utilize nanotechnology to create solutions to these global issues.

Hunt emphasizes the importance of collaborating resources to fight crucial global issues rather than projects that do not benefit humankind by stating that:

“If the expenditure of even more billions of dollars can be seriously contemplated to man a mission to explore a planet of barren red dust and rocks, with no or very little liquid water and without a substantial atmosphere and protection against lethal cosmic radiation, how many dollars ought to be considered to understand a new planet that is lusciously green, bathed in vibrant water, and coated in a life-sustaining and protective atmosphere?”



Inequity of global consumption in 2005 (World Bank Development Indicators 2008).

### *Nanotechnology and Energy*

Currently the energy industry is primarily dependent on fossil fuels. But, as reserves run low and the consequences that they are having on the environment become more of a reality, people may turn to the nanotechnology industry for answers. Nanotechnology

offers the opportunity to enhance energy efficiency in every sector of the marketplace in addition to potentially boosting renewable energy manufacturing economically through the innovation of new products and enhanced manufacturing technology. Currently, nanotechnology can be seen as offering enhancement to each step in the energy value-added chain including sourcing, changing, distribution, storage, and usage (Luther 2008).

### Sourcing Energy

From the very beginning of the value-added chain for energy, nanotechnology offers the capabilities to improve the traditional energy sources, such as nuclear and fossil fuels, as well as alternative energy sources such as solar, wind, biomass, geothermal, or tides. Nanotechnology can be used to improve the efficiency of the traditional energy source of oil drilling by enabling the drilling probes to be resistant to environmental influences like water through nanofiber coatings. This increases the lifespan of the drilling technology and eliminates costs to manufacture new tools. Nanocoatings can also be added to geothermal drills, wind blades, and nuclear power plants to obtain the same benefits. Additionally, lightweight nanomaterials enable extraction technology to extract and store energy in a more efficient manner. Solar energy also has the potential to benefit from increased efficiencies through nanotechnology in various stages of the energy extraction process. Currently, nanotechnology is best suited to assist in the development of solar cells that can be produced in thin layers like polymer or dye solar cells. Polymer solar cells offer the most promise in terms of development because they can be manufactured more cost efficient materials and processes and have properties that allow them to be flexed. This development can most feasibly be seen in the incorporation of small, portable electronic devices. As nanotechnology research continues, it should eventually be able to increase efficiencies of the solar cell to over sixty percent (Luther 2008).

### Converting Energy

Converting raw energy into useful forms of energy like electricity, heat, and kinetic, requires extreme efficiency. Increased efficiencies could potentially decrease carbon dioxide emissions in fossil fuel gas and steam power plants. The conditions that are required to sustain increased efficiency would demand materials that offer better resistance to higher temperatures and corrosion. These conditions can be met using nanofiber coatings and lightweight construction materials. The most prominent method of converting energy currently is through burning coal at power plants and storing the electrical energy created. Although this method is not exactly environmentally friendly, it can be improved to decrease its negative impact. Certain nanomembranes can be utilized in a way that helps to separate the carbon dioxide from the coal and store it more efficiently. Other traditional conversions of energy such as chemical energy from fuel cells, if infused with nanocatalysts and membranes, can increase the amount of energy that is converted into useful energy, resulting in improved efficiency. Conversion of energy from thermodynamics, known as thermoelectric energy, has the potential to capture previously lost energy, or waste energy, such as the energy emitted from the human body or automobiles. Nanotechnology incorporated into material layers that

capture this heat and convert it into useful energy has the potential to power small portable electronics (Luther 2008).

### Transmitting Energy

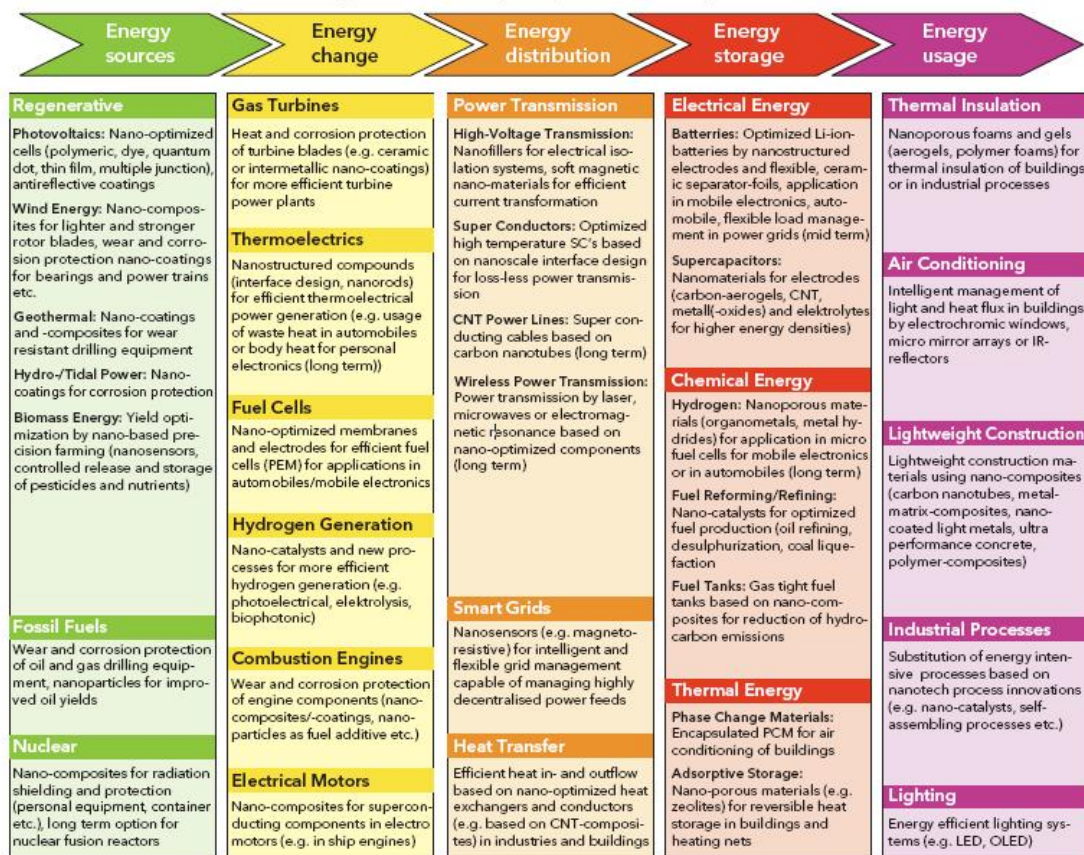
Currently, there are huge losses of energy through transmission lines. Nanomaterials such as carbon nanotubes made from various elements have properties that make them highly conductive. If nanomaterials are used to construct power lines, the potential is that transmission efficiencies would improve significantly. In the distant future nanotechnology may offer wireless energy transmission capabilities through means of lasers, electromagnetic resonance, and microwaves. To improve efficiency, distribution of energy needs to become a system that is responsive in terms of how much it creates and where it would most efficiently be transmitted. Additionally, distribution of energy will need contingency plans for periods during high demand. Implementing sensors to monitor and control transmission, as proposed with Smart Grid meters, can meet these requirements (Luther 2008).

### Storing Energy

Better storage capabilities of energy can be achieved by enhancing current storage technology like super-capacitors and batteries with nanotechnology. Currently, the most practical application of this enhancement is in the lithium-ion battery technology which improves the capacity for storage and increases the product's safety as well. These enhancements can be made by incorporating unique properties of certain materials on the nanoscale that provide heat resistance and flexibility into certain components of the battery, like the separators. Nanotechnology enhancement of the lithium-ion battery is currently being marketed to companies that are developing hybrid vehicles. Another place where storage can be improved is with hydrogen. Hydrogen is believed to be a plausible main source of energy in the future but cannot currently be stored efficiently enough to be useful for practical applications such as running a car. Although increased efficiencies in hydrogen storage have not been developed, it is speculated that the incorporation of nanotechnology will assist this technology (Luther 2008).

### Using Energy

To obtain an integrated energy system that will be sustainable over time, it will be important to utilize local energy sources and improve current uses of energy by reducing consumption. Nanotechnology offers enhancements to many solutions to this problem that have already been identified. One example of this is using nanomaterials in the construction of machines that require energy. This reduces the weight of the machine and results in a lower amount of energy required to run the process. A practical application of this technology could be applied to automobiles. Additionally, nanotechnology can be used to save energy through means of advanced insulation systems that optimize the efficiency of temperature regulation (Luther 2008).



Value added Energy chain (Luther 2008).

### Supplier Analysis

As a start up firm, most of the company's resources are invested into research and development as the technology is being developed for the target market. Currently, most of the suppliers specialize in manufacturing materials associated with nanotechnology and alternative energies. As the firm finalizes its solutions, it will continue to purchase the basic elements needed in research and development, such as nanomaterials from nanomaterial suppliers and will eventually move to outsourcing any supply chain processes that are not considered part of the firm's core competencies. Any processes that do end up being outsourced will only be done to companies that adhere to strict manufacturing standards that the firm will also hold itself to, to ensure health and safety regulations are being met. To enforce company standards, third party inspectors will periodically be hired to evaluate and score the compliance of the partner firms. If the firm's business partners are unable to adhere to company standards, they will be dropped from the supply chain and replaced by another firm that does meet standards. The goals of the manufacturing process will be to create a lean supply chain that will result in lower costs, better response time, and protection against obsolescence, while maintaining high quality products and company ethics.



### *Nanomaterial Suppliers*

#### Altair Nanotechnologies

Altair Nano is a leader in the nanotechnology industry. The firm provides manufacturing and distribution of advanced materials and energy storage products. In addition to the incorporation of nanotechnology, the company differentiates themselves by providing a wide range in energy storage product size and superior customer service (AltairNano 2008).

#### Enviroclean

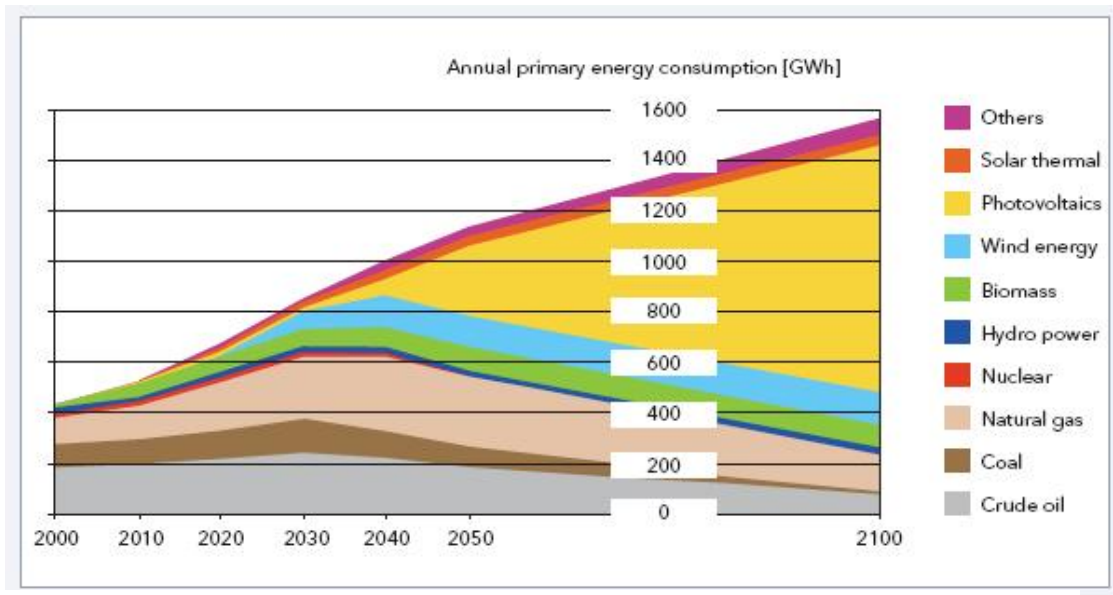
Enviroclean is a domestic company that provides decontamination solutions that incorporate the unique characteristics of nanoparticles. Enviroclean maintains a competitive edge by creating solutions that do not contain contaminants and that are also biodegradable. Extensive research and development by the firm has recently led to the revolutionary introduction of the Bio Shield, a nanocoating that can be applied to any surface to make it hygienic (Enviroclean 2008).

#### Nanodynamics

Nanodynamics creates technologies and produces materials that allow for more efficient use of finite resources while reducing the overall environmental impact of the finished products created by the company's clients. Currently, Nanodynamics is focusing its innovative capabilities on improving different aspects of the energy market. To accomplish this, it is working to improve current processing of traditional fuels, maximizing the use of hydrocarbon fuels, and developing products that generate power from alternative fuels (Nanodynamics 2008).

### *Alternative Energy Material Suppliers*

Fostering cooperative relationships with alternative energy suppliers will be crucial as society continues to reduce its reliance on traditional sources of fuel and simultaneously transitions to more sustainable options. The following figure shows projections for future primary energy consumption through the year 2100.



Projected primary energy consumption by year (Luther 2008).

#### GE Energy – Solar Panels

GE Energy is one of the world's leading suppliers of power generation and distribution products with sales of \$22 billion in 2007. GE Energy recently increased its holding in PrimeStar Solar Inc. to become a majority shareholder of the company. PrimeStar Solar Inc. is a new company that specializes in thin-film solar power technology that is resilient and resistant to weather-wear. PrimeStar Solar Inc. solar power products can be purchased from GE Energy and range from 66 watts to 200 watts (GE Energy 2008).

#### EOLTEC – Wind Turbines

EOLTEC was started in 2001 by a group of engineers in Nice, France. EOLTEC designs and produces highly efficient wind turbines that range from 6kW to 300kW. EOLTEC differentiates itself by staying on the forefront of technological capabilities and by providing cost effective products (EOLTEC 2008).

#### Kinetic Ceramics Inc. – Piezoelectrics

Kinetic Ceramics specializes in providing Electric Piezo Drivers, Electric Piezo Controllers, Piezomotor Piezoelectric Actuators, and Piezomotor Piezoelectric Sensors that can be incorporated into the manufacturing of energy systems in any industry. Kinetic Ceramics Inc. differentiates itself from the competition by providing superior quality products that outperform competitors in response time, force, pressure, durability, and control (Kinetic Ceramics Inc. 2008).

## *Pinpoint Market Opportunity Analysis*

### **Potential Customers**

Rather than focusing on selling products to specific industries, Pinpoint will primarily focus on selling to individuals. However, as a part of the marketing and distribution strategy, some humanitarian not-for profit organizations will provide business opportunities through promotional and distributional partnerships. Depending on each specific situation, Pinpoint products may be distributed to refugee camps, displaced individuals, or simply individuals who lack basic needs at home. Pinpoint's target market includes American Indians living off the electricity grid on reservations. Some key players in this primary market include elders influential in their local communities and tribal government leaders and policy makers. Pinpoint will later expand this market to the international scale, targeting individuals in developing nations with similar un-met needs. The influential decision makers in developing countries again include local governments and policy makers, but further include supply distributors for humanitarian aid/relief organizations. A complete financial analysis of the operations of various humanitarian organizations must be completed to determine which group is most effectively utilizing its assets through the leanest supply chain possible to determine the most effective business partnerships.

Pinpoint's primary marketing strategy involves profiting "from the fortune at the bottom of the pyramid." This business strategy, as explained by C.K. Prahalad in his book by this title, involves creating profit by targeting consumers in developing regions. To reach these consumers, Pinpoint will be selling its products at low price/high volume distribution to the primary market. Furthermore, as part of its business strategy, Pinpoint will sell a number of its products with slight design variations to a secondary market of upper-middle class eco-friendly and equity conscious city dwellers. This dual market strategy of selling original products at an extremely low price-point to the primary target market and selling modified products with high profit margins to the secondary market holds great potential to decrease global inequity. Furthermore, by expanding into two contrary markets, Pinpoint will reach a large customer base and build brand recognition as well as increase consumer awareness for nanotechnology's role in combating climate change.

### *Mission Statement and Objectives*

**Mantra: Energy Independence**

**Tagline: Providing Small Solutions to Big Problems**

Pinpoint is dedicated to solving global problems related to energy and equity. The team is composed of a businesswoman, an engineer, an industrial designer, and a visual communications designer to ensure innovation is taking place at all steps of the product development process. The firm utilizes the talents of all team members to ensure that the final product goal is met in creating a product that is valuable to our user group(s), desirable from a business standpoint, technologically possible, and good for both society

and the environment. The firm relies heavily on the triple bottom line- social, environmental, and economic profit, in achieving the final product goals. Pinpoint's overall objective is to utilize nanotechnology to solve large-scale global inequity in the energy and resources sector by "bringing small solution to big problems." Pinpoint is in the business of providing practical, cost-efficient, and easy to use products to rural, off-the-grid individuals to ensure that they may meet daily needs in eco-friendly ways while simultaneously improving living conditions. Pinpoint's green products are innovative and revolutionary- both in concept and in product design. The team strives to incorporate biomimicry in their products, looking first toward nature for solutions, and then to technology's role in using nature as a guide. Pinpoint then utilizes state of the art nanomaterials to create product solutions previously unheard of while focusing on creating hope and energy independence for the user. Pinpoint will partner with other eco-friendly firms that utilize "free energy" manufacture individual energy capture and storage devices, working together to create solutions for a sustainable future.

### *Objectives*

Pinpoint will ensure that product advertisements accurately depict the product's benefits without creating false promises in the eyes of the consumer. Marketing standards must be kept at all times, keeping in mind the Pinpoint mission statement at all times, even when targeting the secondary market. Sales to the primary market should be in high-volume/low-cost to ensure a low price-point and subsequently a low-price available to members of this user group. For the secondary market however, Pinpoint product sales will follow a pull rather than a push operational strategy, providing users with the product as demanded rather than having products available at all times. Sales to the secondary market will be at a high price-point, ensuring high profit margins from sales to this market. Marketing campaigns will highlight past "success stories" of the product's benefits, personalizing these benefits through strategic advertising to promote sales to the secondary market which will in turn return to benefit the original user group.

### *Strategies and Tactics*

#### *Products*

The initial Pinpoint products are Solstice, Loop, and Everwell. However, Pinpoint will later expand to sell accessories that complement these products, such as a hose to transfer purified water collected from Everwell directly into the home. Pinpoint will ensure that the firm's mission statement is met at all times. Even with accessory products, the firm will ensure that all products with the Pinpoint brand name are truly green, containing eco-friendly elements at all stages of the life-cycle analysis for each specific material used. Pinpoint products meet a variety of different energy and resource needs in an effort to decrease the labor-intensiveness of daily activities and/or to increase the quality of life for individuals in rural regions, depending on the specific product. With each product, Pinpoint strives to increase social equity in the world in a manner respectful of the land.

### *Production*

Production methods vary amongst the three final products. However, as a company dedicated to creating green solutions to combat energy and resource inequity, Pinpoint will ensure that each product is composed of high quality, eco-friendly materials. While each material in the product will be thoroughly analyzed for ecological impact, the nanomaterials used in the product will require the allocation of extra resources to further ensure the human and environmental safety of these materials. Naturally, this requires extensive scientific testing and research, and will cause the final product (that utilizes nanomaterials) to not be available for between five and ten years.

Since nanomanufacturing must take place in a very controlled environment, the nanomaterials required of the device will be produced in scientific laboratories to be later integrated into the final product. Because of this restriction, the product will be assembled in parts. This allows for easily component changes, adaptations, and up-grades for technological innovations, also enabling part replacement from environmental damage rather than disposing of the entire product because of only one part. When possible, individual parts should be manufactured utilizing location economies, manufacturing each part in the location where it may be created most efficiently and effectively to keep costs low. However, as a firm dedicated to combating energy, resource, and social inequity, very often location economies do not prove an option consistent with this goal. Therefore, when determining manufacturing facilities and firms, it is important to thoroughly investigate factory labor policies through third party inspectors to ensure fair labor practices, living wages, and safe working conditions.

### *Promotion and Place*

Pinpoint's business strategy includes dual market penetration. Therefore, the firm will implement two contrasting promotional strategies to target each market. As previously noted, Pinpoint products have been originally designed to be sold to off-the-grid American Indians living on reservations. The promotion strategy for this location will consist of strategically placing products at local stores or trading posts. To effectively integrate Pinpoint products into this marketplace, the firm will rely on partnerships with locals to ensure that the firm does not appear to be invading the culture with more unnecessary American consumer goods. The products will then be promoted through word-of-mouth advertising, as locals see the benefits of the product and encourage others to use it as well. After some success in the secondary market, Pinpoint will use these profits to donate a number of the products to influential members of the American Indian community who are in need of the product. In exchange, these individuals will have agreed to take part in frequent customer satisfaction surveys. This frequent customer feedback will serve two purposes: to better the product design, and as marketing research. The information gathered from customer responses will be used to determine customer values and further develop and improve personalized advertising campaigns based on this information. These advertising campaigns will be used in market expansion, promoting the Pinpoint's positive brand image and its valuable products. The advertising campaigns will be strategically placed in green magazines, a select set of technology magazines, and

business newspapers such as The Wall Street Journal and The Economist. All advertising campaigns will be geared toward the purchaser, which in some instances will not always be the ultimate user of the product. Depending on the product, the decision maker who chooses to buy the Pinpoint product will not always be the end-user. As mentioned earlier, Pinpoint products will be promoted through humanitarian aid organizations, and some advertisements will solicit decision makers to buy the product and donate it to users in need. However, other ads will be directed toward these middle to upper class decision makers as part of the market expansion and profit-growth strategy. The product's green benefits will be promoted through examples from the rural market success, enticing upper-middle class city dwellers to achieve "energy independence."

### *Price*

The business strategy involves making Pinpoint products accessible to lower-income rural individuals by selling it at a loss to individuals in this market. Pinpoint target its products to those in need, rather than targeting convenience products to the wealthy elite. Pinpoint plans to expand into a secondary market, filling a market niche for eco-friendly products for upper-middle class city dwellers. This will enable the firm to finance its products to rural users at a low price point, and to even sell certain product at a loss that is being recovered through sales to the secondary market. Therefore, products will be sold as environmentally sound, green commodity items to the secondary market at a relatively high price point. The product design to this secondary market will be slightly adapted to specifically target design tastes and will undergo annual design innovations (including online personalization options) to keep middle class city-dwellers interested in combating climate change through freedom from fossil fuel dependence.

### *People*

Pinpoint will work with its sponsor, The Center for Nanotechnology in Society (CNS) to promote the environmental and societal benefits of its products. As mentioned earlier, Pinpoint aspires for its products to reach the greatest number of individuals in need as possible. Having direct access to rural off the grid individuals living on American Indian reservations has enabled the firm to directly target this user group. However, the firm's initial business strategy has been to use this as a base to extend to individuals with similar needs in developing nations as well. Selling products to city-dwellers as a secondary market enables Pinpoint to receive the funding necessary to further this business strategy, simultaneously publicizing global, societal, and environmental inequity as well.

## Appendix A

### *Pinpoint Product Brainstorming*

Grouped by category

#### Greater energy efficiency

- 5. chemical reactions for faster energy-less heating
- 22. Solar heat focusing device-like a large satellite dish that focuses light on small point (reflective surfaces)
- 25. Shoes that generate energy while someone is walking to go get water.
- 28. Propane meter that accurately tells user how much fuel remains and records usage
- 36. Nano net, collects lost energy from wood burning (or other open fires) and stores this lost energy for later use in home.
- 37. Nano shoes that capture and store energy, small battery could be removed when not wearing and then put into household appliances.
- 59. Use nano for more efficient house-hold solar wire capture
- 65. Clothes that use nanotechnology to capture and store energy from body heat and movement for later use.
- 70. Cheap plan to build wind turbine from broken down car to produce electricity (and store it)
- 72. Harness energy from the heat on rock surfaces
- 81. Generate energy from casinos to batteries for use in homes
- 84. Piezo electric boots for sheep to produce electricity from sheep's movement and can be later used to cook said sheep
- 87. nano-enabled capture system of energy from compost piles
- 89. horse merry go round that can grind food or generate electricity for cooking
- 92. Pet electric eels
- 94. Geothermal probes for capturing heat
- 95. Nano solar kites
- 98. Brick capacitor- rather than solar panels bricks would capture and store energy (walls instead of just roofs)
- 109. Community hub to transfer wireless energy to homes

#### Alternative energy/fuels

- 17. Fuel chips that can be stored inevitably and give out much more energy than wood or gasoline.
- 32. Central unit powered by natural energy source that inhabitants visit to recharge batteries, gather filtered water, etc
- 42. "Net" to capture harmful smoke from grilling with wood
- 48. Metabolic house
- 54. Solar powered electrolysis (fuel cell) to store H+ instead of propane
- 66. Devices that capture grease from foods and use that as their fuel instead of propane/butane
- 67. Devices that grind down animal bone and use that for fuel

- 91. Device to convert burning wood into H<sub>2</sub> or other gas for ease of use in refrigerator later
- 96. Growing plants for fuel, use nano to change make-up
- 97. Melt fat off meat and use fat for energy
- 99. Livestock poop mixer w/ fibers to be used as fuel
- 100. Methane capture from livestock
- 101. Personal methane fuel-capturing device
- 112. Poop rover collects livestock, uses poop for fuel
- 113. Bicycle to generate energy and store in battery pack to be used for in-home energy needs.
- 114. Nano robot to take waste and package into fuel logs
- 122. "Fermentation" to produce methane in waste
- 125. Livestock control collar for water/food retrieval
- 126. Solar powered roving livestock pen (w/ chickens following to eat worms, etc and purify soil)
- 127. Something that uses salt to generate electricity

### Water

- 3. Nano pumps very deep. Into aquifers that pump water up to each home very small but on all the time
- 7. Nano net to retrieve water from a distant well
- 9. Collapsible water pulleys
- 10. Solar water cookers
- 12. System for making collector rain water potable, in an extremely efficient way. Collection and storage methods might also be improved (filtration/UV)
- 15. Some kind of pipe that attracts water molecules in air and attaches to house to provide running water
- 21. nano-snake, exploits natural weakness in earth's crust for deep water well drilling
- 24. A place where you urinate. A system is set up that creates condensation. Useable and transportable nano water filter
- 38. Foot pumps inside the home to pump up what from underground aquifer and into the home for use.
- 43. Use UV to cut down on dishwashing waste
- 46. Water filtering system so you don't have to go get more every day
- 52. Solar powered water distillation, reuse water
- 64. Namib beetle as inspiration for system for collecting water through condensation
- 68. Use temperature difference between ground water and ambient temperature to power water pump
- 69. Mimic root like structure to "grow" into earth and retract water
- 93. Solar pump that pumps water up hill so it can use flowing water downhill to generate electricity
- 102. Nanobot to navigate ground and find water (underground)
- 103. Backpack used to suck up and store water
- 104. (cactus example) synthetic nano material on roots to captures, store, and purify rainwater
- 105. Frog bladder-water reuse (look to biomimic this)



- 106. Dew collector for livestock (inspired by Namib beetles) from breath, cooking, dew, showers
- 107. GPS water collecting rover
- 124. Nano surface that can be spread out before rain to collect rainfall

#### Cooking/food process

- 2. Solar or wind powered do it all unit, pressure cooker makes the stew-then starts to suck all moisture out. Then bags it in plastic, like dehydrated mutton and fry break (just add water)
- 16. Multi-purpose food processor that is run on solar power (blender/mixer/oven)
- 20. Self contained solar stove
- 26. Metals that conduct heat better so not as much heat is needed to cook things
- 27. Stoves that burn wood and turn the smog into some harmless product
- 35. Fold out solar oven that could be left out during day and folded up and brought inside to cook with.
- 39. Bicycle powered stove
- 44. Create a better solar oven or solar slow cooker (great for AZ reservations)
- 55. Stove that cleanly burns animal waste (cow pie) for cooking
- 57. Stove that uses cooler underground temps to heat up a metal to cook food.
- 58. Stove that holds heat that was not used- like “rollover minutes”
- 63. Molten metal solar oven
- 71. Hydraulic helping arms for elderly natives cooking big meals
- 79. Pressure cookers that use the sun’s heat to raise the pressure
- 80. Use tin can waste to make solar ovens or other household appliances
- 83. Nano coating on kitchen pots, pans, etc for a quicker cook w/ evenly dispersed heat
- 86. Mini-super efficient microwave, “microwave” pan
- 108. Kitchen powered by motion-stirring, slicing, boiling, etc
- 110. Interconnected solar kitchen “kitchen organism” oven, dishwasher, fridge, microwave, sink
- 116. Controllable stick-free plates, cups, forks (using nano film)
- 117. Solar heating dishwasher
- 118. Liquid that dilutes waste into usable energy
- 119. Burn waste to create fuel in safe way

#### Refrigeration/ food storage

- 6. wind-powered outdoor refrigeration
- 11. Collapsible fridge boxes
- 14. Insulated “Tupperware” that preserves and stores- eliminates need for refrigeration..
- 18. Nano dust that coats the food to preserve and is enforced w/ vitamins for ingestion.
- 19. Nano-silver lined food containers- decrease bacterial growth
- 34. Nano material refrigerator that maintains a constant temperature by its constitution and eliminates need for energy.
- 45. Solar thermal system that heats up a fluid to cool down another fluid which runs through a refrigerator
- 51. Home dehydration system (dehydrate milk, eggs etc)
- 53. X-Ray or other treatment to kill microbes that grow and spoil meat

- 56. Underground food storage, pulley system to retrieve when needed
- 75. Food being packaged in reusable packages whether it be edible or a bag, etc
- 82. Edible “blue ice” type food (mix in a bag and gets instantly cold or hot)
- 115. Preserve good w/ nano, not cold

#### Waste disposal/ clean-up

- 23. Nano machine that breaks down trash and waste and turns it into electricity which can be used to prepare or store food
- 29. Nano enabled device that converts table scraps into feed stock
- 41. Food waste used to power refrigerator
- 62. Nano “bots” to safely decompose unused meat in a sort of compost bin
- 73. Nano coated plates that require little to no cleaning
- 90. trash/waste compactor to create usable “logs” for fuel
- 120. Box-like garbage disposal that works w/ a hand crank (or foot pump) and can later be used as livestock feed or garden feed or garden compost
- 121. A personal trash compactor to separate materials into compost and waste to take to landfill

#### Heating and cooling

- 30. super efficient heating and cooling insulation for shelter structure
- 31. (Nano) heated blankets that store solar energy during day to use for night
- 60. chairs/beds heated from lost human heat

#### Lighting

- 61. Nano material in windows that capture daylight and mimic it at night (when needed/wanted)
- 76. Biomimic fireflies for light (a lot of small things together to make light)

#### Transportation and communal services

- 8. Universal raw material transport units (water, food, materials)
- 13. System for tracking need for cooking supplies in a localized area, purchase/transport more efficient, possibly cheaper.
- 49. trash/fresh food/water rover-delivery truck from house to home fully automated robot
- 50. Mobile market that travels to each communal area daily-structure surrounding that protects from items perishing
- 74. Grocery delivery service
- 77. Communication device to plan community cooking- use animal completely, less energy
- 85. Service that collects used cans and repackages them and sends them back with food in them
- 88. Communal food prep building that then distributes meal pods to all the participants (whole cow)

#### Agriculture

- 33. Machine that quickly and efficiently picks, harvests, collects them-no need for humans

47. nano-enabled greenhouses

78. nano-based fertilizers. Use nano technology to deliver nutrients to crops more efficiently, increasing yield/speed

111. Nano health meter for animals

123. Plant bulbs to provide nutrients to plants and monitor dirt, plant, infestation, animals

#### Animal related

1. Electronic collars irritate animals when not moving in right direction

#### Other

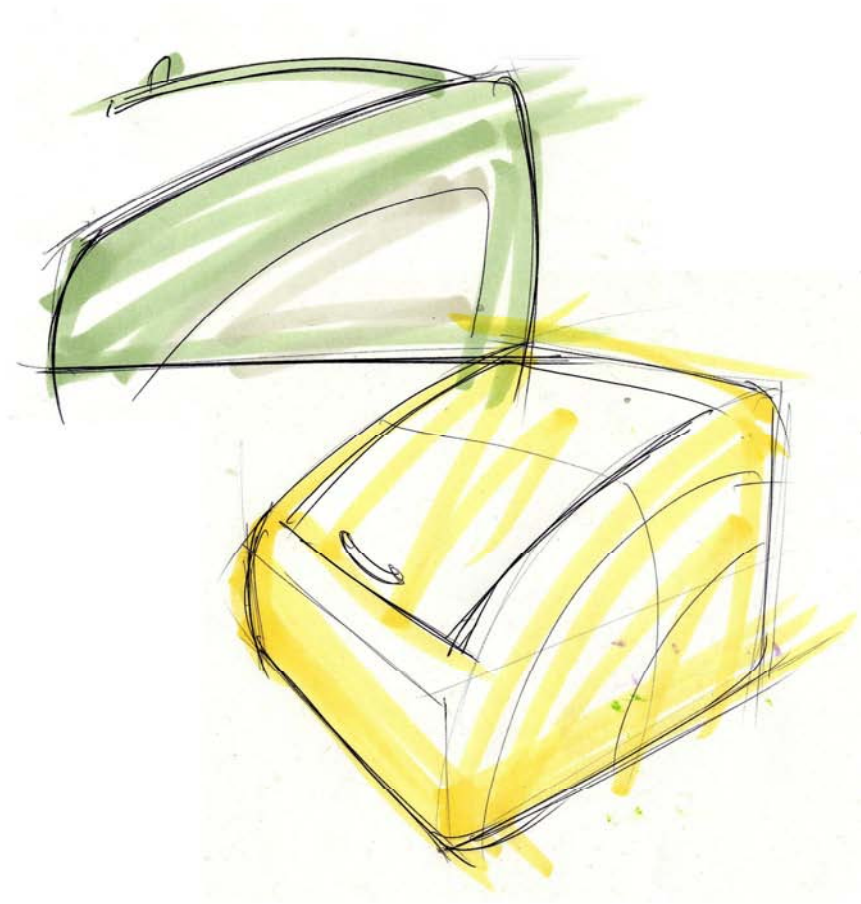
4. Energy generated from a loom when doing weaving = battery power

40. Appliance that samples food and displays nutritional value to promote healthy alternatives (solar powered)



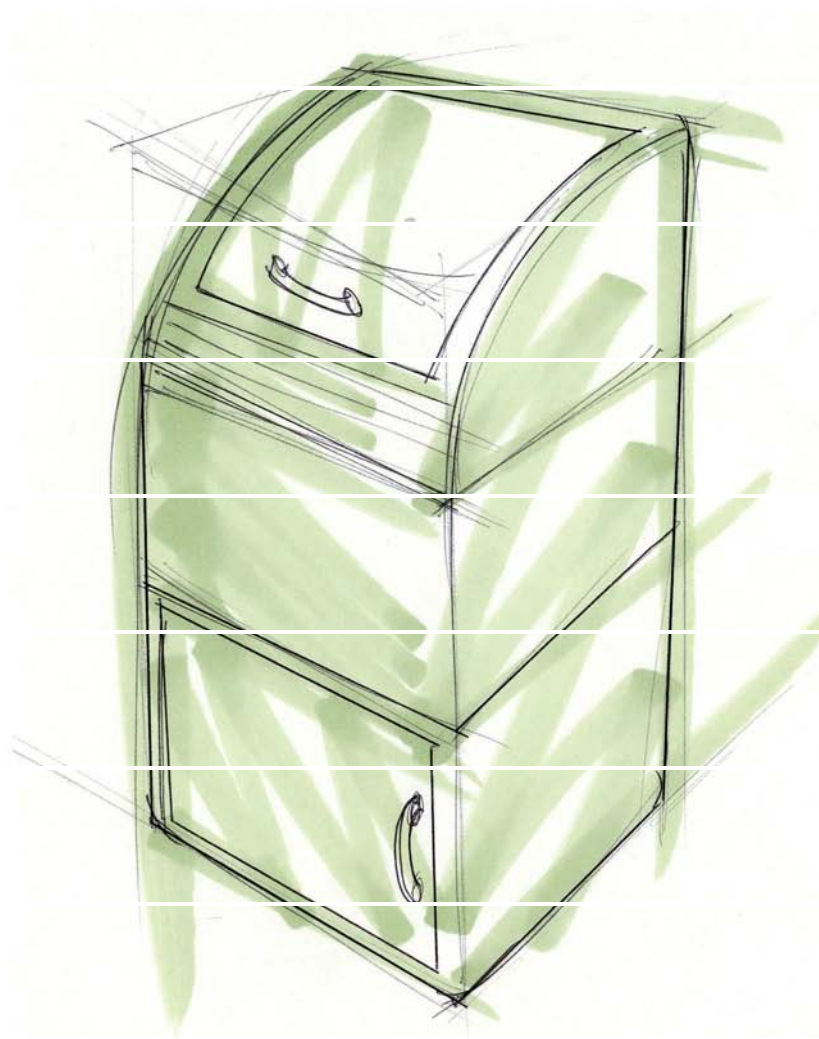
Appendix B

*Final Product Sketches*



Appendix B

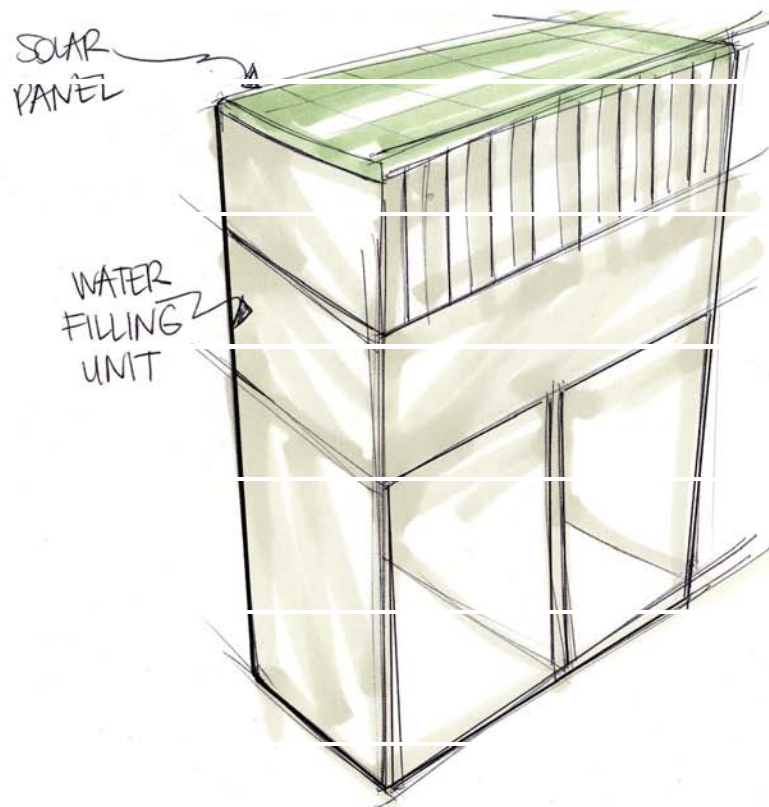
*Final Product Sketches*



Appendix B

*Final Product Sketches*

EVERWELL



*All Sketches and Rendering by Pinpoint Industrial Designer Tiffany Duening*

Appendix C

*Product Renderings*

EVERWELL



Loop

*All Product Logos by Pinpoint Graphic Designer Billy Sweeny*



## Appendix D

### **Marketing Research Insights On User Group**

#### *Themes/Commonalities found in Interviews*

After interviewing many people with direct contact and experience with life on American Indian reservations, I have learned a great deal about the Native American culture. To get different perspectives I interviewed two college students and one recent graduate, one female and two males, a professor of American Indian studies, the former (and first) president of the Navajo Nation, the American Indian Initiatives projects and operations coordinator, and the research analyst at the American Indian Policy Institute. While naturally each interview was different due to personal biases and individual perspectives, I was able to observe many similar themes and commonalities concerning life on reservations. I was able to see that the life that most people live on reservations, especially those without electricity, is drastically different than the life that the majority of Americans live. From what I gathered through my interviews, the life that those with electricity on reservations live is somewhat comparable to those in other rural areas in the United States. Except however, that those modern conveniences, things we consider necessary, such as grocery stores, entertainment and shopping centers, and even schools and hospitals, are all much farther away from many peoples' homes. This has made long commutes become a normal part of daily life for those living on reservations, as ASU student John Bailon told me, "luckily our closest town was 30 miles away so it wasn't as bad," comparing his family's commute with others on the same reservation who faced two to three hour commutes to the nearest town. Therefore, people living on reservations rely on trading posts for a variety of different goods, from food to jewelry. This common trend of "driving long distances" naturally adds to the labor-intensive lifestyle many face living on reservations. Through my interviews, I noticed that many people continually mentioned the great amount of time spent on reservations doing small daily tasks, such as driving to fill up barrels for water, something most Americans take for granted when we simply turn the faucet. ASU alumni Monica Joe, along with many others, explained this process to me, saying, "My grandmother usually hauls water twice a month. The water is hauled in from a windmill about a mile away from my grandparents." Because of the labor-intensiveness required of daily household tasks on the reservation, my Innovation Space team, Pinpoint decided to focus on the entire chain involved in the food preparation process. The simple-sounding activity of preparing food is really very complex, from gathering the raw materials- the food and other items needed in cooking, to gathering the water from a far away well, to filling up the propane tank used to run the oven, to heating the water on the stove, to finally cooking the food and then disposing of the waste in either self-dug landfills, or hauling a lot of trash at once on another long drive to a far-away landfill. Associate Professor Dr. Martinez explained this to me in saying, "one thing that happens a lot on reservations, people haul out their garbage and burn it to dispose of it. There is no regular garbage service [because] most people are so spread out."

I also observed that elderly tribal members living on reservations are in a much higher percentage those living very isolated from others and, consequently, those in higher percentage who are without electricity and/or running water. This means that commonly, the elderly, who naturally may have more difficulty participating in labor-intensive activities, are the ones who must partake in these labor-intensive activities daily. I saw the trend in my interviews that these people would like to maintain their traditional lifestyle as much as possible. However, it appears that many of them would also be happy to have a simple product that would make their lives a little less labor-intensive, as sentiment clearly expressed by research analyst Wenona Benally in saying, "I think the Navajo people would be open to technology to making their lives a little easier."

I also saw many people speak of their cultures' respect for the land. I learned that this deep cultural respect for the land means that the people enjoy and appreciate open space and consequently, do not want to live very near to other people. The former Navajo Nation president Peterson Zah explained this to me in saying, "Think of yourself and if you really like your open space, if you really like the land, if you are the owner of the sheep or cattle would you want 50 other people close to you?" While this naturally means that they have to endure long commutes for many basic activities, I did not observe any expression of wanting to change this infrastructure. I saw no real desire to improve the infrastructure on reservations nor to bring the community physically closer together, as, while these things could naturally make tasks easier, it would also change their culture. I saw the common theme that while there is often a culture-clash between the young and the old, the majority of residents would like to maintain tradition, even when those traditional ways, such as using wood stoves, really may not be very good for the environment. Therefore, it becomes clear that small changes through simple products would be more well-received by these communities. As creating a balance between energy development (preferably renewable energy development), the environment, and the culture, is the key to any market success of a new product.

It is also important to note the differences with the land on reservations. Unlike in the rest of the United States, reservation land is trust land. Trust land is land given (back) to native tribes for their use, and thus belongs to the tribal governments rather than the U.S. government or an individual. Because of this, trust land can only be leased to companies, not bought. Clearly, this makes it more complicated to begin new projects, new infrastructure, and new development in general, as companies do not want to lease land that they could buy elsewhere. This has kept the reservations relatively little-developed, and is why no large city centers exist on reservations but rather on non-tribal land on the border of reservations, creating long commutes for residents. However, while a part of the culture and life on reservations, this lack of infrastructure also causes many youth to leave the reservation in search of economic opportunity in the form of jobs.

Consequently, mines have often been thought of (primarily by the government) to be a solution to economic problems. Due to many issues that have arisen from the coal plants, from disputes over water rights, to re-location, to environmental aspects and the inequity involved in the coal plant energy allocation, it appears that the general public is against further fossil fuel development. Because of this history, combined with the Southwestern American Indian tribes' cultural respect for the land, it appears that most living on

reservations would support clean, renewable energy sources. I saw this sentiment expressed through the people I interviewed who saw not only the environmental benefits of renewable energy sources, but furthermore realize the practicality of installing solar panels on individual homes far away from the grid. However, my interviewees also expressed the financial concerns of those living on reservations, as the renewable energy technology is not affordable for most households. Finally, the people I interviewed also reminded me that many locals are now skeptical of new ideas and promises because of the un-kept promises sold to them by the coal companies after exploiting their sacred land. Clearly, my team will have to work cautiously and with locals to remain culturally sensitive and not intrude on a culture that I still, after so much research, know so little about.

A SWOT analysis, commonly used to analyze a company, can also prove insightful for a variety of different situations. The SWOT analysis enables the researcher to better understand the internal strengths and weaknesses of the firm (or situation) being analyzed as well as the opportunities and threats in the external environment at hand. This analysis assists the firm in properly targeting its product in a way that is consistent with the values of the user group. However, since this specific marketing research situation does not involve the internal analysis of a firm, only the external opportunities and threats as they pertain to the target group will be investigated.

#### Opportunities

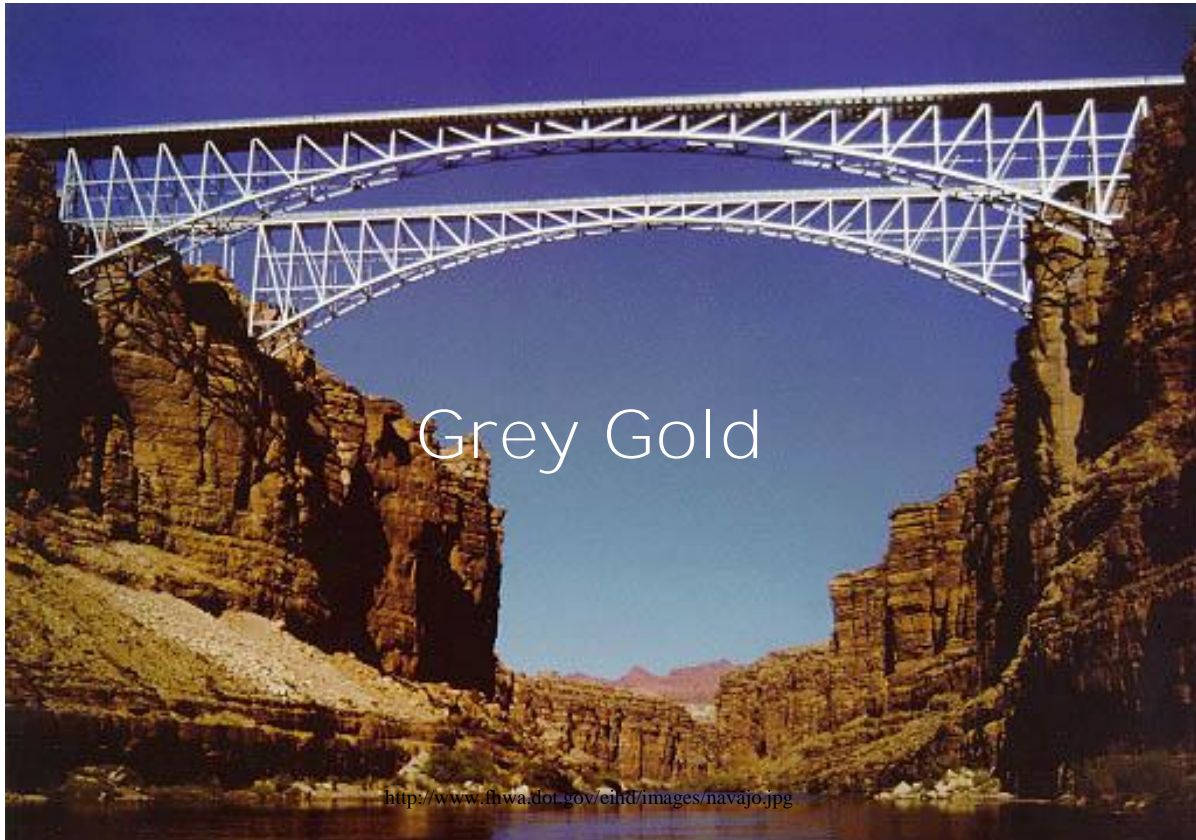
- A clear need for alternative methods to provide homes with energy (as opposed to the electricity grid) exists
- A clear need for cost-effective energy methods exists
- Environmentally friendly products fit-in with the Native American culture
- Gathering natural resources such as wood and water is an extremely labor-intensive process
- A more environmentally friendly and/or less labor-intensive method for disposing of waste
- Renewable energy sources can enable individuals to enjoy modern conveniences without a high utility bill and negative environmental impacts
- Modern conveniences at home might cause more youth to remain on the reservation
- Technological innovations can provide solutions to energy and resource equity issues
- Products create local jobs and enable youth to remain on the reservation

#### Threats

- Locals living on the reservation many not respond well to “outsiders” entering this market.
- Residents may not be open to new, alternative technology for a variety of reasons:
  - They desire to maintain the traditional way of life and do not want change
  - They see the technology as conflicting to their cultural values
  - They are not convinced that the new technology will benefit them
  - They are not convinced that the technology will be cost-efficient

- They believe the technology will be too difficult to operate
- Lack of infrastructure development may make product distribution difficult
- They are simply happy (or complacent) with their current way of doing things
- They may view the products as trying to change their cultural and communal structure (youth will no longer chop and bring wood to elders)
- Tribal government and other bureaucratic issues create long waits to market entry
  - Land and resource difficulties (ability to lease work space and utilize resources, such as water, if necessary)
- Budget restriction of user group

***Appendix E***  
*User group research report*



A brief report about the Navajo Nation and their struggle between the traditional way of life and economic opportunity- with emphasis on energy production

Dusana Schnell  
MGT464  
9/24/2008

## *The Navajo People*

### *Brief Historic Beginning*

Historically, the Navajo people, currently the largest tribe of North American Indians, originate from Northwestern Canada and Alaska. They are thought to have begun the journey south until they reached their present location over 1,000 years ago (“Navajo Indians”). The tribe then became farmers, learning from the nearby Pueblo tribe, planting corn, beans, squash, and melons. They also learned weaving, clothing, and art making from the Pueblo tribe. With the arrival of the Spanish in the 1600s, the Navajo began using sheep and horse in their daily lives, using the sheep for its wool and meat, and the horse as means of transportation, enabling them to trade goods farther away with other tribes.



<http://www.lib.ucdavis.edu/ul/libcoll/harrison/photos/about-navajo2-big.jpg>

Picture of a traditional Navajo home called a Hogan. It is made from wooden poles, mud, and tree bark, and faces the east for sunlight.

Navajo legend says that the Diné (“The People”-the name by which Navajo refer to themselves) passed through three worlds before coming into this world, the fourth, or “Glittering World.” Thus the Navajo put the four mountains in four different directions, Mt. Blanca to the east, Mt. Taylor to the south, the San Francisco Peaks to the west, and Mt. Hesperus to the north to create the boundaries of their sacred land, “Navajoland,” says the legend. The Diné believe in the existence of Earth People, ordinary mortal humans, and Holy People, spiritual beings we cannot see who either harm or help Earth People. The Diné believe in the Great Spirit, proclaiming that their strong spirituality has and will cause their nation to endure. The Navajo have traditionally used a medicine man (qualified for the task by supernatural powers) that used traditional herbs and ceremonies with song and prayer to cure the ill. Today however, some seek only modern medicine, while others use only traditional medicine, and still others combine both the traditional and modern forms.

### *Recent History*

After the Long Walk in the 1860's, the Navajo Nation had shrunk to a mere 8,000. The Navajo Nation has now expanded again to nearly 300,000 people (The 2000 U.S. census reported 298,215 Navajo people in the United States with 173,987 living on the Navajo Nation). The Navajo Nation, called Diné Bikéyah by the Navajo people, is a sovereign nation within the United States and is the largest Indian reservation in the Nation, covering over 27,000 square miles in Arizona, New Mexico, and Utah ("Welcome" 1). Because of a growing population, the Navajo Nation has expanded its landmass over 17.5 million acres in the past several years and plans to increase its land even more.

The Navajo had traditionally governed themselves by a clan system. However, when oil was discovered on Navajo land in the 1920's, a tribal government was formed as an entity through which private oil companies could negotiate deals to lease Navajoland for oil exploitation ("Explore the Navajo Nation" 1). The Navajo Nation Council was reorganized in 1991 to function with a three-branch government consisting of executive, legislative, and judicial branches. This consists of an elected Present, Vice-president and 88 delegates on the council that represent the 110 chapters (the local units) present within the Navajo Nation. The delegates, also a part of the smaller tribal committees, meet all together at least four times a year at the Navajo Nation capital, Window Rock, Arizona ("Explore the Navajo Nation" 1). The challenge to maintain the Navajo culture's traditional values while simultaneously bringing economic betterment to their nation has been a constant struggle. This becomes increasing apparent in the many on-going disputes over land exploitation for energy-uses, as respect for the land, the sacred homeland of the Diné, often clashes with economic opportunity.



[http://www.historycooperative.org/journals/jah/92.4/images/rosier\\_fig03b.jpg](http://www.historycooperative.org/journals/jah/92.4/images/rosier_fig03b.jpg)

## Energy History

### *Black Mesa*

Peabody Western Coal Company (also known as “Peabody Energy”) is the largest private coal company in the world, bringing in sales of 238 million tons of coal and \$4.6 billion in revenues in 2007 (Peabody Energy 1). Peabody Energy’s coal plants fuel about 10% of U.S. electricity generation and about 2% of electricity worldwide. One of their plants, Black Mesa, is located in the Four Corners region of the Navajo and Hopi reservations, and is a major energy supplier to nearby California and Nevada. The plant and its operations have been highly controversial ever since the contract between Peabody Energy and the Navajo tribe began in 1964. The contract, which showed a clear advantage to Peabody, was approved despite much opposition<sup>1</sup>. The natural resources attorney John Sterling Boyden, who was representing the Hopi, was later found to also be working for Peabody Energy.

Another current debate concerning Black Mesa deals with the abnormal mineral lease agreement that enabled Peabody Energy to tap into potable water sources to transport the extracted coal from the mountaintop (aside from other environmental concerns such as pollution, land exploitation, and energy disbursement- none of the energy produced at the site is used on Navajo land). Peabody Energy uses potable water from the Navajo Aquifer as a slurry pipeline to transport the extracted coal over 270 miles for filtration at the Mohave Generating Station in Nevada. Water from the Navajo Aquifer is the primary potable water source used by both the Navajo and Hopi tribes, used in daily domestic life as well as for farming and livestock purposes. Both tribes claim that they have severely less water today, as Peabody uses over a billion gallons of pure groundwater annually, (“Black Mesa Coal Mine and Pipeline” 1), with statistics that chart the Navajo Aquifer down 30% since the beginning of Peabody’s operations (“Drawdown” 1). The Natural Resources Defense Council sites the Navajo Aquifer level at over 100 feet lower since Peabody began its current pumping rates, resulting in poor-quality water seeping into the source (“Drawdown” 1). This has also decreased the flow of water into the Moencipi Wash, and the Hopi believe that at least one of their villages will not have water by 2011 if the Aquifer pumping continues. In addition to these factual disputes the culture-sensitive issue of water arises as well. Both the Navajo and Hopi people consider water sacred, and are religiously and culturally against its over-use.

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<sup>1</sup> The Navajo Nation later successfully took the case to court and was back-paid by Peabody Energy, which was invested in a trust fund by former Navajo Nation president Peterson Zah.





[www.blackmesais.org/peabody\\_road\\_to\\_profit\\_lg.jpg](http://www.blackmesais.org/peabody_road_to_profit_lg.jpg)  
Black Mesa Coal Mine under Construction

Another issue facing Black Mesa is the relocation of Navajos for the coal mining project. In 1974 Navajo families were relocated as the government divided the land for Peabody's use. However, about 300 families refused to leave their sacred land, and are again refusing to leave as Peabody struggles to re-open the coal plant. Peabody's permit to Black Mesa coal mine was threatened in 1996 by the U.S. government if it did not clean-up emissions being produced by the factory. However, it was not until 2005 that the plant was officially shut down by the federal court due to lack of meeting emissions regulations (Leupp Residents Anxious" 1).

On January 1, 2006 Hopi spiritual leaders won a hard-fought battle to shut down the Mohave Generating Station and terminate Peabody's slurry line. The Hopi were able to achieve this victory because of an "escape clause" written into the land-lease and operations contract with Peabody. This clause, enforced by the Department of Interior, stated that the Secretary of the Interior would force Peabody to use other means for coal transportation if the slurry line showed negative effects on the Navajo Aquifer. Nevertheless, even with ample evidence proving this to be true, the clause was not taken into effect until the U.S. government received substantial pressure from environmental groups protesting the plant's sulfur dioxide pollution in the skies around the Grand Canyon.

However, Peabody's two other coal mines, Kayenta Mine and the Lee Ranch Mine, in Arizona and New Mexico, respectively, are still in operation. The Kayenta Mine is operated through leasing from the Navajo Nation and the Hopi Tribe, mining roughly 8 million tons of coal annually that is shipped to the Navajo Generation Station in Page, Arizona.

Despite such heavy opposition, Peabody is in the process of trying to obtain a "life of mine" permit from the U.S. federal Office of Surface Mining that would extend the lease to permit mining indefinitely and allot billions of gallons of water to the site. If accomplished, this permit would permit Peabody the use of both the Coconino Aquifer as

well as the Navajo Aquifer until 2026, the year in which it estimates that virtually all coal will be depleted from the source. Naturally, this would immensely increase the coal extracted at Black Mesa, as the company would begin exporting internationally as well as domestically. Efforts to re-open Black Mesa are currently at a standstill due to public outcry (including government leaders). However, Peabody may still expand its Kayenta Mine onto Black Mesa land which could lead to an added 180 million tons of coal and 32% more water used if the slurry line is put back into use for the project.



[www.monumentvalleyview.com/images/PresShirley.jpg](http://www.monumentvalleyview.com/images/PresShirley.jpg)

Current Navajo Nation President Joe Shirley visiting local coal plant.

## **Future Energy Projects**

### *Coal*

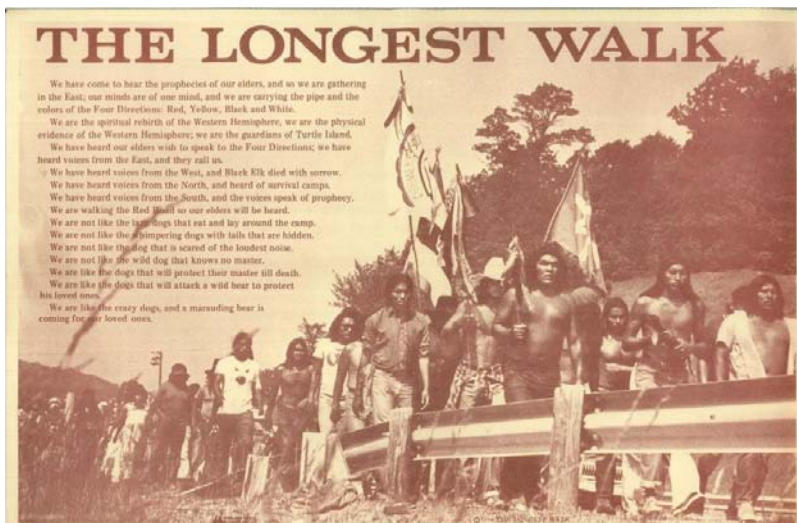
Current Navajo Nation president Joe Shirley is working to build a 1,500 megawatt plant in Northwest New Mexico that will be called Desert Rock. This power plant would be jointly constructed by the Diné Power Authority and private coal plant developer Sithe Global, LLC. Shirley says the plant will offer as many as 400 jobs to Navajos and bring over \$50 million annually to the reservation (“EPA OKs air permit” 1). Because of the job scarcity on the Navajo Nation, many people (especially young men) must commute to off-reservation jobs and eventually move away to these sites. President Shirley is thus looking forward to many returning to the reservation for work in the coal plant. However, building the plant is anything from simple.

Differing from other nations rich in coal resources, the Navajo Nation must be granted a permit by the United States government before developing any power plant. While negotiations of the coal plant have been on-going for over four years, the Environmental Protection Administration (EPA) has only recently (on July 31, 2008), given the plant the needed air permit (“EPA OKs air permit” 1). Dailan Long of local group Dine CARE said that the “EPA’s irresponsible, inappropriate decision has failed Navajo communities” that it is unnecessarily scarifying their air, land and water. Long called it “a devastating blow to tribal members who continually suffer from the large coal complex encroaching upon our land” (“EPA OKs air permit” 1). President Shirley claims that:

*“Desert Rock will be the cleanest pulverized coal-fired power plant in the United States—up to 10 times cleaner than nearby plants for key pollutants...It will set a new baseline for future coal-fired power generation,”*

The EPA however, claims that it still needs more time to review the public’s opinions about an “environmental filing on the site” (“Navajo Nation Struggles to Build Coal Plant” 1).

As the delay on plant-construction increases, so does both cost and public opposition. The cost, originally estimated at \$3 billion, has increased to \$4 billion, with numbers dependant on which clean-up method is used to cover the carbon dioxide green house gas emissions. Shirley also said that the Navajo Nation loses \$5 million in direct benefits that would improve the Navajo people’s quality of life each month the project is delayed. Eventually, the Navajo Nation was granted Clean Air Act Title V operating permit (valid for five years) by the Navajo Nation Environmental Protection Agency’s Air Quality Control program, the first tribe federally authorized to issue this type of permit (“Navajo President Joe Shirley, Jr.”). President Shirley announced on July 21, 2008 that negotiations with the El Paso Pipeline Co. were complete and would be signed at the end of the month after four years of negotiation. After a struggle, El Paso Pipeline Company failed to renew the Right-Of-Way Act in the U.S. Congress (an act that would virtually eliminate the tribes’ rights to withhold land). Aside from environmental, social, and political issues, the project is expected to bring even more annual revenue to the Navajo Nation than the Black Mesa project.



<http://www.prweb.com/prfiles/2007/10/15/231545/LongestWalk.jpg>. Photo of the Longest Walk. The original march to protest re-located due to Black Mesa Construction

Nevertheless, the construction of Desert Rock coal plant, like Black Mesa, would again force many Navajos out of their homes. These people, like years earlier, have banded together to fight against the construction of another coal-fired power plant that would only add to the current pollution from the two other coal plants in the area and further deplete the soil through strip mining the coal and dumping of the coal ash onto the land, resident opponents say (“Navajo Nation struggles to build coal plant” 1). Protesters of

Desert Rock coal plant also remind listeners that the plant would only send its energy to Arizona and Nevada, leaving many still without power. So strong is the opposition that protesters have held two-week blockades of the roads leading to the construction site after Sithe Global, LLC dug water wells for initial Desert Rock construction.

Despite such social and environmental opposition (environmental opposition currently being faced by many other coal plants around the United States as well, as coal emits more CO<sub>2</sub> than any other fuel), President Shirley remains firm on exploiting the coal resources of the nation, even with the announcement of plans for a 500 Megawatt wind farm on the Navajo Nation.

### *Wind power*

The Navajo Nation announced late May of 2008 that it's Diné Power Authority will work together with Citizens Energy Corp (a global, Boston-based company) to cultivate 500 megawatts of wind energy, with a lifetime estimated production between \$60 to \$100 million in total revenue for the Navajo Nation (exclusive of the additional jobs and environmental benefits). In a press release, President Shirley stated that wind-powered energy

*“can bring economic prosperity for the Navajo people and build our energy independence while providing jobs and other benefits for the Navajo Nation”*  
 (“Navajo Nation to develop 500 MW of wind power” 1).



[http://www.scruffydan.com/blog/images/wind\\_turbines.jpg](http://www.scruffydan.com/blog/images/wind_turbines.jpg)

The Navajo Nation will have “ownership stake” in the development of this energy project. This means that, through future investment, it will be able to own a majority of the ownership stake of the wind farm project. Citizens Energy has also agreed to reinvest part of the profits back onto the Navajo Nation, helping the nation to return to its traditional values of respect for the sacred land while simultaneously seeking economic betterment.

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### **Interview Guide-Basic**

Hi my name is Dusana Schnell and I'm a senior Marketing and Spanish major at ASU. I am doing a project called Innovation Space for my honors thesis. Innovation Space is a project that combines business, engineer, industrial design, and visual communication students together to create products. My team is working with nanotechnology and energy. We would like to utilize nanotechnology to provide clean energy to people who do not currently have energy in their homes. We are specifically focusing on Native Americans living on reservations as our user group for this project. Therefore I am trying to gain insight into life on the reservations, what daily life is like for the people and what their needs-especially energy needs are.

First, could you describe to me daily life on the reservation of an elder (or youth)?

What are some current needs people living on reservations face that are currently being unfilled?

Why are these needs being unfilled?

Energy needs- lack of desire to leave the traditional lifestyle or would welcome change (Do they want/ need energy)?

Lots of secondary research but not exactly sure on a few things, how many are without power?

Why are they without power? (Live too far off grid? Etc)

Or, is energy produced on reservation mainly for retail purchases or only excess sold?

Do they need/want lower costing? (Is there a desire for it?)

What are some needs in terms of transportation?

What about, energy needed for emergency situations? (Ex: elder living far away to call for help).

What do you see as some barriers/challenges to implementing renewable energy on reservations?

Do you think that renewable energy would be appealing to different groups?

### **Interview Guide on User Group (for interview with Peterson Zah)**

Explain that I am an ASU student (Marketing/Spanish senior) working with a program at ASU called Innovation Space.

Explain Innovation Space to user- what the program is (groups of students from 4 different disciplines working together to create innovative products).

Sponsor companies-my team with the Center for Nanotechnology in Society with a focus on nanotechnology and energy.

We will be creating a product that uses nanotechnology to better existing renewable energy sources or create entirely new ones.

We have chosen American Indians living on reservations as our target user group so we would like to learn what the needs are, energy use, and daily life in general.

What do you see as current, un-met needs on the reservation?

How many people (or percentage) would you estimate are without power?

Why is this?

What is currently going on with energy/coal mines and existing energy structure?

(Explain that I've done background research on the Black Mesa dispute; current problems with Desert Rock, recent Wind Farm contract, etc.)

Has/Is the energy being produced on the land generally only sold to areas off the reservation as a source of income for the Nation? (From what I've read it ALL is sold elsewhere) Or

Is just excess energy produced sold?

Where are people with energy getting it? Who provides it?

Do the people need lower costing energy?

Do they want renewable energy, OR just any low-cost energy source?

Is their a need for energy on the reservation? Or only as a source of income?

Do you think the people would welcome renewable energy or desire to stick with traditional life-style (no energy)?

What do you see as some challenges my team would face to entering this market (barriers to entry)?

**Interview notes****Jaynie Parish 9/16/08****American Indian Initiatives**

(Initial interview to gather as basic information about the culture. Did before guide)

Black Mesa Coal mine on the Navajo Nation owned by the Peabody Coal company

- supplies nearby regions with energy except the Navajo Nation
- have been fighting over Black Mesa for years

## Tribal Land

- there is a land issue when opening up businesses
- Land is generally trust land-it doesn't belong to people but the trust
- this means that you can't just buy land and open up a business
- land must be leased from the Navajo Nation

## Sustainable energy

- has been a desires in the last 5 years for sustainable energy
- rich in so many natural resources but general exploitation
- are now trying solar, water, and wind
- still many same struggles but on smaller scale

## Some history

- U.S. government tried pushing the tribe to Oklahoma but was able to keep Arizona land
- many tribal members in Oklahoma aren't traditionally from there
- some were given allotments from the government
- many Native Americans killed and/or forced to assimilate into the dominant Euro American culture.
- different than other ethnic groups because is now an official nation within a nation
- Government to Government relationships

Referred me to: -Wenona Bennaly- American Indian Policy Institute (AIPI)

-Peterson Zah- former president of Navajo Nation



**Interview Notes 9/18/08**  
**Cheston Bailon**  
**Marketing, American Indigenous Studies, ASU**

75% on reservation (estimate) mostly elderly  
 -“why change?” attitude

-assimilation

-younger generations butting heads with elders  
 -different cultures/cultural values  
 -many youth don't know the tribal language (only English)

-project: Navajo building greenhouses with low energy

Problems:

- Lack of funding
- government restrictions
- problems with trust land (can only be leased not bought)

-many people so far off the grid that it would just be too expensive to connect them

-some main roads and most families live on small roads

An issue goes 1<sup>st</sup> to the Tribal government house, then to the Navajo Nation, then to The Bureau of Indian Affairs, then Federal government

-3 plants in small area

-EPA approved New Mexico government re-asses and review

-Extreme home make-over

- made a “green” home w/ solar and wind power, efficient lighting
- but problems with selling or giving excess land to neighbors
- dispute with the NTUA-problems w/ family not getting a fair deal on energy

\*NTUA is the energy monopoly (energy, water, and natural gas) on the Navajo Nation

Zah trust case

- tribes (the Hopi and the Navajo) sold energy extremely cheap because didn't know better (not “business savvy”)
- won lawsuit in the Supreme Court
- were back paid last 20 years
- Peterson Zah put the money into a trust fund

**Interview notes 9/26/08****John Bailon****Pre-Business student, ASU**

John told me a story about a typical summer day of his childhood:

He said that his grandmother would always have breakfast waiting for him and his brother. Then he and his brother would meet a few friend and walk along the road picking up trash and aluminum cans until they thought they had gathered enough (usually a few hours). They would then go over to the aluminum can redemption center and collect usually at least \$5- enough money for them to go swimming at the local high school's pool. Then they would walk over to Taco Bell where they spent the remaining money on one bean burrito which they cut into three pieces for a snack before returning home.

-Some neighbors, about ¼ mile away from his family on the reservation don't have any electricity or indoor plumbing.

-use outhouse and have wood or coal burning stoves

3% of U.S. population doesn't have electricity

-65% of this 3% live on the Navajo reservation (had heard from article)

-Tribes always trying to find ways to help people but often very tight budget

4-5 year waiting list for people to have solar panels installed on their homes from the Navajo Nation government

-Some on Navajo Nation don't have running water

-many of them use a septic tank for the waste.

-Have to drive daily (subject's friends drive about five miles) to get water from a well

-also many do not have phone lines

A lot of people (without electricity) have oil lamps

-Also candles are used

Most people (without electricity) just go to sleep early when it gets dark as get up early.

Subject thinks that a lot of people say they like that type of lifestyle

But also say things would be much easier with electricity.

-it would especially make things easy for older people

-Says: most people our age (college-aged) have moved to towns with electricity

-Also many younger generation moved away to join the military, or went to college

-Most of the high school graduates don't go to four year colleges but get construction jobs (off the reservation) or become a truck driver or go to a two year college only

-interviewee believes that their definitely would be a demand for renewable energy for use on the reservations-

They would see it as something practical to help them with their daily lives, he says.

-Most of money from reservations actually spent in the nearby towns outside reservations  
Car dealerships, movie theater/rentals, malls, etc.

-some people drive two to three miles to get to these places

-a real hardship for some, especially w/ cost of gas so high now

-interviewee said that he/his family were luck to have the closest town (non-reservation town) only 30 miles away

-said that more stores might want to come to reservations but land problems

-would have to lease the land and companies only want to buy land not lease it

-low development on reservation because of this

**Interview Notes:**  
**Dr. David Martinez**  
**Asst Professor**  
**American Indian Studies, ASU**  
**Interviewed: 9/26/08**

Life on the reservation can be very hard for many people

- high unemployment rate; not many go to college or graduate from college
  - many who do cannot return to the reservation due to the economy (job shortages)

- high rate of alcoholism and drug abuse (while stressing that most of “us” are not substance abusers, but the rate on reservations is higher than the national avg. he said)

- says high rate of substance abuse due to high unemployment rate.
  - “Anyone who is denied the right to earn their own living or denied the satisfaction of providing for themselves will have their self esteem go way down. Different people have different ways of handling that kind of depression. Some are reclusive, some turn to the bottle, lash out at others, or use drugs.”

- coal mines provide much less employment than the jobs promised originally when signing contract (and those given are very remedial jobs)

- coal mines make a mess out of the land and move on

Coal mines are a high cost to the community

- environment impact to the land
- bring in money but with no long term plan

- Many on the Gila reservation get plumbing installed and electricity when they have their homes build but many do not have access to electricity or only able to use a small amount.

- others (many elderly) have electricity but have never used the air conditioning (just what they’re used to).

- Many schools are in portable buildings, not permanent structures.

- the AC might not always work or is often too expensive to run

Dr. Martinez thinks that most Native American communities would be open to other energy ideas such as solar and wind power

He says, particularly in the Southwest, where the whole idea of being close to nature would blend in with solar energy.

- however, will be a core of people on the reservation who will reject any modern technology

- most Natives try to combine the traditional with modern
- people on reservations generally have to haul their garbage; no standard garbage collection services (people so spread out)
  - people generally take it and trucks and then burn it to dispose of it
  - many broken down cars in yards because they have nowhere to take them (dispose of them)
- There is no recycling on reservations (maybe no money in the tribal budget for it)
- all services provided on the reservation is dependent of the local tribal government's budget
- sometimes can get human development/other grants but difficult because they eventually need to be renewed
  - people were originally close together but government programs forced them to live more spread apart
- Land ownership laws are very complicated:
  - some land is trust land
  - other land leased
  - some reservation land is also on National Parks
- Some energy problems:
  - People on reservation do have a higher rate of heat stroke or heat exhaustion
  - other example: a tribe in the South Dakota area who were in trouble in the winter because they ran out of firewood. People came to their aid and chopped wood for them and other came to help shovel snow.
- no public transportation
- In some remote it takes a very long time for the fire department, police or ambulance to arrive.
  - Help could be at least 200 miles away.
  - (But other areas such as Sacaton have a medical facility close by so it varies from reservation to reservation)
- many reservations stress going to vocational school a lot and never stress going to college
- “In the Light of Reverence” by Melinda Banner. Covers the Lakota and Peabody Coal issue. “A classic”
- Talk to Peterson Zah. He will have the best answer on how to best approach the tribal people.

**Interview Notes****Wenona Benally 10/07/08****Policy Research Analyst****American Indian Policy Institute**

- Grandmother lives without running water or electricity
  - has to haul in water for herself and for her livestock (she has sheep and cornfield)
    - Sheep are a very big part of Navajo culture.
  - other family members help her with this labor
  - many family members come together to help with the harvest (tradition)
  
- too expensive to hook up her and people like her to the electricity grid because live so far away
  
- Sandia Labs working with Navajo Nation to set up PV systems and provide electricity
  
- many tribes working with the Indian Health agencies under the federal government to provide potable water to reservations
  - they put water in tanks which then have to be hauled in from far away for the family's use.
    - water usually hauled about twice a month
    - brought in barrels which are stored in a shed or a room so that it is protected from outside elements.
  
- water brought inside in smaller containers and "scooped out" as needed
  
- Benally says that people need to consider the health issues of this, especially with water from wells. She mentioned how her family boiled the water before drinking it.
  
- bath tubs are filled up using this water for bathing.
- for hot water, it has to be heated up on the stove first
  
- many cook w/ butane stoves and (if lucky) have refrigerators that run off butane/propane.
  
- many who cannot afford butane refrigerators store food in the cellar
  - don't buy items that need to be kept colder than the cellar allows for
  - example: people butcher an animal in the morning and the rest of the day is spent cooking it
  
- people cook outside often
  
- mud ovens used during harvest
  - break is cooked in these ovens
  
- food often prepared in bulk (especially the corn) in harvest time

-fire pit dug out, fire started and when fire burns out, ashes removed and corn put into pit and corn buried and left in ground to roast for a few days.

-reservation life is VERY labor intensive. Difficult for people who do not have extended family near by.

-wood stoves used to keep warm in the winter

-sometimes people put coal in these stoves

-very dangerous to breathe this

-program under the federal government that replaces these wood stoves for some people

-but it's difficult to convince some people not to use their wood stoves

- "Tradition is tough to change in most families."

-many people cannot afford butane for refrigerators

-Something lower cost great

-also, something less labor intensive than going to fill up the butane and hauling it back

-people might be receptive of alternative energy-powered refrigerators, etc

-more efficient way to purify and heat up water

-many people don't have indoor plumbing, only outhouses

-current renewable energy projects on reservations encountering problems because no maintenance system

-little communication for people in remote areas

"Green" house on reservation from Home Makeover TV show

-ran into problems w/ selling excess energy

-extra energy wasn't going back to community

-a lot of people do want modern conveniences

-especially something that would make their lives a bit less labor-intensive.

-Navajo Utility Tribal Authority supplies energy to those with energy on the reservation

-however this energy does not come from the power plants on the reservation

-generally the tribal people are against building new plants

-but government generally supports it for economic growth

\*look up NTA (Navajo Tribal Authority)- Samuel Adams to see what is being done with solar panels

-however usually people cannot afford the payment plans to have solar panels on homes

- best for my team to partner with a local to talk with before trying to initiate any project
- people very suspicious because of Peabody Coal mine dispute
- most people without electricity are elders
  - many of these elders do not speak English, so it would be necessary to go with someone who could translate for us



## **Interview Notes**

**Peterson Zah**

**Former Navajo Nation President**

**American Indian Initiatives, ASU**

People want a balance between energy development and the environment

-“the two go hand in hand,” you can’t overdo energy development and sacrifice the environment

-may mean not getting all of personal needs met

-must consider the whole tribe and the southwest in the long run

-too much energy development with coal

-obvious direct effect on environment

-may even mean decreasing the number of people working for Peabody Energy or other coal company

-but this is generally supported by the people

-Tremendous need for energy and the use of energy by locals on reservation

-But, we shouldn’t assume that all Navajo families require the same amount of energy

### Problem:

Companies like Peabody, Utah International (coal company right next to Window Rock the Navajo Nation’s capital) have 20-year contracts

-really nothing can be done until the 20 years is up (or it violates contract and can be penalized)

So every 20 years is an opportunity

-Navajo Nation always positions to raise the price of coal (so coal companies pay more) \*getting coal companies to pay more “has precedence over everything else”\*

-each year more Navajo youth (increasing population) so greater energy demand

-not enough resources to develop the infrastructure to meet the needs of the people

-example: electricity

-wire to all the families is a problem because everyone so spread apart

-all homes require sewer lines and electrical lines but just too expensive

### Culture:

Families don't want community to be crowded

- People only want to be responsible for their own family
- the Navajo people really like open space, the land, sheep and cattle owners so don't want too many people together crowding the space
- have to look to the culture to see what is really needed

### Solar

- answer may not be lines/infrastructure but alternative ways
  - “Solar energy is a good idea” for the tribes

Panels on individual homes would be enough to take care of the family (and fits in with the culture)

- However that technology is still not there yet, (slowly getting there)
  - technology provide for energy needs, but not excessive energy usage (like the TV, kitchen appliances, and radio all on at once for example)
- The Navajo government is not doing a whole lot about solar.
- Takes a tremendous amount of money for government to do anything
- Who has first priority?
  - Solar energy means being removed from the coal plant
  - Coal Power plant used to generate revenues (power goes to Phoenix, San Diego, Las Angeles, Las Vegas because that's where the money is

“The money flows in and the electricity flows out” from the Navajo Nation

- local people forgotten in purpose of generating revenue
- need a different program to take care of their needs
- current program going very slowly now
  - promoting self-sufficiency in energy development
  - someday will get where it should be (should be using solar power he says)

### Education/Awareness

-some families have solar and it stores enough energy for the home in the battery but if kids turn on radio and TV at the same time and the mother goes to cook it goes out

-families need to be educated on not to run too many things at once

-if they can master the discipline, the idea of solar would work, says Zah

-elderly couple who can comfortably live with solar but then grandchildren visit in the summer and then solar energy is a problem

-hopes that students try to promote alternative energy for the families and develop technology to do it

-also education: families would have to discipline each other about energy usage

-when power line going to home TV can be on all night (he says)

-need to be educated to think about expense of electricity also (especially youth)

Says that everyone on Navajo Nation wants energy until the meter start running the bill

-problem with family coming over and using electricity and running up bill

-some families choose not to have electricity because they do not want this hassle

-also, many can't afford it

-Want to be dependant only on their families- not to an electricity company

-people with energy on land get it through private companies or tribe gets it from APS  
Companies may subsidize some development but not on a large-scale

-AZ utility commission has begun getting percentage of money that the state of AZ spends on alternative energy

Percentages increasing: APS used 2% -3% of revenue to develop solar energy in past

-now the percentage up to 8-10% so more money available to help rural people.

### Tradition

Told how his 80-something year old mother lives the traditional lifestyle by choice without electricity

She lives a very basic lifestyle, drinking only water, cooking and picking her own food from her garden because that is what her body is used to.

-cooks her food over an open fire

-The Navajo traditionally heat homes with wood in the winter (preferred way-if youth can bring wood)

-Says that the elderly may be happier with modern conveniences but only they, not us, can make this choice

-other elders like her may need some energy but not a lot, just something simple and basic

-possibly a phone (solar charged?) with numbers just to call the first born, second born, third born, etc to be able to talk with family (communication very important to the Navajo culture)

### Solutions

-Thinks that if shown the advantages of having solar power general families would choose to use it (especially over an electric line)

An educational program would be essential to implement renewable energy

-tribal government needs to accept that they have to work with locals to effectively provide for their energy needs (so far nothing really much been done)

-need a nationwide Navajo system provided by the government to do such a large-scale project

-Remember that we shouldn't assume that all Navajo families need the same amount of energy

## **Interview Notes**

**Monica Joe**

**Psychology Graduate, ASU**

Monica Interview Notes

- Many elderly speak no English, only Navajo
- Many people without hot water always keep a pot of water on the stove at all times for hot water
- solar water heater being put into some homes by APS (not economical to connect far-away homes to the grid)
- for bathing water that is warmed on the stove is used
  - many without running water take sponge baths, or have a hand-held shower head outside (but of course too cold for this in the winter)
- many elderly and also people who are less well off financially live in very remote areas
- Navajo culture is a matriarchal society
  - Most of the responsibilities are on the woman
  - It is the woman's job to cook
  - many times men will not cook unless the woman is not there
- Many without electricity at home have propane stoves.
- In the summer many people grill outside or over an open fire
- some people cook with wood stoves, but takes awhile for the fire to get hot enough to cook
- people have a wooden stove inside or sometimes put coal on it, to heat the home
- water is brought in from a windmill
  - large tanks with spouts to pour out water are filled up and brought home but stored outside
  - then smaller gallon size buckets are filled up from these to be kept in the home
  - buckets are always kept sealed to prevent contamination

### Food

- fried potatoes, spam, corned beef, anything with potatoes very common food
- Home-made tortillas a staple food eaten with everything (made daily, a Navajo tradition)
- people don't drink much milk (because many don't have refrigerators) and don't eat eggs much for the same reason (but fall/winter cold enough to store eggs outside)

- fridge may be kept in a shed outside in the winter to be kept cooler
- meat is stored in an icebox with a block of ice
- Because of the lack of refrigeration, people buy groceries in smaller amounts rather than in bulk
- Usually people buy their groceries and everything else (livestock feed, etc) at Trading Posts: much closer to homes than the big supermarkets which can be an hour away.
- many people eat lots of mutton that they slaughter themselves
- after butchering the mutton many people hang it to dry in a cool shed
  - it is then cooked and ALL parts are usually eaten
  - the wool from the goat is saved to make blankets or is sold
- in the summer most people eat canned meet because real meat will not stay cool in the shed
- “Many elder accept this way of life and are fine without electricity.”
- “Having running water though would make the elders’ life a lot easier.”
- in Navajo culture a girl should be able to make dough for tortillas by about age 10 or 12

#### Solar power

- Some families on the reservation beginning to have solar panels on homes
- but is a very long process: family has to apply; then very costly

#### Waste disposal

- many people dig holes near their homes and use as landfills (because landfills so far away and would have to store the garbage until able to travel to the town landfill)
- sometimes families make personal landfill that is used by extended family who live nearby also
- landfill may be up to 30 miles away

**Transcript from interview with John Bailon**

d- Ok so you're an ASU student correct?

j- Yes.

d- What do you study?

j- Pre-business

d- How long did you and your brother live on the reservation?

j- All of our lives up to college.

j- We lived in the mountain during one part when we were young and played a lot of war games. Got ideas from seeing "Rambo" and other movies. We started to go to military school during high school years but our parents couldn't afford it so we went back to the reservation high school. The private school was really hard as the rez high school was very laid back and easy. Hardly ever had homework on the rez but the private school gave tons of homework and all the subjects were very difficult. Then we had the idea we should go to West Point. I had a Congressional nomination to go to West Point but was not accepted. My mom had applied for him (brother) to other colleges so then pulled out the acceptance letters! So I chose ASU. Then found out my brother enlisted in the Marine Corps and would go to boot camp as soon as he graduated from high school. My brother wanted me to quit ASU and join him in the Marines. So he talked me into it and I enlisted also.

d- Oh interesting. Could you please tell me about a normal day on the reservation?

j- I could tell you a story about our childhood. There weren't many summer programs. The majority were church based. That wasn't very interesting to us. Our grandmother would always have breakfast waiting for us. Then we would meet a few friends, grab a couple trash bags and walk along the road picking up trash and aluminum cans. Then we headed over to the aluminum can redemption center and collected our money. Usually we got at least \$5 which was enough to go swimming on. Then we'd head over to the local swimming pool at the high school. There were two hour swimming sessions. Then we'd walk over to Taco Bell. We still had money left for one bean burrito which we cut into three pieces for a snack before we headed home. Then we played games like "Dare" or watch movies. On weekends we'd hang out with our parents.

d- Were there many fast food places on the reservation?

j- Taco Bell, and KFC were there earlier, then later on came McDonalds, Burger King, and Sonic.

d- I was reading an article about how the fast food is affecting the health of Native Americans. More high blood pressure and diabetes. People used to live till they were 100

years. But like expectancy is now way down. But well that's not too relevant... Did Cheston tell you about the project we're working on? I'm a senior Marketing and Spanish major. I'm doing this project for my honors thesis. It's called Innovation Space. It's very cool. We're with three other students on a team and they are an engineer, industrial designer, and graphic designer. We have the whole year to create a project. The first semester we create three potential projects and the second semester we narrow it down. We are working with nanotechnology, it's pretty exciting. We have to find how to utilize nanotechnology with energy sources. We want to show respect for the land too of course. This is why we want to use renewable energy. But right now we're just in the preliminary stage asking "can we really do this?" So we're doing research on our target user group first to find out what is really needed.

We thought of developing countries but they're so far away so of course we have no access to them. But then we thought there are people here that don't always have electricity. So we thought of the Native American reservations. So we are thinking about what projects are possible and what people might like.

j- Here's something interesting. Our neighbors about a quarter mile away on the rez don't have any electricity or indoor plumbing. They also have to haul water from a nearby source.

So that restriction is unique these days. When my brother and I were in Iraq, we would complain about waking up and needing to use the restroom and having to walk all the way through the barracks to the Porta Johns. During the day, it was very smelly if you can imagine at 120 degrees. So when we got home, we really appreciated the closeness of the bathroom and the air conditioning. Then we thought of our neighbors having to go outside when it's very very cold. They usually have wood or coal burning stoves. That's an idea we could explore. The tribe often has a very tight budget. I've read that 3% of the U.S. population does not have electricity. And 65% of the 3% live on the Navajo reservation. The tribes are trying to find ways to help people.

d-And do most people say they want electricity?

j- There is a 4 or 5 year waiting list for people to get solar panels installed on their homes I've heard, so yes, there is definitely a demand for it. They say there's not enough power up there for wind energy. But I think there is.

d-Didn't the President of the Navajo Nation say there is 5 megawatts of wind energy? I read an article that he recently signed a deal to develop a wind farm on the reservation. But then would the wind energy go to the Navajo nation or would it be sold to other areas? What do people do when they don't have electricity in their homes? Or running water?

j-My girlfriend's parents didn't have running water but had a septic tank for the waste. They had to drive about five miles to get water from an artesian well. Then they poured the water into a tank and hauled it back. Then it would be pumped out. Also there's no phone line.



d-What do the people use if they have no electricity?

j-A lot of people have oil lamps. Also candles are used. Most people just go to sleep early when it gets dark as they get up early.

d-Would most people welcome electricity or maybe not?

j-A lot of people say they like that type of lifestyle but then they also say things would be much easier with electricity. When the people are young and strong, no problem, but when they get older electricity would make things much easier for them. Most of the younger people our age have moved away to the towns that do have electricity. Also many of the younger generation moved away to join the military or went to college. Most of the high school graduates don't go to four year colleges but get construction jobs or become a truck driver or go to a two year college only.

d-If we could bring something like renewable energy, to the Navajos what do you think would be the biggest barrier?

j- Well probably cost, most people here cannot even afford solar panes on their homes, let alone people living on the rez who have a much lower income.

d-Is there interest in the tribe regarding renewable energy?

J-Maybe wind power. They would need to see it as practical in their daily lives.

D-Yes, we want to go for something that's practical. Do you remember where you heard that there's a five year waiting list for solar panels?

j-I can find out for you. If you would take 100% of income earned by the Navajo nation, most of it is spent off the rez. Many places like Wal-Mart provide services that are not on the rez. Car dealerships and movie rentals are another example. Some people have to drive 2-3 hours to get to these places. The cost of gas is so high so this is a real hardship. Luckily our closest town was 30 miles away so it wasn't as bad. More stores might want to come in but they want to own the land not lease it. The federal government owns the land so the store can't own it. I'll look for more info for you.

d- Oh OK, well I guess that's all the questions I have for you right now. Thanks a lot for letting me interview you.

**Transcript from interview with Dr. Martinez on 9/26/08**

D- Could you tell me a little about your background?

M- I'm a member of Gila, a reservation just south of here. Grew up in California. Went to school in number of places. PhD by Long Island. Masters in American Indian Studies from U of A. Prior to arriving here at ASU last fall, I taught 7 yrs at University of Minnesota, American Indian studies.

D- Oh neat. Ok could you please describe to me daily life of people on the reservation?

M- it's the kind of life you get when there's a high unemployment rate, not a lot of people going to college or graduating from college. There are a number of people who do graduate from college but can't return home due to the economy. Depending on individual circumstances, life on the reservation can be very hard. Many people get involved with bad elements. High rate of alcoholism and drug abuse. Do want to underscore that most of us are not substance abusers. But our rate is higher than the national average. High rate of abuse due to high unemployment rate. Anyone who is denied the right to earn their own living or denied the satisfaction of providing for themselves will have their self esteem go way down. Different people have different ways of handling that kind of depression. Some are reclusive, some turn to the bottle, lash out at others, or use drugs.

D- Oh, OK. I've done a lot of research on the Navajo Nation but I don't know a lot about the Gila.

I've read about the huge dispute with the Peabody coal mine issue. Do you think that this was there to bring jobs to the community or to sell energy as income?

M- That's how they try to sell the idea to people. Navajo-Hopi were sold a bill of goods where if you let us come in, we'll start this mine. But far fewer native people were hired than promised. They were given medial positions. Mining people came in and made a wreck of the land.

D- So you would say it was just a temporary situation?

M- Yes, and cost to the community very high. Environmental impact to the land not good at all. Bring in money but no long term plan.

D- Was the energy produced to supply other nearby communities like the Peabody energy shipped off to California or Nevada? Or to be kept on reservation to meet the energy needs of the people there?

M- There's no agreement that I'm aware of between the utility people and the people on the reservation. Such as a promise to stay 'x' number of years or keep an 'x' quantity of energy in the community. Usually the promise they make and don't keep is the promise of employment and economic benefit.

D-So then the tribe has to find another source of energy?

M-Companies are going to go where the market is. 175,000 (people) is nothing compared to 3 million outside the reservation.

D-So do most people there have energy in their homes?

M-The Gila reservation is close to Phoenix and Mesa. A lot of the people will get the plumbing installed and electricity installed but only able to use a small amount. Not all have electricity. My grandfather had electricity but never used the air conditioning. Just used to not having it and then didn't have to pay for it. Seems it's what a person gets used to.

D-Oh yeah, that reminds me of other very warm countries such as Spain (when I studied abroad there); hardly anyone has AC even though it's very hot, they are just used to it.

D-But what about schools and other public buildings, do they have electricity?

M-Many schools are in portable buildings, not permanent structures. AC might not always work. Also it's often too expensive to run the air.

D-Do you think the people on the reservation would welcome other energy sources?

M-Yes, I do think most Native American communities would be open to other energy ideas such as solar and wind power. Particularly in the Southwest, where the whole idea of being close to nature would blend in with solar energy.

D- Oh great, that's what we are hoping to propose.

M-I believe the Navajo nation now is on contract for wind power. But there will be a core of people on the reservation who will deliberately reject modern technology.

D- And would it be the elders are mostly anyone?

M-It would depend on their personal background and what they regard as traditional. Most natives try to combine modern with traditional.

D- Ok yeah. We want to bring in modern conveniences but without destroying the land. (Abrupt topic change)

M-Speaking of tradition, one thing that happens a lot on reservations, people haul out their garbage and burn it to dispose of it. There is no regular garbage service. Most people are so spread out. People were closer together at first but government wanted them spread out. Land ownership laws are very complicated. Some land is held in trust, other land is leased. Some land in national parks. Do you have any specific things your group is focusing on doing?

D-No, no specific plan yet, we are still in the research phase. We're trying to find the actual needs people have and gathering as much information as we can first before focusing specifically on one thing.

M- There is a woman you should talk with, a Native female activist, vice president... She has a website on resource exploitation .....This will give you a good broad picture. Definitely look this up.

D- Ok great I will thanks. I've been doing a lot of research online and in journals and have been trying to find specific examples because it's like the more I read, the more questions I have.

But that is interesting about the trash. I wonder if we could get something together, create something like individual trash composts? Maybe ones that would use solar power?

M-Yes, this even goes into that there are so many broken down cars in front yards- not because we're a hillbilly but because there's no place to take stuff.

Once you leave the reservation you're in a whole other universe. There are different jurisdictions, locally organized by local government. Providing services to the community depends on the local tribal government budget. Maybe no money for recycling or trash trucks. Maybe someone could get a human development grant. It is hard to keep up as grants need to be renewed though.

Cheston: I'm thinking of title of a book regarding the Cherokee or Cheyenne that speaks a lot about the environment.

M- One I can think of is called "In the Light of Reverence" by Melinda Banner. It covers the Lakota and Peabody Coal issue. It's a classic

Cheston- How is it best to approach people with this new idea? For example: I knew someone who wanted to build an RV park, he took eight years and then his ideas were voted down many times. They weren't too receptive about a white guy coming in. How can the students best approach people? They don't want to come on like they are intruding.

M- Talk to Peterson Zah. He will have the best answer on how to best approach the tribal people. I'm sure he's talked to many other groups who want to talk to the tribal people. You don't want to get off on the wrong foot. A lot of people come in with ideas and promises. Then their resources or commitment don't pan out.

D-I'm not sure about our resources. I think at first we create a prototype. Then I think the company that's sponsoring us will have the option of actually implementing our product. We need to find out more on that end. We have the whole year to work on this project.

M-How do you guys get graded? If the Navajo nation says 'no', do you get an 'F'?!  
(Laughing)

D-So, do you have energy ideas for the elderly, especially if they live alone?

M-They do have a higher rate of heat stroke or heat exhaustion. I don't have the exact statistics. Another example is a tribe in the South Dakota area who were in trouble in the winter because they ran out of firewood. People came to their aid and chopped wood for them.

Cheston-I remember my mom talked about people helping the elderly shovel snow as the winters can be very brutal.

D- And do most people have vehicles on the reservations?

M-Yes, but not always running! A lot of people do hitchhike. Their isn't really a bus or any other public transportation, everyone just lives too spread out. They do have safe ride number they can call though.

D-And do they have ambulance service?

M-Yes, but in some areas that are very remote it takes a very long time for the fire department, police or ambulance to arrive.

Cheston- My house was broken into in my senior of high school year and it took the police six hours to get there.

M-Help could be at least 200 miles away. But other areas such as Sacaton have a medical facility close by. So very fast response rate. So responses vary from rez to rez.

Cheston: So many problems, it's like you research one thing and it branches off in 20 more things a person could research about. But Peterson Zah says it's a man made problem so there's a man made solution so he has a hopeful aspiration.

D-Do you think most people on the reservations have the mindset of wanting to find solutions?

Cheston-Among my peer group, yes but a lot of older people are stuck in the traditional ways and want nothing to do with alternative thinking. Some think economically there's no way. Others don't like outsiders with their degree thinking they have all the answers.

M-A lot of the people are just too complacent. They listen to their parents or grandparents talk about their day. We need to get more people educated in terms of tribal government, and history and learn the big picture, we need to get more people interested. Then more problems can be solved. Many don't have the tools they need to make their experience effective.

Cheston: I didn't learn any Native American history till I came to ASU. So people must really want to learn about their history as hardly anything is taught in high school. Also vocational schools are stressed more than going to college. Students are not motivated to go on to four year colleges. Some kids are passed out of high school, even though they don't attend class.

D- Oh wow.

M- Well, anything else?

D-Well, I guess that's all the questions I have, for now. Thanks so much for meeting with me. It's been very interesting. It's really cool that I'm learning so much about a subject I knew hardly anything about before. Thank you very much for taking the time to meet with me.

**Transcript from Interview with Wenona Benally on 10/22/08**

d- Hi I'm Dusana Schnell and I'm a senior Marketing and Spanish major at ASU. I'm doing a project called Innovation Space for my honors thesis. Have you heard of it? Ok, well Innovation Space is a project that combines business students, engineers, industrial design students, and visual communication students together in a team to create products. We have three different companies that sponsor Innovation Space. My team is working with nanotechnology and energy, sponsored by the Center for Nanotechnology in Society here at ASU. So, for my team's project we would like to utilize nanotechnology to provide clean energy for people currently without energy. We are focusing on Native Americans living on reservations for our user group. This is why I'm trying to gain insight on life on the reservations, what daily life is like for the people, and what some of their needs, and especially energy needs are.

d-I've been doing a lot of research on-line and in peer journals about energy use on reservations, especially on the Navajo Nation. I've found that most of the energy from the Peabody Coal mine was sold off to other places and not kept in the community. Is this correct?

w- Yes. The dispute is this plant was tapping into the water aquifer also.

d- Oh, sorry first can you please tell me a little bit about your background. Then we'll go into more detail.

w-My name is Wenona Benally and I grew up on the Navajo reservation. I did my undergrad work here at ASU. Then I left and went away to law school. I decided to come back to ASU. I'm working now at the Coliseum as a policy research analyst. The areas that I've been focusing on here at the institute are sustainability, renewable energy and sustainable energy.

d- Great, that's what I'm really interested in. I would like to do marketing for sustainability and especially renewable energy. So this project with Innovation Space is very exciting for me.

d- Oh, I was reading an article about "The Longest Walk." In the 70's when people protested against the coal mining on the reservation and I saw that someone who led the protest also had the last name of Benally. Are you related to this person?

w-Oh, my last name is very common on the res.

d-Oh OK. Could you please describe your daily life on the reservation for me?

w- Well, I haven't been home for 6 to 7 years now. So I can tell you what my grandmother's life is like. She lives about 7 miles outside a large town called Gallup, New Mexico. She lives in an area where there is no electricity for her or running water. She collects her water from a natural water well. So she continues to haul water each day. My aunt lives with my grandmother so she helps her a lot. Also a nephew lives close by

to help also. It's good she has help there as within the past two years, she can't haul water by herself anymore. She still herds sheep. That's a big part of Navajo life. She also takes care of the other livestock. She also has a cornfield. So a great part of the spring, summer and fall is spent outdoors taking care of the animals and tending to the corn crop. It's part of the culture where on weekends many members of the extended family come in and take care of the farm. At the very end of the summer season, when it's time to harvest again the extended family comes in the help with the harvest.

d-And just wondering, how old is your grandmother?

w-I'm not exactly sure but I know she's in her 80's.

D-Just a few days ago, my group decided we're going to focus on people who don't have energy on the reservation. And we want to have a smaller focus because there are so many different issues that we want to narrow our focus down. So we decided to focus on food preparation. There are so many things that go into food preparation. Like you mentioned getting the water, boiling the water if needed, starting the fire to cook, preparation, and storage of the food. Do you think this would be a help to the people?

w- Yes, this would be a big help. Many of us have thought about running PV systems to bring water. Because even if they could get hooked up to the grid it would be too far and too expensive. The Navajo Nation has been working with Sandia Labs outside of Albuquerque. Sandia Labs has been a really great partner in helping some Navajo families. They've helped set up some PV systems for them so they could have electricity. A lot of tribes have been working with the Indian Health agencies under the Federal government to bring potable water to the tribes. They have been putting in water tanks. So many of the families are in remote areas and have to haul their water in. They need water for themselves and for their livestock.

d-And Do they have to haul water every daily, monthly, or how often?

w- When the livestock need water, it would be several times a month. My grandmother usually hauls water twice a month. Usually the water is hauled in barrels. The barrels are stored in a room in a home. This protects the water from the elements. When we needed water, we would just go scoop some up with a container that's kept close by.

People need to think about the health issues also. For drinking, usually my family would boil the water, especially since it comes right from the wells.

d-So, how does it work for bathing?

w-We take out larger containers and fill up tubs for bathing. If hot water is needed in the winter or for cooking, it would need to be heated up.

d-And how is the water heated up?



w-My mother had a wood stove and a butane stove. The butane gas was used mainly for cooking and also for keeping the refrigerator cold. The butane tank is hooked up to the back of the refrigerator.

d- Oh, OK interesting. We were wondering about after the food is cooked how it's stored or kept from spoiling?

w- It depends on the price of propane or butane and what the families can afford. There have been times when my grandmother did not have a refrigerator. She has an underground cellar. It's like a cave and food stays really really cold in there. There are certain items that might not stay cold enough in the cellar so she just wouldn't buy those items.

d-Then do most people have to eat vegetarian diets?

w-No people have the livestock so they just butcher what they can eat and not have to worry about storage for a long period of time. So if the animal is butchered in the morning, the whole rest of the day is spent cooking.

w- People also do a lot of cooking outdoors. During the harvesting of corn, there are large mud ovens used. Bread is baked in the ovens. Also a lot of foods are prepared with all the corn that is harvested. Often a huge pit is dug out; a fire is started in the pit, after the fire burns out, a lot of the ashes are taken out, and then it's filled with corn, buried, and stays in the ground to roast for a few days.

Life on the reservation is very labor intensive. If there would be some way to decrease the labor some it would be very helpful. Sometimes not everyone has an extended family to help them and it's very hard for them.

d-You were talking about outside cooking. Is the indoor cooking a problem with pollution due to the wood stoves?

w- Yes, it is unfortunate. Some places on the reservation are very cold in the winter. The wood stoves help to keep warm. Sometimes people go out and find pieces of coal. They'll put the coal in their stoves and that is very dangerous to breathe. So that is definitely health hazard. There is a program under the federal government. I don't know if it's under USDA or another program. I can check for you. They may replace the wood stoves for some families. The people in the program have a tough job trying to convince some families to not use wood burning stoves. Tradition is tough to change in most families.

d- One of our professors is from India and he told us the main cause of death in young children under the age of five is indoor pollution. He told us to look into that as a problem here on the reservations also, so that's very interesting.

d- So, with most people who have butane, do you think they would they like something else instead?

w- Yes, a lot of people can't afford the butane for a refrigerator so if there was some other way without the high cost it would be great. Plus it's so labor intensive. The tank has to be hauled in to the city and brought back. It's not convenient to have refrigeration that way.

D-So do you think if we made a product like solar powered refrigerators or some other renewable energy appliance people would be receptive of it?

w-That would be great.

D-Ok, great, like solar or wind energy. I'm really excited about it. We're trying to look now into what all is possible with nanotechnology. Our engineer is working on this idea and I'm trying to look into what people in our user need.

Well OK, about what you were talking about with the water. What would you think of something easier to purify the water other than boiling it?

w- That would be very helpful. Water purification is very important. There might be some kind of water heater system that would be very helpful. Another thing that a lot of people don't have are indoor bathrooms. They have only the outhouses. I don't know how renewable energy could help with that part. But at least providing water for cooking purposes would be great.

d- Oh yeah definitely. Both of my parents grew up on farms and had only outhouses until they were older. They talk about going outside when it was snowy and very cold. I can't even imagine! At the dorm I complained about having to walk all the way down the hallway!! So my team should look into this issue also.

d- Do you think people on reservations would be receptive to renewable energy?

W-When I was talking about Sandia Labs outside of Albuquerque—close to Los Alamos I think, they've gone out to the Navajo reservation for at least 10 years now. They tried a lot of trial and error projects with solar energy. A lot of the problems they've come across are that people don't know how to maintain the energy systems. If something goes wrong, there's no one to come out and help them. There's no technical support available to help them troubleshoot. Especially if a person is in a really remote area, there's no form of communication.

d-Is Sandia Labs the one that is supplying solar panels to some homes?

W-Yes, it is.

d-And there is a five year waiting list or something for people to get solar panels put onto their homes? I heard this from another student I spoke with.

w- There could be because now there is starting to be a demand. They have been out there trying to work with the Navajo people. Maybe it would be good to find out when they do have the solar panels installed, what they are being used for. Electricity or running water or what? I can check into this.

d- I've heard that sometimes solar panels supply some extra energy. I was talking to a woman who works at the Nano technology in Society Institute, our sponsor group, and she and her husband have solar panels on their home. Then they can sell their excess energy back to the company and it is then used by neighbors. So I wonder if this idea would work on reservations.

w- There was a house installed w/solar on a remote part that was part of an experiment. It was a home makeover—from the TV show. The whole house was designed with sustainability in mind. It had solar panels. The idea was then to sell back the extra energy to the other people close by. There was an article about it in the Navajo Times. There were a few problems mentioned like the extra energy wasn't going back into the community.

d- Oh that's interesting; I'll have to look for that article.

d- I know that in the Navajo tradition respect for the land is very important. Do you think people would be receptive to this new technology? Would they look at it as trying to create energy in an environmentally way or do you think most people would rather keep living in the traditional ways?

w-I think the Navajo people would be open to technology to making their lives a little easier. If the idea would be given as less labor intensive than the processes they're using now, I think people would be receptive. A lot of people do want modern conveniences.

d- OK great. Now I'm wondering, I know that some homes are connected to the electric grid. Do you know how this works?

w-We have a utility authority called the Navajo Tribal Utility Authority. They supply electricity to people living on the reservation. But I'm not sure where the power supply comes from. It's not from the coal mines [on the reservation]. There is controversy regarding proposed nuclear power plants. There's one going up or up by Window Rock. The tribe would like their energy to come from that power plant. If it would bring more jobs to the people, they would be happy also. It seems like more tribal people are against the plant but the government is trying to push it. There's a huge divide a lot of controversy.

D-When I was reading about these energy issues I noticed this. The more I read the more questions I had. It's interesting because I don't know that much about Native American history.

w- Samuel Adams (??) is working with the NTA—Navajo Tribal Auth. The Utility Authority does sell solar panels. If you go on their website, a person can buy or enter some agreement to buy a solar panel.

d- And can most people afford one?

w-No, it's not affordable. They can put people on a payment system but even that payment plan is usually too high.

D-Do you know anything about what the Navajo Nation president just signed? The contract about opening up a wind farm?

w-No, just what I read in the paper. A couple of feasibility studies have been conducted. There's a corridor that runs between the Navajo Nation and the Hopi Nation. There needs to be a consensus between the Navajo government and the local governments about who should oversee the running of the wind turbines.

D-It doesn't seem like the wind energy project is getting much publicity. Do you think with my project we would encounter many barriers or difficulties trying to bring in our ideas? Would we be looked at as outsiders or would people be receptive? One person I interviewed says yes, we need to be careful because we are outsiders. They might look at us as just another outsider trying to come in and solve the problems.

w- Yes, I think it's very important that you try to partner with someone who works with the Navajo Nation or even better if you could find someone at the local level like in a close by town to talk to first. Then that person could go in with your group and talk to more people. It's unfortunate but a lot of the larger corporations see the potential of bringing in renewable energy because of the vast tracks of land. Unfortunately the lucrative deals are not always there. The people got burned with the Peabody Coal deal so they are suspicious of everyone. So it's very important to hook up with someone on the local level. Someone actually living on the reservation-there on a daily basis to tell you what is going on.

d- Maybe they would be more receptive to us because we are students and not some large corporation? I know Cheston's family lives there and he said we might be able to go with him to see first-hand what things are like on the reservation. Do you have any contacts or know of people we might be able to speak with or visit?

w-I can check into it for you.

d- Also we were told to go with a Navajo person and not just show up on our own. We want to be culturally sensitive of course and not be intrusive.

w- Mostly the elders don't have electricity and a lot don't speak English. So yes, take someone along who could translate. Well Good luck and I have your e-mail address to send you any more information I come across.

d- Ok great. Thank you so much for meeting with me and sharing with me all this information, it's been so helpful to me. Bye.

**Transcript from interview with Peterson Zah 10/30/08**

I'm a senior and a Marketing and Spanish major. I'm doing a project for my Honors Thesis that's called Innovation Space. I don't know if you've heard of it but it brings students from four different disciplines together --business students, engineering, industrial design and graphic design. We're all together in different groups of four and have a company that sponsors us. The company that is sponsoring my team is the Center for Nano Technology in society. Our focus for the year is nanotechnology and energy. What we're trying to focus on is using nanotechnology to create new renewable energy sources and products or to better use the existing energy resources. Well OK, why I'm here to speak with you is because we decided we wanted to target Native Americans living on reservations for our user group. So I've been doing lots of research and also conducting interviews. I've interviewed Cheston and his brother, Dr. Martinez, and Jaynie also. I'm trying to get different opinions on what the energy needs are and what would be possible and what people living on reservations need. We want to help people on the reservation by proving those who want and need energy with alternative energy resources. But first of course I'm trying to get a better understanding of what life is like on the reservation and also I'm trying to find out what their needs are. Of course my team also wants to find out if the people there would be accepting to the new energy ideas.

D-So, do you see any energy needs that are being un-met or need to be met on reservations?

P-Are you familiar with any of the Indian reservations in AZ?

d-I've mainly read about the Navajo reservation and I've done research the Peabody coal mine. I know about the mine shut down but I'm confused about actually what's happening now. I've heard people are trying to get it reopened again. They're trying to get a permit for life lining I've heard. Also, that a lot of people are protesting this.

p- Let me put you in the perspective of energy development. From the Navajo side, what the people really really want in terms of their own needs is before you can start considering the needs of individuals you must balance between energy development and the environment. The two go hand in hand and you cannot overdo energy development and sacrifice the environment. You must balance the two. They always tell us that. Even if that means we don't get all that we really need as far as our personal needs go. In the long run, we must consider the whole tribe, the southwest and all that is happening. The information that we receive is that there is too much energy development using coal.

d-We definitely want to go away from using coal.

p-And that has a direct effect on the environment. And they always said even if it means diminishing the number of people that are working for the Peabody Coal Company or another coal company. That is something that I felt very strongly coming from the people.

P-There is a tremendous need for energy and the use of energy by the local people. People who live on the reservations. The problem in trying to satisfy those needs is that organization and energy companies such as Peabody Coal, Utah Int'l, the coal company right next to Window Rock--east side of Window Rock all those companies have what they call contract with the Nation. The contract goes for 20 years at a time. Every 20 years there's what is called an opener. You can discuss those contracts every 20 years but there's really nothing that can be done before the 20 years. There's no leverage before the 20 years is up. If you do that it is violating the contract and is cause for penalties. So every 20 yrs there is an opener. That's the window of opportunity for the contract. The nation always takes the position to raise the price of coal. Because each year more young Navajo people are added to the population so the demand is greater. So as a tribal leader, he tries to make the coal companies pay more. That has precedence over anything else. Increasing the price of the coal because there is more demand from the younger people is the most important part of the talks.

What happens is that there aren't enough resources to develop the infrastructure to feed into the needs of the local people. Or in order to meet the needs of the local people, for example electricity. That means there must be wire to go to all the communities or all the families. What compounds the problem is when you go through the reservation everybody is so spread all so far apart. All those houses need sewer lines and electrical lines and it is just so expensive. While here in Tempe, everyone lives in clusters much closer together so the utility line is run and everybody can connect easily. On the Navajo reservation everyone lives so far apart and a lot of money is spent just to get a line to one house. A lot of the families don't want their community to be too crowded and have 100 families close together. They only want to make a commitment to the immediate members of their family. Maybe a family would want to get with the leaders of the tribe, but otherwise they like their open space.

Think of yourself and if you really like your open space, if you really like the land, if you are the owner of the sheep or cattle would you want 50 other people close to you? Or 100 yards from where you live? You have to look at their culture and see what is really really needed. That's part of the problem. For me the answer is maybe not necessarily the lines, the infrastructure but there are different ways it could be done. For electricity why not solar? Put the panel on top of the house. Enough electricity could be stored to take care of that one family. But the technology is not there yet. It's getting there, maybe within the next few years it will be there to take care of the needs of those particular families. Because when the young ones come home from school, they should do their homework but they want to watch TV. The TV burns up a lot of electricity. The family would have to discipline their own family members about the usage of electricity. When there's a power line going to their home, the TV is turned on and it will be on all night. But the expense has to be thought about. They don't have much money. So the young ones have to be educated about the cost of electricity and the bill so there are other ones to bring electricity to the home. Solar is a good idea.

d-Is the government providing solar to some homes. Cheston told me they are doing something like this but that there is a 5 yr waiting list? Is that what the Navajo nation government is doing?

p-The Navajo government is not doing a whole lot about solar. They are not satisfied about the status quo. For the government do anything, it takes a tremendous amount of money. So who gets in line first, priority wise? So that's very hard to do. If you develop the solar, it has nothing to do with the power plant. You would be completely divorced from the coal power plant. The power plant is all done in such a way that the commodity coal is used to generate revenues. They feed into Phoenix, San Diego, Los Angeles, and Las Vegas because that is where the money is. The money flows in and the electricity flows out. Because to go back to your initial purpose to generate revenue, the local people are forgotten. There must be a different program to take care of their needs.

d-What is their program now?

p-They are going very slowly and trying to promote self sufficiency in energy development. That program will be there some day. It will get to be where it should be to use the power of the sun but it's not there yet. As an older person, I'm hoping students around here would get the idea of trying to promote the idea of alternative energy for the families. Also that they would be involved in the process and the development of the technology to do that.

D-Do the people who have energy now go through a private company? They don't get energy from the Peabody Coal company right?

P-Yes, they go through private companies or the tribe gets electricity from APS (Arizona Public Service). Sometimes those companies will subsidize some of that development but that's about it. It's not being developed on a grand scale. The utility companies in Arizona are starting to put in more services in that area. The Arizona utility commission is beginning to get a percentage of the money that the state of AZ spends to put into alternative energy. They are now just beginning to do this. I read an article where during the last few years the percentage of money for research has increased. It used to be APS used 2% -3% of their revenue to develop solar energy. But now the percentage has gone up to 8-10% which will make more money available to help the rural people.

D-Do you think people on the reservations would welcome the idea of energy if they don't have it? Or are there many elders who want to continue living the traditional lifestyle?

p-The problem is this: Everybody wants to have energy except when you allow the utility company to run a line to your house the meter starts running. Then you don't have control over your children, grandchildren and neighbors coming over and using your electricity. That bill you have to pay on a monthly basis goes up and up. Sometimes people then throw up their arms and say this is really crazy. That is what holds a lot of people back from getting electricity. It's not that they don't want energy or that the tribal



government doesn't want to provide the energy, but often the local family will make a choice. They will say they don't want electricity. They don't want to pay an outside company or owe money to anyone. They want to take care of their own family and have the simple life. My mother is that way. My mother lives so that she does not depend on anyone. It's one of those things where you have to make that choice.

d-I know there are different needs for different reservations. But how do the Navajo people stay warm in the winter. Do they burn wood for heat?

P-Yes, for heat, the traditional way is to use wood. If you can get the young people to bring in the wood, it's the preferred way.

D-Do you think people would welcome having renewable energy sources like solar or wind power?

p- I think if one would demonstrate all the advantages of having solar power to a family they would make that choice as a family. I think they would agree to that choice rather than a conventional electrical line that goes to their home. It makes a lot of common sense to do that. But as I said the technology is not there yet for the sun to produce enough energy for the families' needs. There are families where we install the photovoltaic to put on their house. The sun hits it and produces enough energy. It stores enough energy in the battery. But if the kids turn on the radio or the TV, and the mother turns on the toaster it doesn't work as too many things are using energy at the same time. So there needs to be a discipline in the family in order for it to be effective. If the people can master that discipline than the idea would work. I know of a family where there's grandfather and grandmother who are the only ones living in the home. They have a photovoltaic battery on top of their home. They have enough electricity to take care of their needs. But when the grandchildren visit in the summer, then there is a problem.

D-If the people would be receptive to the solar program, would they need people to teach an educational program about it?

p-I think an educational program would be essential.

D-Do you think my group would be able to provide the education with the project we are doing? What do you think the biggest challenge would be? Budget? Technology? Do you see other problems or challenges?

p-I think the tribal government has to accept the fact that they have to work w/the local people to figure out some effective way of providing them the energy they need. So far that has not been done. But it needs to be done. It needs to have an overall Navajo nationwide system provided by the government to do this project. I always go back and think about my mother. She does not speak English. We all think these people need power. But how do we know what they are thinking or what their need is?

D-Yes, that's what our group is trying to figure out. We definitely do not want to just assume that others have the same needs as us.

p-My mother might be happier without all the modern conveniences. But I can't make that choice or your group can't make that choice for her. She is the only one that should make that choice. She probably does need some energy but she doesn't need a tremendous amount. It's almost like a car for transportation. She might be happy with just an older model pickup truck with only 6 cylinders and just take care of the tires and nothing like a 4 wheeler, 12 miles per gallon extra fancy automobile. That's not their style that's not them. People should not assume all Navajo families need the same amount of energy. It's the same example with food. My mother doesn't drink coffee. She only drinks water not coca cola only water. She also cooks her own food and picks her own food. She says "All those other things, my body is not used to". "All those other things make me sick. I'll just eat the foods I'm used to." I don't take her to a restaurant. She's happy just eating the foods she grows. When she visits, we just turn on the grill and she cooks what she likes. At her home she cooks w/charcoal over the open fire.

D-Do you think like for people like her, a smaller charge would work?

The tape then cut-off, but luckily this was basically the entire interview. Mr. Zah mentioned an example of how "smaller change," like a very simple phone, possibly charged by solar power, with only a few numbers just to call the first born, second born, and third born to be able to talk with the family. He talked about how communication is very important to the Navajo culture. We then concluded the interview and thankfully nothing really was lost in this "technical difficulty."

**Monica Joe Transcript from Interview 11/1**

D-Please tell me about your background.

m-My name is Monica Joe. I'm 23 yrs old. I'm originally from Tucson, AZ. I attended ASU for 2 and a half years. I have my BA in Psychology. I'm an undergrad and currently an alumni. I want to go on to Grad School.

D-Have you lived on the reservation?

m-I lived on the rez about 21 yrs of my life. Yes, I grew up there.

d-Has Cheston told you about our project?

M-Yes, he mentioned an Honors Thesis.

d- Mainly it's for a program called Innovation Space. It brings students from three different disciplines together. This semester we're researching many possibilities. We are targeting people living on reservations for our user group. We want to focus on food preparation because it's something that involves lots of various processes. We found a lot of families don't have electricity. So we're trying to see how we could make this process less labor intensive. Maybe something to store the water or purify the water. I was told people have to drive quite a distance to bring water back in barrels or tanks. Maybe something else to heat the water without using gas or propane would be an idea. We want to use nanotechnology with renewable energy. Maybe a refrigerator that uses solar power is one example.

m-My grandparents still live on the reservation. They speak fluent Navajo but no English. It depends what part of the rez you're on. Some people do speak English but others don't. So with my grandparents we need to speak Navajo. They now do have running water to their home. They have a wood stove and always keep a pan of water on top to stay warm.

I heard on the radio that APS (Arizona Public Service) is now offering water heaters that are generated by solar power. This would be good for a lot of people in the very remote areas as to provide energy by the Tribal Council is very expensive. So it's not in their benefit money wise to put electricity poles up in the remote area. So having solar panels installed would be a great advantage.

d-So do people have to shower or bathe with cold water?

m-The water is warmed on the stove. A lot of people take sponge baths. A lot of people shower outside with a hand-held shower head and the water runs down by gravity. But that would be too cold in the winter. Or people go to another relatives' house to use their showers. If a family lives closer to the city, they probably have running water.

d-Is it mainly the elders who live in the remote areas?

m- Elders mainly but also people who are not as well off financially. My grandparents live in that remote area because that's where they were born and they've always lived there.

d-Could you tell me about the cooking process?

M-Yes, it's usually the woman's job to do the cooking. Like a matriarchal society. Most of the responsibilities are on the women. My grandfather doesn't cook unless he absolutely has to. My grandparents have an oven that is propane. So they have to buy propane from the trading post. But in the summer, they stay in a different place to take care of the livestock and there's no oven there. So they use firewood on an open fire or a grill to cook with. Also some people use wood stoves to cook with but the wood stove would have to get very very hot to cook with.

d- One of the professors in Innovation Space is from India and has told us that the number one cause of death in children under five is indoor pollution. So, I was wondering if this is also a problem on reservations.

m-Some people use coal in the wood stove but just for heating not cooking. The water is hauled in from a windmill about a mile away from my grandparents. There's a large spout and a tank to get water from. The big tank sits outside. We take gallon buckets, fill them up and bring them inside the house.

d-Is there a problem with water contamination?

m- Not in my family. There's a small opening on the side of the barrel and it's covered all the time. The buckets have lids so the water is always covered. Its ground water so we feel it's very safe. There's always a fire going so there's always warm water to wash up in.

Fried potatoes are a common food. Spam or corned beef or anything with potatoes also. Homemade tortillas are another staple. Most people don't have refrigerators in their homes so they don't have milk and cereal for breakfast. Or maybe the fridge is kept in another shed in the winter so it stays colder. So people don't drink much milk and we don't buy eggs. But in November or December its cold enough for eggs to be stored outside. Meat could be stored in the icebox with a block of ice. People can't buy groceries in bulk but in small amounts. The trading post has everything: hay for the livestock, feed for the animals, gas, groceries like canned goods, also jewelry or Native American things that tourists can buy.

Sure, I think a solar panel for a fridge would be great. I don't know if there could be a solar panel for a stove. There are a few homes now on the rez that have solar panels. It would be great to have a solar panel for each home so people could have electric stoves instead of having to use propane. It's a long process. A family has to apply first, be approved and the cost is a factor.

My grandparents had sheep and a goat. So they had a lot of mutton to eat. They have a shed behind the house that stays very cold. The meat can be stored there over a rod, tied down. It dries then is cooked. All the parts are eaten. The wool is saved to make blankets. The wool can also be sold. In the summer, most people eat canned meat instead as it wont stay cold in the shed. Also people eat potted meat like sausage.

A lot of the older generation accept this as a way of life and are fine without electricity.

Having running water though would make the elders life a lot easier.

d-And can waste disposal or garbage pickup be a problem?

m-A lot of people just dig a hole and put the cans in. It's like their own land fill. Or some people burn the trash that can be burned. It's not good for the environment but the other alternative would be to store the smelly garbage, and then haul it into town to the town's landfill. My dad has been trying to get more landfills set up. But it's very costly. Sometimes the closest landfill is 30 miles away. We made our own with a tractor for my family and our aunt and her family to use.

m-In my Navajo culture, a girl should know how to make dough by the time she is 10 or 12 years old. I always tried to make dough but I was never consistent in doing it. My mom didn't really push me into doing it. When you make dough, you don't use measuring cups. When you're very experienced, you just know how much flour or other ingredients to put in. My mom, grandmother, and aunts just grab a couple handfuls of flour from a bucket and know what's the correct amount. They know a handful is a cup. Even Cheston knows how to make dough. You also need a tablespoon of baking powder and a little salt. But measuring is not the hardest part. The hardest part is adding the water. It can't be too hot or too cold. The dough is then mixed with water. It can't be too sticky. It's not kneaded or then it would be too hard. Just mushed or stirred together. Then you let it rise. Tortillas are made from the dough. A little ball is started which expands on the grill outside. It's usually made each day as it's eaten every day. When I went home this past weekend, our dinner was tortillas, hamburger meat, and corn mixed into the hamburger meat. We made chicken enchiladas the next night. This takes a lot more time to go to the store, buy some ingredients and bake in the oven. The tortillas we make are called manescada (sp??) in Navajo. We use Red Rose flour not from corn meal. The dough we use is the same kind that's used for fry bread. It's dipped into lard and fried. We cook the tortillas fresh when we're going to eat them. If there are any left over, just put a lid on it and eat it the next day. But my mom and grandmother are really good at knowing how much to make that there are hardly ever any leftovers. Tortillas are really a big tradition. They are eaten with everything even soup.

D- Oh, cool, that's so interesting. Ok well I guess that's all. Thanks a lot for taking the time to speak with me.

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