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Mineral Resource

Renewable Energy - Pros and Cons

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Although there is considerable debate as to the causes of global warming, it is clear that there has been an increase in the overall temperature in the environment of our planet over the past few decades. It is accepted by some that one of the contributing factors to this climate change is the increase in the carbon in the atmosphere. Much of this is in the form of carbon dioxide (CO_2) emissions from a variety of sources. The use of fossil fuels in the production of electricity has been blamed for a portion of this contaminant. This has led to a campaign for the development of "clean energy." The United States' dependence on foreign oil has been another motivation. Some strategies suggested for Arizona are discussed below.

Solar

Solar power refers to electricity generated from solar energy. Although the uppermost layers of the earth's atmosphere receive 174 petawatts (Pw) of incoming solar radiation (insolation), 6% of it is reflected back and 16% is absorbed during its passage through the air. Because of clouds, dust, and particulate material, about 20% of the remaining insolation is reflected and another 3% is absorbed. However, there is still more than enough that reaches the earth's surface compared to that used by mankind. The average daily solar insolation density is 3-7 kwh/m^2 for the contiguous United States. For Arizona cities this figure varies from 5.5 to 7.5, with an average of around 6.5.

One common method of converting solar light to electricity is with photovoltaic cells, often referred to as solar cells. The first photovoltaic cells (PV) were invented by Charles Fritts in 1883 and made of selenium. These were only 1% efficient. Gradual progress in the production and efficiency of PVs has been made over the years, with a special impetus provided by the oil embargo of 1973. The manufacturing costs have fallen from $100 per watt in 1970 to around $3-$4 per watt at this time. Efficiencies have also increased to about 10% and are expected to reach 14% or 15% in the next few years. These improvements will make the cost of PV electricity more competitive with conventionally-produced power. According to Solarbuzz, an industry website, the costs for residential energy in May 2008 is 37.61 cents per kilowatt-hour (kwh), for commercial use it is 27.33 cents/kwh, and for industrial plants 21.29 cents/kwh. These do not compare favorably with the 8-10 cents/kwh that is available from conventional fuels (coal, oil or natural gas; nuclear power costs 3-4 cents/kwh to generate).

Geotech Ltd. flies a VTEM survey for Quaterra on the Arizona Strip uranium project. Courtesy: Quaterra Resources

Blind Discovery! In April, Quaterra Resources announced the discovery of a 'hidden' breccia pipe with significant uranium mineralization using an airborne time-domain electromagnetic system (VTEM). This was the first VTEM geophysical anomaly tested by drilling of their Arizona Strip Project.

The company contracted with Geotech Ltd. to conduct widespread airborne time-domain electromagnetic system exploration to identify mineralized collapse structures in early 2007. The VTEM system has identified anomalies related to collapse structures in a majority of the known breccia pipes as well as 200 additional anomalies with similar geophysical signature.

The discovery, called the A-1 pipe, is considered a hidden pipe because the throat is not present at the surface. The discovery hole intercepted a thickness of 57 feet averaging 0.33 percent U_3O_8 at a depth of 1,034 feet. The intercept includes a higher grade interval of 28 feet averaging 0.58 percent.

The hidden pipe is the first new mineralized breccia pipe identified on the Arizona Strip in more than 18 years. The VTEM is proving to be a successful breccia pipe exploration tool for Quaterra.

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One of the advantages claimed for PV cells is that they could be installed on individual houses. These generate direct current (DC) which would have to be converted to alternating current (AC) for connection to the existing grid, with the use of a tie inverter. Since solar light is not available at night or is reduced on cloudy days storage devices are required if the system is not tied into the grid. Currently there are financial incentives available from government and private sources for installation of this technology. However, if a residential fire burns a solar panel, the occupants and neighbors could be at risk for exposure to toxic vapors and smoke.

The manufacture of photovoltaic panels entails highly toxic heavy metals, gases, and solvents that are carcinogenic, although newer designs are less toxic. Several flammable substances and hazardous chemicals go into panel production; some of the gases are lethal while others are explosive. Few plants have scrubbers to control inadvertent releases, so the plant employees should be protected. Considerable health impacts would occur if an industrial fire were to occur. Disposal in special toxic waste dumps would be required after the 20-30 years of useful life of panels, when they are decommissioned. If incinerated, the heavy metals – such as cadmium and lead based solder – would partially vaporize into the surrounding air; the ash would be dispatched to a controlled landfill. In municipal landfills the heavy metals, for example arsenic and lead, could leach into the soil and water. Solar farms designed to generate 1,000 megawatts (Mw) would cover 50 square miles of land, so an accident could pose a significant hazard and prove difficult and costly to control. Decommissioning the plant could also be a major effort and expense; under current law no bonding is required. One company in Tempe recycles the panels when their useful life is over, and attests to no deleterious health effects in the event of a fire; its employees are regularly examined medically.

The Solana Generating Station envisioned to be built near Gila Bend is to be constructed by Abengoa, a Spanish company. The system will use solar heat instead of light and spread over 1,920 acres. The company will spend $1 billion in building the 280-megawatt (Mw) plant; it will be paid $4 billion over 30 years by Arizona Power Services (APS), into whose grid the system will be linked. This operation will only be constructed if the federal solar tax credit is available.

Recently it has been suggested that by 2050 solar power for the entire nation could be generated in the Southwest and then transmitted throughout the land. Energy storage would be provided by compressed air. It is asserted that this would end dependence on foreign oil and slash greenhouse gases.

Wind

Wind energy can be converted into electrical power with the use of turbines. This is non-polluting and gaining acceptance among a number of communities. At the current time about 1% of the world's electricity, over 94 gigawatts (Gw), is produced by wind. Denmark generates 19% of its power from this source. One of their turbines exploded recently. There are no wind farms in Arizona at present, although some are being considered – one is in the Navajo Nation, near Gray Mountain, another is planned near Bisbee. Some individuals have installed wind turbines, and Northern Arizona University is considering one. A residential installation of two 33-foot tall turbines has resulted in the Bullhead City council passing a law imposing restrictions. Many cities across the nation have codes that are barriers to the erection of wind turbines and getting permits for them is onerous. Often neighbors object to the aesthetics and the noise. Wind turbines are more acceptable in rural areas.

Winds are intermittent, so the electricity generated can be very variable – throughout the day, from day to day, and seasonally. Winds may fail during heat waves, as was the case in California during the summer of 2006, when the capacity plunged from 33% to 4% at a time of peak demand. The power generated cannot be readily stored. It is necessary to maintain a balance between the electricity generated and its consumption; this presents significant challenges if large amounts of wind power are connected to the grid system. If the generation is high, energy demand management and even load shedding may be required. Alternatively, storage mechanisms have to be provided. If wind penetration levels are low, then provision needs to be made for load fluctuation and regulation of variable generation.

A 1,000-Mw wind farm may occupy 200 to 300 square miles of land, but ardent advocates of wind power have a motto: "It's not the vista, it's the vision." Arizona has the capability to produce 1090 Mw of power and ranks 30th in the U.S. with regard to potential capacity.

The Altamont Pass Wind Resource Area in California's eastern Alameda and Contra Costa Counties, which covers 50, 000 acres and has 5,000 turbines, is the largest wind farm in the United States to date and serves as a poster for how the farm should not be sited or designed. It lies on a major migratory route for a large numbers of birds and has be referred to as a "condor Cusinart" and "raptor-matics." It is estimated that 1,700 to 4,700 birds are killed here annually. A settlement reached between the environmental groups and the power generator in January 2007 does not seem to be effective. Wind farms at Mountaineer Wind Energy Center, West Virginia and near Meyersdale, Pennsylvania where the hundreds of bat carcasses found with "battered wings and bloodied faces" have created tremendous concern.

The birds not only die from collisions with turbine blades and structures but also from electrocution by the overhead electrical wires. The Audubon Society claims that there is reduced breeding productivity or decreased survival because of dislocation from the preferred habitat. Additionally, wind farms serve as blockades to movement that disturbs links between feeding, wintering, breeding, and molting areas.

Much has been learned from the various studies that have been conducted at these sites. Collaboration between

the wind industry, the environmental community, wildlife biologists, state departments of fish and wildlife, and other interested parties can develop guidelines that address impacts on wildlife and habitats of particular concern at a site. Based on this information, as well as surveys conducted at the location, wind developers could obtain land to mitigate the habitat around the project through a conservation easement. This approach instigates potential developers to build on "fragmented" lands rather than more pristine areas, which are preferred by the conservation community. Lack of transmission capacity may pose another challenge to wind farms.

Since Arizona is the largest copper producing state in the United States it is of interest to note that electricity from wind farms requires 4.5 times the amount of copper than a traditional power plant for per Mw. There is a manufacturer of windmills located in Flagstaff that caters primarily to smaller installations.

Geothermal

As the name implies, geothermal energy is obtained from the heat of the earth. The heat is derived from the radioactive decay or deformational movement within the earth. If the temperature of the water is above 150°C (302°F), it is feasible to generate electricity from it. There are no geothermal power operations in Arizona, but some plants exist in the Imperial Valley in California, west of Yuma. Opportunities to use geothermal waters in Arizona are quite limited, but some sources are known – Buckhorn Baths in Apache Junction, Castle Hot Springs in the Bradshaw Mountains, and Childs on the Verde River. The highest temperature springs (70-82°C, that is 158-180°F) are at Clifton and Gillard in the Clifton-Morenci region. Temperatures at depth get up to 140°C (284°F), but these sites are only appropriate for low-grade steam. Recently, some researchers have correlated $^{3}He/^{4}He$ ratios in the Basin and Range physiographic province in the western United States to high potential for geothermal energy development. This finding may facilitate locating new sites.

Biofuels

Vehicle emissions are another source of carbon in the atmosphere. Efforts are underway to develop fuels that are less harmful to the environment and would reduce dependence on imported oil. Aircraft emissions are a similar concern.

Although the recent rise in the prices of food are primarily related to the increases in charges for oil and natural gas, which affect transportation and fertilizer costs, the use of corn for the production of ethanol is also a factor. Subsidies for ethanol production have led to 28% of the corn grown being used. In spite of the drumbeat for globalization, the U.S. has imposed a tariff of 54 cents/gallon of ethanol on Brazilian imports and provided 51 cents/gallon to producers in the U.S. Some of the land used for soybeans has now been converted to growing corn. Costs for animal feed have risen. Use of corn-stalks and agricultural waste for making of ethanol deny the land of nutrient-rich humus. To date there is one plant that makes ethanol from corn in Arizona, near Maricopa.

Development and use of alternative fuels is a noble goal, but other means of achieving this goal should be emphasized. Production of cellulosic ethanol may still be a couple of years away, although this is being considered. Cellulosic ethanol is made from non-food substances such as agricultural wastes (for example, corn stover and cereal straws), industrial waste (saw dust, paper pulp), or energy crops like switchgrass. Although cellulosic ethanol requires a complex refining process, it contains more net energy and produces less greenhouse gases than corn-based ethanol. The US Department of Energy (DOE) is spending $33.8 million over a 4-year period to develop improved enzyme systems to convert cellulosic materials into sugars that can be used for making biofuels. In addition, DOE is funding small-scale biorefineries to investigate new, novel refining processes.

Production of oils from algae is being diligently pursued. Some methods expose the algae to sunlight so that they produce sugar using photosynthesis. This has the added advantage that it absorbs CO_2 from the atmosphere during growth. These algae are grown in ponds or bioreactors placed in the sun. Other techniques use darkness to grow the algae, without photosynthesis, but feed them sugar. When biomass is broken down into sugars it may contain lignin or other substances that poison other microorganisms; the lignin needs to be removed to keep them healthy. Some Arizona companies are investigating algae-based fuel production. One firm has developed algae that are fed directly to a power plant, replacing natural gas. A Phoenix jet engine manufacturer has formed a consortium to make jet fuel from algae and jatropha. The use of bacteria for production of diesel fuel is being investigated.

Waste oils and fats from potato frying plants and restaurants can be used as renewable fuel resources. They can be converted into biodiesel, but this may entail the use of toxic or caustic materials. This implies there could be impediments to the disposal of the resulting refuse. Two companies in the State, one in Arlington and the other in Chandler, make biodiesel commercially. Alternatively, the vegetable oils or rendered animal fats may be used in relatively unmodified form. This eliminates the problems associated with chemical disposal. However, some modifications to engines may be required.

Large amounts of land are required for biofuel production. Compared to about one-third of a square mile needed to site a traditional 1,000-Mw power plant (oil, natural gas, coal, or nuclear), bio-alcohol takes 6,200 square miles for cornfields, bio-oil occupies 9,000 square miles of rapeseed fields, and bio-mass from wood 12,000 square miles.

Conclusion

In the effort to generate "green energy" it is our obligation to take a holistic approach and ascertain the total amount of energy consumed to attain that end. Besides, the societal effects should be considered, so that we do not have unintended consequences which are undesirable. That is the true nature of sustainable development.

Scanning Support Sought

The Department will soon begin scanning a recently-donated, extensive collection of exploration data. Companies or individuals are invited to participate in this project, and receive early copies of the scanned files, by making a donation of $2500. If interested, please contact Nyal Niemuth at 602-771-1604 or njn22r@hotmail.com.

New Circular Released

Arizona Mining Update—2007, Circular 129, by Nyal Niemuth has been released and is available at the Mining Information Center or as a download at our website.
The circular is an overview of exploration and mining in Arizona for last year, with production charts, company activity, and commodity reviews covering copper, uranium, and industrial minerals.

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