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How The Army Can Be An Environmental
Paragon Through Energy

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Army Environmental Policy Institute
1550 Crystal Drive, Suite 1301
Arlington, VA 22201-4136
www.aepi.army.mil
Office of the Director
(703) 604-2308

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U. S. ARMY WAR COLLEGE

HOW THE ARMY CAN BE AN ENVIRONMENTAL PARAGON THROUGH ENERGY

by

Felicia French, LTC, US Army

Army Environmental Policy Institute

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ABSTRACT

AUTHOR: French, Felicia

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This paper will examine the use and conservation of energy for both army mobility and facility operations. The military has been on the forefront of many social, medical and technological changes; therefore we can use our credibility and resources to be the vanguard of change to renewable energy into mainstream society. As a voracious consumer of energy, it will be financially and politically feasible for the army to decrease dependence on fossil fuel. To do so would facilitate use of alternative energy by the public and private sector. Additionally, it is more conducive to a positive public image of being environmentally and fiscally responsible consequentially allowing greater access to local training sites-further decreasing our requirement for mobility fuel.

The presentation offers recommendations for alternative and renewable energy to be used by the army and the numerous positive consequences of this transformation to include: diminishing US dependence on Middle Eastern oil, decreased dependence on one source of energy, halt the catastrophic effects of global warming, and ameliorate the deleterious health effects of fossil fuel combustion.

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Introduction

The Army can use our credibility and resources to lead the change to renewable energy in American society. The Army has been at the forefront of many social (racial integration, equal pay and promotion), medical (prosthetics, medical evacuation, and anti-shock trousers) and technological changes (the internet and robotics).

The Army has an opportunity to change its current energy strategy to a strategy that applies alternate sources of energy because its voracious consumption of fossil fuels significantly contributes to a long logistics tail. This leadership could also influence the use of alternative renewable public and private energy. This paper will discuss the financial feasibility, public perceptions and environmental considerations.

The phenomenon of “global warming” from carbon dioxide (the crucial greenhouse gas and primary product of burning fossil fuel) appears certain. Scientists from around the world have validated this and are urging countries to reduce their carbon dioxide (CO2) emissions. The U.S. population comprises less than one fifth of the world’s population yet disproportionately consumes 26 percent of the world’s oil consequentially resulting in a comparable amount of global CO2 emissions (21: 12).

Electricity is commonly thought of as being “clean” and fossil fuel free; however, about 71 percent of all electricity in the U.S. is produced through the combustion of fossil fuels (petroleum, coal and natural gas) (13: NP). Over 92 percent of U.S. coal is used to produce more than half of all American electricity. In the U.S., carbon dioxide emissions from coal combustion produces about one-third of all CO_2 emitted from fossil fuels, making electric power production the single largest emitter of these green house gases (13: NP).

Our current dependence on fossil fuel for energy has the most profound deleterious effects on human health, and is the single greatest contributor toward environmental degradation. Therefore, this paper will focus on energy conservation and renewable energy as a path for Army leadership in environmental progress, by addressing the six goals of the Army's new Strategy for the Environment:

1. Foster a Sustainability Ethic
2. Strengthen Army Operations
3. Meet Test, Training, and Mission Requirements
4. Minimize Impacts and Total Ownership Costs
5. Enhance Well-Being
6. Drive Innovation

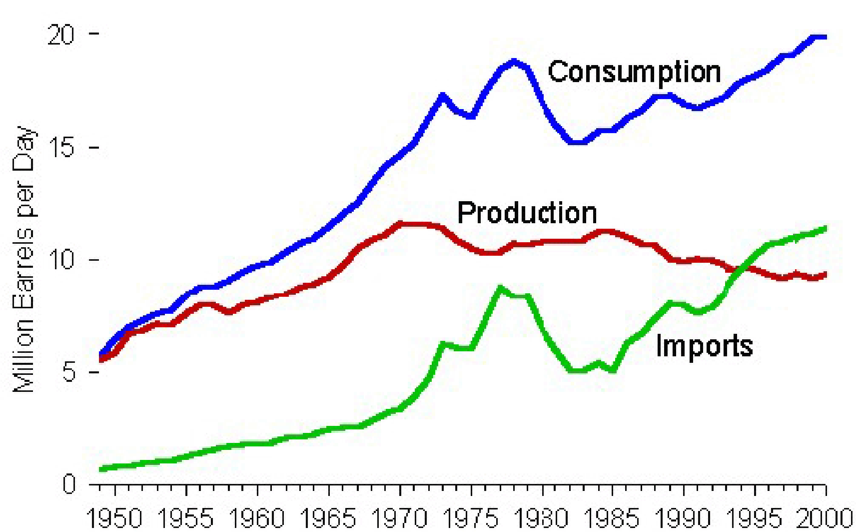
Chapter 2

Background

Energy Usage

Fossil fuels provide 85 percent of our energy (39 percent oil, 23 percent coal, and 23 percent natural gas) in the United States (14: 3). The U.S. disproportionately produces only 9 percent of the world's oil and only owns 2-3 percent of the world's oil reserves, but our consumption is 26 percent of all petroleum (21: 12). Until the 1950s the United States produced nearly all the petroleum it consumed. However, because of increased consumption in the United States and cheaper Middle East oil, by 1994 the Nation began importing more petroleum than it produced (see figure 1) (13: NP). And by 2002, the U.S. imported over 62 percent of all its petroleum (33: NP).

(Figure 1) Petroleum Energy



The Army does not have the luxury of ignoring its dependence on fossil fuel. Along with the rest of the Nation, it is almost completely dependent on fossil fuel to accomplish its mission. The Department of Defense (DoD) bill for mobility and installation energy was over $8.2 billion in fiscal year 2004 (27: NP). DoD is the largest single consumer of the total U.S. energy consumed. The Army uses about 6 percent of DoD mobility fuels (gas, diesel and jet fuel) to power tactical and utility vehicles, and weapons platforms to include M1 Abrams tanks and all helicopters (9: 4). However, this does not account for the fuel used by Air Force planes and Navy ships in transporting Army personnel and equipment in peacetime and especially in wartime. Fuel logistics for the Army accounts for 70 percent of all tonnage hauled when the Army mobilizes. The transportation of that same fuel from base to projection platform comprises 8 percent of the cost (21: 85). The Army also pays $3.2 billion annually to 20,000 active duty and 40,000 reserve component personnel to transport this fuel (21: 88). The Army could have more “teeth” and less “tail” if we weren’t so dependent upon this fuel. This logistical behemoth impedes deployment, maneuverability, and increases our personnel and equipment requirements and diverts troops from combat arms.

Additionally, in 2003 it costs $769 million in energy bills for the Army to maintain over 4,100 installations and sites (about two-thirds of all DoD installations) including Army National Guard, Army Reserve, and overseas facilities. This totaled 896 million square feet in 158,690 buildings (10: 1).

Global Warming or Climate Change

What exactly is “Global Warming”? The term is somewhat of a misnomer as some of the effects of Global Warming can produce drastic climate changes that can be manifested as extreme weather, either hot or cold. When sunlight radiates heat to the Earth warming the surface, the Earth re-radiates the heat into the atmosphere and space. Carbon dioxide, water vapor and other gases absorb and trap some of the heat inside the atmosphere so that it cannot escape into space--similar to a greenhouse glass roof (37: 110-111). The increased heat delivered to the Earth's land and water has resulted in an acceleration of the hydrological cycle. The hydrological cycle is the process of water evaporating, transporting into the atmosphere and depositing again as rain or snow. This acceleration is believed to be why there has been an increase in flooding and blizzards in some parts of the world. The heat, and especially the warm water vapor over the tropic regions, dissipate toward the colder polar regions and create more severe and frequent hurricanes and typhoons (2: 65-66). Melting polar icecaps could create a rise in sea level, creating massive flooding in much of the coastal nations, which are home to about four-fifths of the world's population (4: 22). Because carbon dioxide does not readily degrade and has a life span of hundreds of years in the atmosphere, it accumulates and can affect the climate for generations to come (4: 21). We only have to look to the more than 170,000 deaths and vast economic and environmental damage of the 2004 Tsunami in South East Asia to visualize the unfathomable potential magnitude of destruction that a rise in the sea level could produce.

Health Hazards

Oil

Within the U.S., transportation is the single greatest source of air pollution (33: NP). Airborne pollution consists of carbon monoxide, hydrocarbons, nitrogen oxides (principal cause of smog), sulfur oxides and particulates (another contributor to smog) (18: 30). These chemicals cause harmful effects on human health such as ocular irritation, respiratory and cardiovascular disease, cancer and death. The American Lung Association estimates that 335,000 Americans die each year from lung diseases such as asthma, respiratory tract infections and lung cancer from air pollution alone (26: NP). The cost of these pollution induced illnesses and deaths are not calculated into the total amount we pay for gas at the pump and therefore the price of gasoline and coal is in fact higher.

Coal

In addition to creating air pollution, coal fired power plants are the greatest emitters of airborne mercury, which can travel and be deposited thousands of miles from plant smokestacks. Annually, mercury released into the environment from the over 600 coal-fired power plants in the U.S. is: 98,000 pounds of mercury into the air, another 81,000 pounds of mercury in solid waste, and 200,000 pounds from the process of cleaning coal prior to burning. Mercury is toxic to the neurological system. In 55 percent of the 500 lakes and reservoirs tested by the Environmental Protection Agency (EPA), the fish exceeded the EPA's safe level of mercury for women and 76 percent of the fish exceeded the safe levels for children under three years old. Four out of five tuna and swordfish exceeded the safe mercury limits altogether causing warnings on their safe edibility (20: 2). Sulfur dioxide, another byproduct of fossil fuel combustion (specifically coal) produces acid rain, which is corrosive to plants as well as buildings, statues and other manmade and natural structures.

The Army used 440,661.1 tons of coal for energy in 2004 at a cost of $31,797, 700 and an estimated 277,616,000 metric tons of CO_2 were emitted as a result (27: NP).

Nuclear energy

Although nuclear power is carbon free and doesn't pose the same deleterious effects that oil and coal do, the plutonium and uranium is exhaustible and, therefore, not renewable. Furthermore, nuclear energy is not without inherent risks. Nuclear power accounts for about 17 percent of the world's electric energy today (28: 15). Safety and construction has improved since the infamous 1979 Three Mile Island and 1986 Chernobyl nuclear plant accidents, yet these enhancements do not negate the risks. The entire process of creating nuclear power; uranium mining, nuclear plant operations and nuclear waste disposal, all create risks to the health of humans and the environment. Albeit a minute potential risk, the consequences of a nuclear plant related accident would likely be far more catastrophic than the terrorist attacks on Sep 11, 2001. There is also the potential for weapons proliferation with plutonium, as well as the prospective of "dirty" bombs built from the radioactive waste from nuclear power plants.

Radioactive nuclear waste from spent fuel takes several hundred years to decay to safe levels and the spent fuel itself takes tens of thousands of years before it is safe in the biosphere. Currently, the spent fuel is stored in temporary facilities. To date, there are no permanent repositories for the accumulating nuclear waste in the world (35: 286). This poses a significant menace to our national security in that it must be guarded and protected from would be terrorists trying to build a dirty bomb or worse make a nuclear explosive from weapons grade plutonium. This is not just a concern within U.S. borders;

we need to be concerned about nuclear waste disposal of other countries with nuclear power plants as they may be even more vulnerable than ours.

National Security Strategy

The 2002 National Security Strategy (NSS) states: "The aim of the NSS is to help make the world not just safer but better. In promoting free trade, two of the NSS goals are: Protect the environment and workers and enhance energy security". The strategies for obtaining these goals are to:

1. Obtain agreements with key industries to cut emissions of some of the most potent greenhouse gases and give transferable credits to companies that show real cuts.
2. Promote renewable energy production and clean coal technology, as well as nuclear power…while also improving fuel economy for U.S. cars and trucks.
3. Increase spending on research and new conservation technologies…
4. Assist developing countries, especially the major greenhouse gas emitters such as China and India…

Presently, the economies of China (with over 1.3 billion people) and India (with over one billion people) are rapidly developing, creating a middle class in both countries which appear to desire the individual mobility and independence that the U. S. enjoys (5: NP). As it is now, the average American uses 10 times the amount of energy than the average Chinese and 20 times the amount of energy than that of the average Indian (40: NP). An analogous increase in consumption of fuel has created competition for petroleum resources and expedites the exhaustion of fossil fuels, further increasing CO2 into the atmosphere. Both countries already suffer from air pollution, deforestation, and desertification. Two-thirds of China's total energy (which is also a quarter of the world's energy consumption) is derived from coal. This makes China a key contributor to the

CO_2 in the global atmosphere (15: 37). Therefore, China's conversion to renewable energy would significantly reduce global CO_2 levels.

Another compelling reason to transfer fuel sources to renewable energy is to prevent blackouts such as the one that substantially paralyzed the entire North Eastern United States and South Eastern Canada in 2003. Being tied to an electrical grid makes everyone associated with it vulnerable to mechanical or human failures and the not so unthinkable terrorist attempting to bring chaos to our lives.

Our dependence on fossil fuel leaves us completely susceptible (militarily and economically) to the whims and precariousness of foreign oil producers. Not only do we have to buy the oil at whatever prices they ultimately set, but also we incur a significant monetary and human cost defending it.

Throughout this research, world scientist and leaders have noted the current and future effects of fossil fuel combustion on the earth's atmosphere. This creation of an insidious heat trapping blanket is altering the climate with devastating consequences globally, thus creating a potentially greater threat to the world than terrorism. Add to that the deleterious health effects caused by the particulates and gases produced by fossil fuel combustion; it becomes quite apparent that it is foolish and irresponsible to ignore these consequences.

In The March of Folly by the Pulitzer Prize winning historian, Barbara Tuchman, folly is described as "the pursuit of policy contrary too the self-interest of the constituency or state involved". If we continue to pursue a course of dependence on fossil fuel whether it is foreign or domestic, we will be in fact marching to folly (32: 8).

Chapter 3

Conservation

Green or Sustainable Buildings

The DoD Instruction for Installation Energy Management Number 4170.11 dated October 13, 2004 directs the:

> Development of programs that shall result in facilities that are designed, operated, and maintained to achieve optimum performance and maximize energy efficiency in accordance with sustainable design principles.

Since about 33 percent of energy used today is used to maintain the climate and lighting in buildings, constructing energy efficient (green or sustainable) buildings, would impact energy and cost (4: 27). Green or sustainable buildings use material, energy, water and land more efficiently and on average use 30 percent less energy than conventionally constructed buildings (18: 19).

Many Army facilities, specifically housing areas and barracks, are aging and either in the process of being (or slated to be) renovated. This is an opportune time for the Army to simultaneously improve the quality of life for soldiers and their families and also incorporate its sustainability strategy by making these new facilities energy efficient and self-sustaining. Considering that operating cost over the lifetime of most buildings is significantly greater than the initial construction cost, the Army can save money over the long term by putting up front money into constructing the most energy self sustaining buildings in the first place.

Another way to conserve energy is by reducing the size of buildings as the more spacious a building the more energy is required to light, heat, and cool it. Over the decades, the average American home has increased in size to double the average homes in Japan or Europe and over 25 times the size of the average African home (40: NP).

Preexisting buildings can be retrofitted with energy efficient applications. Such as installing thermal paned windows with coatings to keep heat from escaping but allow light to enter and thereby drastically reduce the energy demand to heat and cool a building. Other efforts would be to replace incandescent lighting with more energy efficient compact fluorescent lighting, add reflective backings in the light housing to increase illumines of the bulbs, and add solar tubes or sky lights to lighten rooms naturally during daylight hours. Natural lighting and cleaner air contributes to a healthier working, living and learning environment (18: 19).

Construct buildings for maximum use of passive and active solar energy by properly orienting them to the sun and insulating with recycled energy efficient material. Installing solar heating and solar energy devices on all new buildings will allow water to be heated directly by the sun and electricity provided through photovoltaic panels.

Constructing energy self-sustaining facilities with a clean renewable energy micropower plant would eliminate the need for the installation to be connected to the local power grid. This will also decrease the energy bill and the threat of a blackout-whether the cause is due to nature or man. While we are in transition to distributed energy, we can send any excess energy to installation buildings that are not yet modified with micropower or send the excess energy to the community electric grid and receive credit on the electric bill.

Building water-collecting roofs with cisterns would reduce the need to pipe water from an outside source and reduce its inherent vulnerability to a potential wide scale contamination of the community water supply. If the installation is in an arid region such as the Southwest, these cisterns could be used when rainfall is available and serve as a backup to any already existing plumbing. The Army would save money on the water bill and reduce the roof rain runoff into the sanitary system, which requires energy to treat. Gray water from showers and sinks can also be diverted from the sewage system to be recycled with less energy than would be required to treat raw sewage.

A prototype of such a self sustaining building is the Eco-building constructed by the Arizona Army National Guard on the Papago Park Military Reservation in Phoenix, Arizona. The 5,200 square foot facility is built from adobe (mud and straw) with discarded tires and aluminum cans which add to the support structure. The building has a photovoltaic system that provides 11 kilowatts of electricity-enough to provide lighting and run desktop computers. It is geothermal cooled by 8-foot concrete pipes tunneled under the building where the cooler underground air is pushed through the building from the outside. Water is captured and stored from the roof that is sloped to funnel any rainfall into large cisterns built into each corner of the building (25: 10). Unfortunately, no data of energy savings have been collected on the Eco-building. And presently, the building is experiencing some structural flaws as a result of the greater than normal precipitation experienced in the Phoenix area in 2004, however many lessons can be learned to ameliorate these for future Eco-buildings.

Shared Facility Usage

In many instances, there are Army National Guard (ARNG) armories located or in near proximity to Army Reserve armories. The units of the two components can alternate and coordinate their Inactive Duty Training (IDT) schedules so that they are not training on the same days. Shared usage and consolidation of buildings would reduce the energy required to maintain the temperature and water heating in separate buildings throughout the month. Increased shared usage of Active Component (AC) facilities where Reserve Component (RC) units are in close proximity should be implemented for energy conservation as well. For the most part, the RC conducts the preponderance of their training on weekends when the AC is not utilizing their facilities. Currently, and in the foreseeable near future, many units (both AC and RC) are deployed and either not occupying their facilities or at a reduced level of occupancy making consolidating and sharing facilities more advantageous.

Installation Design

The housing areas should be designed so that they are within walking distance to the post exchange (PX), shoppette, commissary, library, bowling alley, school and other facilities that are used on a regular basis by soldiers and their families. Design the installation's streets so that they are bicycle and pedestrian friendly through: traffic calming, bike lanes with ramped sidewalks, and tree shaded sidewalks and paths. Planting more indigenous shading trees would provide the added benefits of enhancing the aesthetics of the post, the absorption of the global warming gas carbon dioxide, and increase the production of life essential oxygen. Making the post conducive for soldiers and families to walk and bike increases their physical fitness and overall readiness and reduces the vehicular traffic congestion with its unhealthy emissions. Reduced vehicular traffic lessens the requirement for parking lots and subsequently reduces the heat trapped by the parking lot asphalt (urban heat island effect). This would then reduce the energy requirement to cool adjacent buildings.

On larger Army installations were shuttle transportation service is provided; only fossil free buses or vans should be used. Many soldiers only have one or no car as in the case of some of our younger soldiers. This would decrease their family's requirement to own more than one car or allow them to do without a car during the workweek. Once we build the infrastructure on military installations to support a fossil free fuel for our military vehicles, it will be available for sale to the soldiers and their families. This convenience could further encourage the purchase of alternative fueled vehicles and their increased production.

Many water conservation measures also conserve energy. As previously noted, it requires energy to treat and purify sewage; therefore, drainage from rain and snow melt runoff from the streets can be diverted and stored in reservoirs instead of into the sewage system or out to sea. Xeriscape is a form of landscape that uses only plants that are indigenous to the region and minimizes water usage and lawn care. An inordinate amount of time, water, energy, labor and money are required to maintain lawns on Army installations. By minimizing grass lawns on our installations we also reduce the amount of fertilizers, herbicides, and their chemical runoff. Furthermore, the cacophonous noise and fumes from lawn mowers, blowers and hedgers will also be reduced (16: 219).

Micropower and Distributed Energy

Micropower is technology that is smaller than the standard generators used today. Solar cells, microturbines, and fuel cells are examples of micropower. Micropower can increase the energy efficiency of transmission because the micropower stations are collocated at the user site. This reduces reliance and demand on distant transmission systems, facilitates local control over power usage that contributes to local economic development (12: 7-8).

Conventional fossil fuel-based power plants waste up to 66 percent of the energy they consume in waste heat. This waste heat can be more readily captured and used at the location were the power is used (12: 8). Traditional power lines lose on average 6 percent energy through transmission and distribution from the power plant location to the use site (23: 61). Distributed energy does away with the need and vulnerability of unsightly overhead and underground wiring and transformers.

The Center for Army Analysis is currently evaluating the Mobile Alternating Current Power System (MACS). This is a prototype remote electric power generator carried on the Army M105 trailer, designed to replace the Army's standard diesel engine generator used in the field. The MACS's hybrid electric hydrogen fuel cell is quieter, produces fewer air and thermal emissions, and requires less fuel and maintenance than current generators.

Another example of a distributed generator is the Mobile Power Station (MPS) manufactured by SkyBuilt Power. It is configured in as a standard freight container that can be transported anywhere worldwide and provides stand-alone energy for climate controlled operations, emergency, telecommunications, and storage. The energy is provided by solar panels and wind turbines generating up to 50 kilowatts or more when additional solar panels are attached. Set up requires only a few hours with two people and maintenance is minimal compared to a diesel generator (30: NP).

The Defense Advanced Research Projects Agency (DARPA) is researching the ability to turn discarded Meals Ready to Eat (MRE) packaging and other waste into energy through the Mobile Integrated Sustainable Energy Recovery (MISER). The average person living in the Third World generates less than 1 pound of trash per day. The U.S. soldier generates about 7 pounds of trash per day. For 150,000 soldiers in Iraq this amounts to approximately 525 tons of trash per day. This volume of trash can be overwhelming to many of the regions we have been and will be operating in. The prospective energy in 14 pounds of mixed waste or 7 pounds of plastic (petroleum polymer) in MREs and water bottles equal about 7 pounds of JP-8 fuel. MISER could have the capability of reducing 80 percent of field waste (plastic, paper, food, and fiberboard) to energy and recycling the remainder (glass and metal) (7: NP). This has profound applications for the combat theater as well as Army bases by simultaneously addressing energy production and waste reduction-with its additional requirements of personnel and fuel for hauling and disposal (burn or bury).

Not only would the U. S. benefit greatly from the efficiency and independence of micropower and distributed energy, but also the nearly 1.6 to 2 billion people (about one third of the world's population) worldwide who are without electric power because they are not near a power grid (28: 9). What underdeveloped countries do use in the way of energy to heat or cook is charcoal or cow dung, which is harmful to health and the environment. It is estimated by the World Energy Assessment that annually 2.5 million deaths occur globally as a result of noxious fumes from charcoal and cow dung while cooking in inadequately ventilated facilities. Most of these deaths occur in women and children, as they are primarily the ones to perform the cooking chores in these regions (35: 295). The charcoal is often made from firewood cut down from already sparsely forested regions. This deforestation or desertification causes land erosion, flooding and contributes to climate change. An extreme example of this deforestation is taking place in sub-Saharan Africa where 90 percent of household energy is derived from burning wood or other biomass (15: 36).

Although most of these countries do not have fossil fuel reserves, they have vast supplies of renewable energy in the way of solar, wind, biomass, and geothermal. Using these renewable energy sources will not only supply the much needed electricity to provide such fundamental luxuries as light for children to read by at night, but also refrigeration to prevent food, medication and vaccination spoilage. It can create millions of jobs and reduce the dependence and dept from importing petroleum fuel these poorer nations have been incurring. Facilitating job production, the economy, and overall quality of life in these regions reduces the likelihood of civil unrest and therefore the potential for that unrest to spread and the need for global military or economic involvement.

> "People in countries with severe population, environment, and health problems get desperate. If they have no hope, they turn to drastic things like civil war and terrorism and make trouble not only for themselves but also for other countries" (11: 10)
>
> (Dr. Jared Diamond, January 30, 2004).

Using Reusable Products

There are many seemingly small initiatives such as reusing products rather than discarding them that can have profound long-term impacts. It requires less energy, water and raw materials to recycle a product than it does to manufacture a new product and no resources (beyond the initial production) to reuse it. A principal example of this is that it takes 95 percent less energy to recycle aluminum than it does to refine it from raw material (40: NP). It requires 6-8 kilowatts of electricity (36: NP) and up to four pounds of bauxite ore to make one pound of aluminum or about 23 aluminum cans. Because bauxite ore deposits are usually located close to the earth's surface, mining it can lead to unsightly scaring, erosion, and ground and surface water contamination (34: NP).

The Army can promote the discontinued use of paper and plastic grocery bags in the commissary, PX, and shoppette on all posts and require cloth reusable bags such as the ones currently sold in some Army PXs. To facilitate this transition, the Army could supply an initial allowance of cloth grocery bags to each soldier and then have more available for sale at the PX and commissaries. The elimination of plastic and paper bags would reduce the litter on post and the community as well as reduce the use of resources (trees, water, and petroleum) to produce or recycle these bags.

The plethora of discarded worn tires from military and privately owned vehicles, tires shreds found on the road sides, as well as worn out running sneakers, could be shredded and processed to make: (1) safer impact absorbing playgrounds on post (such as the ones found at McDonald's Playgrounds); (2) safer rubberized running tracks and trails to reduce the impact and jarring on lower body joints and in so doing reducing running (or falling) injuries. Old tires can be further used to pave roads to reduce vehicular traffic noise and wear and tear on the tires of the vehicles using these roads. This could help eliminate the unsightly monolithic mounds and fire hazard of old tires seen occupying space around the country.

Another way the Army can reduce waste and encourage recycling is through the practices and procedures used in the procurement of goods. We can stipulate from those we purchase from that they must provide us with “extended product responsibility” or cradle-to-cradle service (1: 14). This is a way of holding manufactures responsible for the production process, quality and recycling of their products. By doing so, the Army can reduce our own and encourage the reduction of waste such as electronic appliances (i.e. computers, monitors, washers, dryers, and refrigerators) as well as carpets, flooring and roofs. These products end up in garbage dumps leaching toxic chemicals into the ground.

Purchase and installation of all energy efficient rated appliances would save energy and reduce green house gas emissions. Home appliances account for 30 percent of electrical consumption and 12 percent of green house gas emissions in the U.S. (40: NP).

By reducing our footprint on the community environment, we make ourselves more attractive and desirable to have as tenants and neighbors than a land developer with possibly little or no regard and consideration for the environment. The Army will be viewed as providing environmental stewardship as well providing jobs for the local economy.

Conserving and reducing our requirements for energy by applying the principles mentioned in this chapter will facilitate the Army’s meeting all the goals of The Army Strategy for the Environment. Construction of Green buildings and using reusable products is completely in line with fostering a sustainable ethic. Sharing facilities with other AC and RC units strengthens Army operations and minimizes impacts and total ownership costs.   Green installation design enhances the well being of Army families and our communities. Procurement and use of micropower and distributed energy will facilitate meeting our testing, training, and mission requirements and will help drive innovation in the private and public sector. Using reusable products will foster a sustainability ethic, and minimize impacts and total ownership costs.

Chapter 4

Renewable Energy

Renewable energy or carbon-free energy can be replenished and never exhausted such as the sun (solar or photovoltaic energy), wind, hydrogen, biomass, geothermal, tides, waves and hydroelectric (17: 124). Currently, the World is only meeting 2 percent of all energy consumption requirements through renewable energy (28: 7). Because we currently do not have the infrastructure to convert to renewable energy, the initial transition will require a substantial capital cost. However, as with many new technologies e.g., the automobile and personnel computers, the cost will decline as the infrastructure advances to meet the demand through economies of production. Furthermore, the savings must be factored into the cost of replacing non-renewable with renewable energy with the numerous compensations: (1) they can be replenished for future generations; (2) they do not negatively impact the environment; (3) they stimulate the local community economies; and (4) they will provide the U.S. with energy security and increased national security.

Restoration and cleanup

In 2005, the Army estimates spending $400.9 million dollars on environmental clean up to restore some of the contaminated sites caused by previous years of military operations and activities (8: 43). Our transition to renewable energy will reduce if not eliminate much of this requirement and expense in the future. Renewable energy can also be used to clean up some of these preexisting environmentally contaminated areas. At the Los Alimitos Training Center in California, the California Army National Guard is planning on using phytoremediation to clean up JP-4 fuel. This fuel leakage from an old JP-4 tank farm has seeped into the local community ground water and the clean up will prevent further seepage. Phytoremediation is a natural cleanup process using vegetation such as poplar trees, to absorb the diluted chemicals from the ground after the initial extraction of the groundwater has been treated at the site. The Arizona Army National Guard is using biomass e.g. composted straw, vegetables, wood chips and manure to clean up 6,100 tons of TNT. This clean and expedient process reduced the TNT concentrations of more than 5,000 parts per million to 10 parts per million in only 11 days (25: 37). In Maryland, the regional EPA office is looking at using wind turbines to circulate ground water to clean water contaminants from an Army ammunition plant (29: NP).

The Renewables

Biomass energy

Biomass or bioenergy is energy from organic matter such as wood (the most common), plants, methane gas from landfills, and organic wastes and is thus completely renewable. Biomass accounts for up to 4 percent of the total energy produced and 47 percent of all renewable energy used in the U. S. Most of our biomass resources come from farming and forestry residues (33: NP). Biomass and biofuel can be completely grown and produced in the U. S., sustaining our agricultural and rural economies. Biomass energy can be obtained by way of biofuels and biopower.

Biofuels

Biofuels convert biomass to liquid fuel for transportation needs and contain oxygen resulting in cleaner combustion and less toxic emissions than fossil fuels. Although biofuels release the global warming gas carbon dioxide when combusted; carbon dioxide is also absorbed from plants grown for biofuels. This in essence recycles the carbon dioxide and ultimately is a neutral carbon net exchange (33: NP). Unlike fossil fuel oil spills or leaks, a biofuel spill would not be deleterious to the environment and would more easily biodegrade into the soil or water.

Biomass derived ethanol and biodiesel can be mixed with or directly replaced for gasoline and diesel, respectively. At present, these are the only two alternative liquid fuels available that can be substituted for the two thirds of all petroleum used in the U.S. for transportation and of which 50 percent is imported. (33: NP). Increasing our production and use of biofuels will drastically decrease our dependence on imported oil. Thus biomass and biofuel have significant economic, health, environmental, and security benefits.

Ethanol is an alcohol produced from the fermentation of carbohydrates and predominantly used for a fuel additive (up to 85 percent mixture) to decrease smog emissions such as carbon monoxide (26: NP). The overall research on whether or not it requires more BTUs to produce ethanol than what BTUs are actually yielded from ethanol is inconclusive.

Biodiesel combines alcohol, and either clean or recycled vegetable oil, animal fats, or cooking grease. It can also be added to current fuels (about 20 percent) to decrease smog emissions or alone in diesel engines (26: NP)

In relatively minimal time, the Army can start supplementing our fuel requirements with biofuel in most of if not all of its vehicles. Since a number of our vehicles currently run on diesel fuel, we can convert them over to biodiesel. It would even be possible to sell or turn in our mess hall cooking grease to recycle into biodiesel fuel for our own use.

Through the Army's increased purchase of biofuels, we could begin to influence the increase in production and with it the infrastructure to produce greater supplies of biofuel. This will leave our country less vulnerable to near term and future oil interruptions. With the Nation's aging petroleum oil refineries at or near maximum capacity, building biofuel refineries to replace them would be the most prudent and economically feasible course of action. However, using biofuel is primarily an interim action as it has the potential to remove food from the Third World.

Biopower

Biopower or biomass power is the process of either combusting biomass directly or converting it into a gaseous fuel or oil to generate electricity. Most biopower plants burn feedstock (direct-fired) to produce steam that is caught in a turbine and then a generator, which converts it into electricity. The heat from the steam can also be used to heat the buildings (26: NP). The gasification of biomass into hydrogen, methane and carbon monoxide can then be used to fuel a gas turbine, and then a generator to create electricity. Similar to a jet engine but instead of turning a propeller, the electric generator is turned (26: NP).

Methane produced in the gasification process or from the decaying organic material in landfills or manure can also be used in microturbines and in a fuel cell. Making further use of the otherwise wasted and pungent gas and manure from stockyards has the advantage of reducing these odors and would be a welcome aspect of biofuel production in many local communities.

The United States Department of Agriculture (USDA) Forest Service is currently using a portable prototype biopower plant, BioMax that uses the wood debris from the forest floor to make energy. The wood feedstock is put into the biopower plant where the excess heat produced by the unit itself dries the wooden debris and is then fed into the gasifier. The gases emitted (carbon monoxide and hydrogen) power the internal combustion engine (ICE) generating 15 kW of electric power and 50 kW of heat. These power units have been placed at four National Forests facilitate the health of the forest (through the removal of excess undergrowth) and provide electricity at the remote sites. Smaller scale units that can use wood pellets will be available for commercial and home use (6: 5).

Geothermal

Steam from the earth can be used to run geothermal power plants or heat from just below the earth’s surface can be used in heat pumps to heat air in the winter and cool air in the summer. Geothermal heat uses the heat from the upper ten feet of earth that maintains a temperature of 50 to 60 degrees F. This shallow ground temperature remains constant throughout the U. S. and is therefore conducive to using geothermal heat pumps (26: NP).

Geothermal Heat Pumps

Geothermal heat pump systems are made of a ground heat exchanger, heat pump, and ductwork to deliver the air. The heat exchanger consists of pipes (a loop) buried under the ground close to a building. Water or water plus antifreeze flows through the heat exchanger pipes absorbing heat (in the winter) and giving up heat (in the summer) through the ground. This heated air (relative to the outside ambient air) from the heat exchanger is pumped into the indoor ductwork to heat buildings in the winter. In the summer the heat pump extracts the heated indoor air into the heat exchanger in the ground. This heated air can also serve to heat water at no extra cost. This process saves energy, money and does not create any air pollutants (26: NP).

Geothermal heat pumps have great potential application for the Army. They can be used in regions where solar systems are not advantageous as in the Northwestern and Northeastern United States and they can also be used to supplement and backup solar or other energy systems. They can also be used under street and sidewalk surfaces to melt snow.

Geothermal Power Plants

Geothermal power plants most commonly use steam from the earth to turn turbines that activate a generator producing electric power. Instead of combusting fossil fuels to create enough heat to produce steam from water, geothermal plants obtain the steam already created from the earth's heat. This steam is drawn from hot water reservoirs located just below the ground to miles below the surface. Because there is no fossil fuel combustion, geothermal power is nonpolluting.

Obtaining the geothermal heat directly is called “direct use geothermal energy”, such as in hot springs or by drilling a well and drawing the hot water up through a pipe, heat exchanger and controls. After the water is cooled, it can be injected back into the ground to be reheated. Most geothermal reservoirs in America are in Northern California, Wyoming, Alaska, and Hawaii (26: NP).

Hydrogen

Hydrogen is the most abundant element on earth as well as the universe; however, it combines with other elements and therefore it is not found naturally as a gas. Hydrogen is extremely energy intensive and produces no pollutants upon combustion (26: NP). The most common way of obtaining hydrogen is through reforming which is the process of separating the hydrogen from hydrocarbons (principally natural gas) by applying heat (24: 45). Separating hydrogen and oxygen from water through electrolysis is a cleaner way of obtaining hydrogen, as hydrogen and oxygen are the only byproducts. Liquid hydrogen fuel has been used by NASA to propel the space shuttles and hydrogen fuels cells provide the energy for the electronics (26: NP).

Fuel cells are micropower plants that act as large batteries producing electricity through a chemical reaction, but fuel cells have a much greater power density than batteries and they do not lose energy as long as they have fuel. As fuel, hydrogen combines with oxygen to create electricity leaving water and heat as the only byproduct.

Hydrogen fuel cells are quieter, more efficient, and cleaner emitting than conventional gasoline burning ICE (35: 14). They can be used to replace petroleum-fueled vehicles and provide electric power for buildings such as the Conde Nast Building in New York City that has two fuel cells providing 400 kW of electric power. About 35 buildings in the U.S. today use fuel cells as their primary source of electrical energy (38: NP).

Fuel cell application can have a great value to our soldiers as fuel cells have the potential to be used in cell phones, notebook computers, and climate-controlled bodysuits (35: 14). In addition to fuel cells replacing the ICE vehicles, they can act as an auxiliary power unit or backup generator off the vehicle's engine that will be a valuable asset in remote areas. This would decrease or eliminate the need for units to haul the heavy, cacophonous, maintenance and petroleum intensive generators to the training or combat zone.

As of this writing, Daimler, Toyota, Honda, and GM either have or are in the process of producing fuel-cell cars for commercial use with the intent of mass production within ten years (35: 15). Hydrogen fuel cells are projected to be 2.2 times more efficient than current conventional ICE which will bring the cost of hydrogen to as low as $1.81 per kilogram (about one gallon of gasoline) before tax, refiner and distributor markup (23: 66).

If the Army puts in a requisition to replace many if not all its garrison vehicles with fuel-cell vehicles, a contract this large would be the catalyst to speed up the production for commercial and private use. Procuring and using hydrogen fuel cells is in line with the goals of the Army Strategy for the Environment, but perhaps of greatest significance are with the goal to Drive Innovation.

Hydropower

Hydropower or hydroelectric power incorporates flowing water through a turbine to activate a generator to create electricity or power machinery. Since hydropower's fuel is water that is not destroyed or depleted it is considered a renewable energy. About 10 percent of electric power in the U.S. comes from hydroelectric power (33: NP). Most hydroelectric power plants use river dams to store water in a lake or reservoir to help supply water and provide flood control to the area. Water is released as needed to meet energy requirements; however, it might have limited capacity to produce energy in the event of reduced water as with a drought. Another negative aspect of hydropower is the impact building the dams and reservoirs has on the environment and natural habitats for plants, animals and humans.

A new technology is the use of underwater turbines (somewhat similar to those used for wind turbines). The turbines are slow moving suspensions on a pontoon like platform. Because they are slow moving, they do not pose any harm to fish. A test installation with 200 turbines has recently been installed in the East River of New York City off the banks of Roosevelt Island that can produce 10 megawatts (MW). This is enough energy to provide power to the United Nations building (30: NP). Of course, hydropower applications for the Army are limited to installations with a natural water source.

Ocean Energy

The Earth's surface is composed of over 70 percent water, which makes oceans the world's largest collector of solar energy plus thousands of miles of coastline for tidal energy. Ocean energy comes from mechanical energy (waves and tides) and thermal energy (sun's heat). There is estimated to be 2 to 3 million MW of power in the breaking of waves along the world's coastlines and up to 65 MW of energy per mile over some coastlines (33: NP).

Wave power

Wave power can be obtained from the surface or through fluctuations in pressure subsurface. There is estimated to be as much as two trillion watts (terawatts) of power from breaking waves over the world's coastlines or beaches. Wave energy can be turned into electricity by way of onshore or offshore systems. In the northeastern and northwestern coastlines the waves are the most powerful. On the over 1,000 miles of the U. S. western coast, it is feasible that there is up to 70 kilowatts per meter of shoreline (33: NP). Wave power stations are rare because it is difficult to harness waves and convert it into electricity on a mass scale. There is a wave station on the Scottish Island Islay run by the company Wavegen. It works when the waves enter an air chamber causing the water and air to rise and fall forcing the air in and out of an opening at the top of the chamber. At the top of the chamber is a turbine that turns as a result of the air pushing through. The turbine turns the generator creating electrical energy. (39: NP). Another wave power plant is the pilot offshore AquaEnergy's AquaBuOY in Makah Bay, Washington which has modular buoys that can produce 80-250 kW of electricity each. It should be capable of generating 1500MWh per year to Washington State. The power plant uses a closed loop hydraulic system converting the wave energy into a water flow that is high-pressured which turns a turbine generator. The energy generated is then transmitted to shore by submerged cables (22: NP). Army applications for wave power would only be feasible of course on coastal installations specifically Ft. Lewis Washington.

Tidal power

There are two high and two low tides over all coasts but only in the 20 global sites where the tidal differences are at least five meters, can tidal forces be converted into electricity. The technology is similar to that of hydroelectric plants. A dam along a tidal basin is built with gates and turbines; however, it is better if the tidal area has a bay with a narrow channel eliminating the need to build a dam. As the tidal level on each side of the dam becomes dissimilar enough, the ocean water on the elevated side is channeled through opened gates, then through the turbines, and to the generator producing electricity (31: NP).

The largest drawback to tidal power is that they can only generate about ten hours a day when the tide is rising and falling. As with hydropower, there can be negative environmental impacts with tidal power plants- altered tidal flow resulting in silt build up that impacts the ecosystem of the basin for many miles up and downstream (31: NP).

France has the world's only large-scale tidal power station, which produces 240 MW of power from the estuary of the La Rance River built in 1966. Although conditions are favorable for tidal energy in the Pacific Northwest and Atlantic Northwest of the U. S., there are no tidal power plants in the U.S (33: NP)

Ocean Thermal Energy Conversion

Ocean Thermal Energy Conversion (OTEC) uses the thermal energy (heat) stored in the ocean. Daily, the world's oceans absorb heat energy from the sun equal to that energy available in 250 billion barrels of oil. This thermal energy can be converted to electricity by OTEC and produce desalinated water in the process (33: NP). Desalination of ocean water can help alleviate many drought conditions in the Middle East, Africa as well as the Southwestern U.S.

The Natural Energy Laboratory in Kona, Hawaii is one of the lead OTEC testing laboratories in the world. India built a 1MW floating OTEC plant and Japan is doing research and development on OTEC systems (33: NP). OTEC systems could possibly be used on Army installations in Hawaii and other costal areas throughout the world were we have a presence. OTEC can be used offshore as well through the use of barges.

Thermal energy is available through the differential temperature between the ocean surface water and deep ocean water. These differences in temperature are greatest at the coastal areas between the Tropic of Capricorn and the Tropic of Cancer. OTEC plants require large diameter pipes submerged about a mile off the coast to draw in the deeper and colder ocean water. OTEC can convert thermal energy into electricity by three methods: closed-cycle, open-cycle, or a combination of the two: hybrid (33: NP).

Closed-cycle systems

Closed-cycle systems use a low boiling point liquid (i.e. ammonia) and warm ocean surface water to vaporize the liquid. The expanding vapor turns the turbine–generator- producing electricity. Then cold deep ocean water is pumped through another heat exchanger, which condenses the remaining vapor back to liquid and recycles it back through the closed system (33: NP).

Open-cycle systems

Open-cycle systems use low pressure to boil warm ocean water. This produces steam to pass through the turbine-generator creating electricity. Cold deep-ocean water condenses the steam back to water. Salt from the ocean water is retained in the low-pressure container leaving nearly pure water (33: NP).

Hybrid systems

Hybrid systems use features from both closed-cycle and open-cycle systems. As in the open-cycle method, warm ocean water is drawn into a vacuumed chamber and flash evaporated into steam. Then as in the closed-cycle method, a lower boiling point liquid is vaporized by the steam, which turns the turbine-generator creating electric power (33: NP).

Solar Energy

Solar Energy is the most feasible energy source as it is nearly ubiquitous and thereby available in developing countries. Each year the sun radiates 10,000 times the power necessary to meet all our energy requirements on Earth yet only one percent of US electrical output is generated by solar power (28: 22). There are a number of ways to use solar energy. Photovoltaic (light-electricity) cells have the greatest potential by using semiconductor material to produce electric power directly from sunlight. Concentrating Solar Systems produce electricity from the sun's heat. Solar Heat uses passive and active means to heat water and air in buildings. Solar Lightening provides illumination through the collection of focused sunlight into fiber optics.

Photovoltaic

Photovoltaic (PV) cells are more commonly known as solar cells, are used in many products today from calculators, outdoor lights and water pumps to satellites and the Sojourner vehicle on Mars. One PV cell supplies about 1 to 2 watts of power (33: NP).

Connecting PV cells like Legos to make modules and connecting modules to make arrays, this in turn can be connected to create a PV system, further increases that wattage to meet almost any electrical PV application. PV systems can power direct current (dc) or alternating current (ac) electrical needs with minimal energy lost in the dc to ac conversion through an inverter. The PV batteries that are the size of a regular ICE car battery, can store electricity when it is not used and draw energy from it when the sun is obscured. Because weather (to include snow or hail) has rather negligible impact on PV cell's performance, they are ideal for use by the Army (33: NP).

The Army can use PV systems not only to provide quiet and pollutant free energy on our facilities and remote operation sites, but also in many of our vehicles. These fossil-fuel less, fumeless, and quiet vehicles can be plugged into PV buildings, PV generators or PV systems to be recharged. These PV power plants have a secondary use as cover for motor pools, parking areas, playgrounds and recreation areas. Furthermore, the PV systems on our facilities can be connected to the local utility power grid to allow any of our excess electrical production to be either sold or given back to the grid providing energy for lower income families. Just as with the fuel-cell, the Army's extensive use of PV will make possible the reduction in cost of PV production and further development.

Concentrating Solar Power

Concentrating Solar Power (CSP) concentrate the sun's heat energy by using reflective devises or material to produce electricity. Mirrors are used to concentrate or focus energy from the sun and convert it to heat that is then channeled to a generator. Currently, over 350 megawatts (MW) of energy is provided by CSP plants in the U. S.

CSPs can also be made as small as a 10-kilowatt (KW) generator or as a 100 MW plant and future plants may produce 400 MW (33: NP). CSP systems can accumulate energy in thermal storage to provide power when the sun isn't shining. CSP differs from other solar technologies in the way they capture solar energy. Other solar systems use sunlight directly to produce heat or electricity, whereas CSP uses the sun's heat to create steam to drive a generator to create electricity (33: NP). Just as with PV, the Army can use CSP systems to meet some energy needs.

Solar heating

Solar heating uses passive (without additional mechanical support) or active heating (uses collectors and a pump). Passive solar heating can be accomplished through placing windows facing southerly and using heat absorbing material or heating water directly in the sun. As soldiers in the field place black water cans in the sun to have a "solar shower". Active solar heating amplifies the power of the sun using a collector and pump. This process can generate more heat for water and air than passive heating. There are at least four types of collectors that absorb light energy and convert it to heat energy, which heats water and air, more than just by passive solar (33: NP). The Army can use passive heating principles in its positioning of windows and buildings and can use active heating to replace conventional water heaters and to heat installation swimming pools.

Solar lighting

Solar lighting uses direct sunlight collected from lens, reflective pipes or fiber optics to provide interior lighting. Roof mounted concentrators pull together sunlight and send full-spectrum light through optic fibers into the building. Full-spectrum sunlight is healthier than incandescent or florescent lighting and studies have indicated increased productivity as a result. A new technology is the Hybrid Solar Lighting (HSL) that uses sunlight to illuminate interiors and provide electric energy. This could have profound energy savings since lightening accounts for about a third of all commercial electric power in the U. S. (33: NP). As mentioned in the discussion on green buildings in the conservation chapter, the Army can relatively inexpensively reduce the lighting cost by using solar lighting with the use of solar tubes with reflective pipes or fiber optics.

Wind Energy

Wind turbines harness the energy on towers usually 100 feet or higher above the ground where the winds are steadier and faster. Rotating blades turn the shaft that spins a generator to create electricity. The wind turbines thus convert kinetic energy into mechanical power. Because air movement fuels it, wind turbines do not create pollution and of course wind is a renewable source that is relatively abundant in much of the U.S. Wind energy currently produces about 1,700 megawatts (MW) of power in the U.S primarily from California. On average, wind energy is cheap at 4 to 6 cents a kilowatt-hour (kWh) compared to the average price of electricity in the U.S. at 7.42 cents a kWh (13: NP). Like solar devices, wind turbines can be placed in remote areas as stand-alone units. These units can do explicit duties such as pumping water, grinding grain or power telecommunications dishes. Like solar devices, wind turbines can be combined and connected to an electric grid. Unlike solar devices, the rotating blades do produce some noise, can be more obtrusive and can pose a risk to birds. However, with proper placement and some technological improvements, they can be quieted and less hazardous to birds. Applications for the Army are that larger wind turbines can be place on more remote areas of our larger installations-away from parachute drop zones! Smaller wind turbines can be used in conjunction with PV systems and batteries as in the MPS discussed under micropower and distributed energy.

Nanotechnology

Nanotechnology is the ability to manipulate matter at the molecular level of one billionth of a meter or one nanometer. Nanotechnology is relatively nascent and therefore its applications are under development at this time. However, Konarka Technologies has received a contract from DARPA for research and development for new materials for photovoltaic cells. Konarka developed a new solar cell that is lighter weight, suppler, and more versatile than previous generation solar cells. Their hybrid photovoltaic cells intersect dye-sensitized cells with polymer cells that have an efficiency of greater than 20 percent conversion of light to electricity. Current thin film solar cells efficiency ratings are 15 percent. Konarka's photovoltaic nanotechnology has vast applications for the Army through providing power to the individual soldier, unmanned vehicles, and sensor networks (19: NP).

At the University of Toronto, researches have made particles that are only a few nanometers in size from semiconductor crystals that can be suspended in solvents similar to particles in paint. These small nanocrystals can catch infrared light and be painted onto surfaces to absorb solar energy and convert it to electricity at five times the efficiency of current materials (3: NP). One possible application for this technology is incorporating the material into a soldier's uniform allowing them to recharge wireless devises (cell phone, PDA, and GPS)

Using some, all, or a combination of the renewable energies discussed in this chapter will further facilitate the Army's meeting the six goals of The Army Strategy for the

Environment. Expressly: Foster a Sustainability Ethic by embracing the fact that current energy resources are exhaustible and substituting them for renewable resources; Strengthen Army Operations by reducing unhealthy heat, noise, and waste emissions and decreasing our logistical tail; Meet Test, Training, and Mission Requirements by sustaining the land, water, and air at our training sites; Minimize Impacts and Total Ownership Costs through the use of on site domestic renewable energy; Enhance Well-being by sustaining our natural resources and protecting human health through the use of clean and less raw material intensive renewable energy; Drive Innovation by accelerating the transfer of fossil fuel to renewable energy technology to meet present and future requirements.

Chapter 5

Conclusions

This paper demonstrates the need for an Army Energy Strategy that supports the new Army Strategy for the Environment six goals. This analysis indicates that currently the Army has an energy program that is insular, fragmented and needs an integrated approach. This is not to say that the Army is not already making an effort toward conserving energy and using renewable energy in a number of sites and areas. However, because of the Army's limited resources, it needs to make a concerted effort to focus and prioritize against the Army's Strategy for the Environment until it is expanded into our everyday life and on every Army installation and operation. Just as it is not advisable to put all of ones money into one stock or only into a savings account, it is not advisable to depend on only one source of energy or conservation of energy alone.

Whether one wants to argue the validity or dubiousness of fossil fuel combustion's contribution to global warming or climate change, there are a variety of other compelling reasons to reduce and eliminate our need for fossil fuel. The cost benefits of energy conservation and use of renewable energy are vast and have profound and numerous positive repercussions to our quality of life. Our national security, health, economy, and environment are all affected by our use of energy making it imperative that we take every possible action to ameliorate our energy policies and usage. As the Army is a defender of freedom, it in turn also defends our quality of life. This is why the Army should be at the vanguard of an energy transition to renewable energy and restorative conservation.

The Army's large procurement requirements can facilitate driving innovation, raising standards and reducing cost. Those we contract with will need to comply with our energy standards and consequently drive costs down through economies of production so that the public and private sectors can afford renewable energy.

Another invaluable upshot of the Army becoming an Environmental Paragon will be a favorable public perception and acceptance of the Army as an integral member of the community leading to greater access to training sites. A win-win situation!

> "History will judge harshly those who saw this coming danger but failed to act. In the new world we have entered, the only path to peace and security is the path to action."
>
> (President George W. Bush, September 17, 2002).

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