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Energy Crisis: A Review

Swati Pathak*
*Department of Biotechnology, Sapthagiri College of Engineering, Bangalore-560057

ABSTRACT
The impending energy crisis and climate change concerns coupled with the mounting oil prices and the depleting fossil fuel sources, have grabbed significant attention from around the globe toward the establishment of environment friendly, renewable, carbon-neutral alternative fuels to fulfil the growing energy demands. Bioenergy derived from the micro-organisms is of great interest in the present world's energy scenario due to its renewability. Fuel cells and batteries powered by various sources such as blood, urine, bacteria, viruses, mitochondria have been discussed herein. Energy from biomass and derived fuels like biodiesel, which is a promising candidate to replace fossil fuels as the primary transport energy source may also lead to an era of economic bloom and prosperity of the society. The batteries and fuels discussed in the composition could be the next-generation fuels and a breakthrough to a less polluted, better, greener society, the way we all dream our world to be!
Keywords:Alternative fuels, biodiesel, bioenergy, fossil fuels, renewability.

I. INTRODUCTION

The energy crisis is spinning out of control,at the same time the world is faced with a major development crisis; the world population is expected to reach 9.6 billion by 2050, [1]majority of whom will lead a life of poverty, sans energy resourcesif we fail to alter our current path of development.

Economic growth, industrial civilisation and lifestyle of the developed world are dependent on the energy extracted by oil and gas supplies. Affordable food production by industrial agriculture requires inexpensive natural gas and oil supplies for; fertilisers, pesticides, industrial machinery planting, cultivating, harvesting, processing, packaging, transportation and marketing. The products and energy from cheap oil have made the major changes in the global industrial civilisation in the last century possible, including its huge impact on indigenous cultures and planetary ecosystems.[2]

High standards of living correspond to an increased consumption of fossil fuels. There has been a dramatic increase in the use of energy in many developed nations where people's lives are driven by fossil fuels.

Concerns about a global energy crisis also raise doubts on available amounts of oil and gas that can actually be recovered.The non-renewable resources i.e. Coal, natural gas and oil produced million years ago is all that the world has now as new resources aren't being created now**Figure 1**. Ultimately, the world would run out of those supplies too, though how far in the future would that occur has been disputed vigorously.

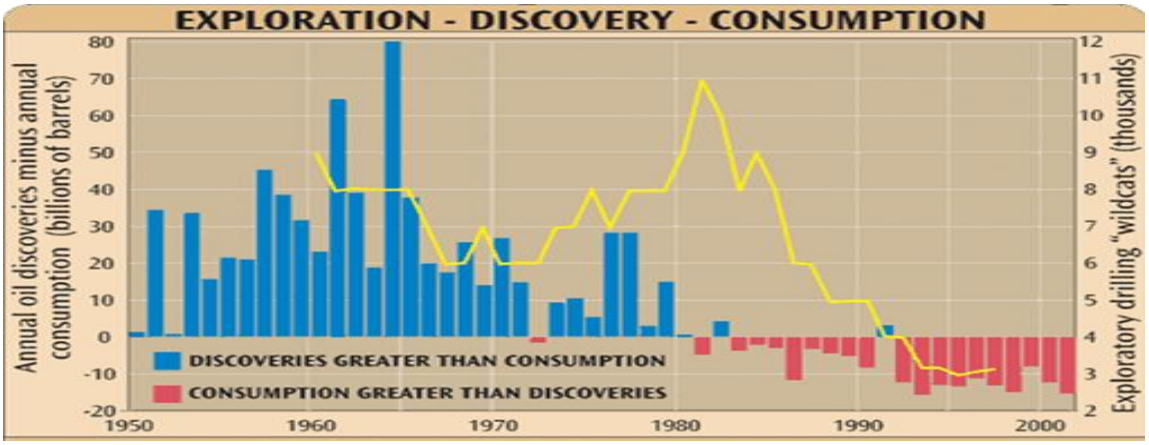
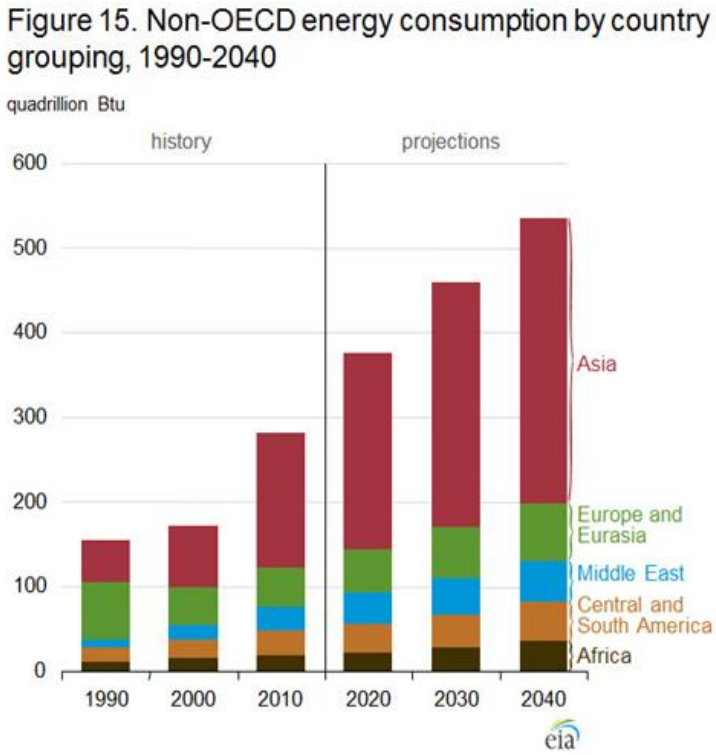


Figure 1THE EXXPLORATION-DISCOVERY-CONSUMTION RELATIONSHIP [2]

For those, who believe that peak energy exists, the challenge is to find ways of conserving the energy supplies at present, so as to possibly delay the upcoming peak oil-gas-fuel age and find alternative energy sources that can replace fossils. For such people, it is crucial to explore the renewable options presented by solar, wind, geothermal, nuclear powers and also biofuels. This challenge is discussed further in this composition. [3, pp. 16,65]

We rely on fossil fuels for approximately **85%** of our energy needs today. [4]Also, as powerful economies bloom in India and China, the energy demands are only rising, every day. **Figure 2**Thus, discovering new ways to reshape the economy is crucial which includes finding ways to economically and effectively replace carbon-emitting energy with carbon-free energy. It would hence take decades to rearrange and re-establish our industries, power grids and lives to the new energy sources.



"It is ironical that our dream to move to a fossil-free world will take a considerable amount of petroleum to get there." [3, p. 134]

Figure 2 Non-OECD energy consumption by countries[5]

ENERGY CRISIS?

One kind of crisis refers to the world's growing need for energy with its ever-growing population.

The other is ethical. Since we want a healthy, eco-friendly '**green-energy**' source, but almost all the available sources have some kind of negatives attached to them. Hydro keeps the air clean but is obstreperous to the marine life and the communities residing on the banks of the water body.

Nuclear power is clean as well but it gives out nuclear waste and can be hazardous during mishaps (witnessed in Chernobyl and Fukuyama already). Wind and Solarpowers are the cleanest with the least negatives but are less efficient i.e. large input is required for a comparatively small amount of power output. To reach the Renewable energy levels being projected in many scenarios over future decades will require integration of Renewable Energy technologies at a higher rate of deployment than at present in each of the electricity generation, heating/ cooling, gas and liquid fuel distribution, and autonomous energy supply systems.

II. BIOLOGICAL FUELS, CELLS AND BATTERIES

Biological fuel cell and batteries have been grabbing a lot of interest since these help in environmental treatment, harnessing energy and act as small-scale power sources. These cells can produce power in the very same manner as the regular chemical fuel-cells.

The small, flexible, long-lasting and environmentally friendly bio-battery technology

shows researchers great possibilities, especially for the field of medicine. With that in mind, scientists seem to be exploring every possible option in bio-battery and fuel-cell technology.

Many researchunits are competing to produce feasible bio batteries that can bepowered off of organic compounds, especially human fluids.

III. TYPES OF BIO-BATTERIES AND CELLS

3.1 BATTERIES POWERED BY BLOOD SOURCE

Scientists at the Rensselaer Polytechnique Institute (RPI) have created a paper thin battery, 90% of which is made up of **cellulose**, a source of traditional paper and other paper products, while the other 10% comprises of **aligned carbon nanotubes** that provide the black colour of the battery along with the conductance. The nanotubes are essentially imprinted in the fabric of the paper creating a **Nanocomposite** paper, thus giving it the same feel and weight as that of paper.

The battery could run on **human blood** and sweat, providing it with a replenishing electrolyte source and ideal for medical applications. While implanted on the body it would run as long as you eat and when using it away from the body it could run on an **ionic fluid** (salt in liquid form) like tears, urine or even sweat, that provides the electrolytes.

The battery's paper-like structure makes it very **flexible**. The nanocomposite paper can have holes poked in it or be cut into unusual shapes and continueto function. They can even be printed on long sheets while several sheets of it can be stacked together to power the medical implants such as a pacemaker or artificial hearts.

The battery can be employed on a wide range of temperature ranging from **100-300 degrees Fahrenheit** since the ionic liquid fuel doesn't freeze or evaporate. The battery is considered to be eco-friendly due to the lack of chemicals and high cellulose content used. The device is unique since it can both act as a high energy battery or **supercapacitor**.[6]

3.2 BATTERIESUSINGCLEANELECTRICITY FROMBACTERIA

Figure 3Shewanella oneidensis bacteria[7]

ShewanellaoneidensisFigure 3is descendant of a family of marine bacteria. Theresearch shows that the bacteria to lie directly on the surface of a metal or mineral and transfer electrical charge through their cell membranes. This means that it is possible toleash thebacteria directly to electrodes getting the scientists a step closer to creating efficient**microbial fuel cells**or "bio-batteries."

The researchers created a synthetic version of this bacteria comprising only of the proteins that would help in the transfer of electrons from the microbe to the rock. The research shows that the these proteins can directly 'touch' the metal surface and produce an electric current, which means that the bacteria can lie on the surface of a metal or mineral and conduct through the cell membrane.

These bacteria can be potential microbial fuel cells where electricity could be generated with the breakdown of agricultural or domestic wastes. Another option would be to use these bacteria as mini power-grids on the surface ofan electrode, where chemical reactions occur inside the cell using power supplied by the electrode through these proteins.

This was a great system developed to mimic the regular electron transfer in cell that could help us understand how the bacteria controls the Carbon-cycle in a better way, as when iron is used as a power source the carbon dioxide is incorporated by the microbe as food. It also gives us an insight as to how the components of a bacterial cell membrane are able to interact with different substances.[7](*White et al, 2013)*

3.3 BIO-BATTERY POWEREDBY MITOCHONDRIA

Mitochondria or the **powerhouse of the cell** has now been harnessed in a battery like device that can turn pyruvate and fatty acids, that are obtained by the digestion of fats and sugars into Adenosine triphosphate (**ATP**) that accounts for the cell's energy supplies. **Pyruvate** is the initial product of the Krebs's cycle while ATP being the end product. **Shelley Minteer** and her team from the US have invented a bio-battery that can integrate the whole mitochondria that produces the small power in the above discussed manner.

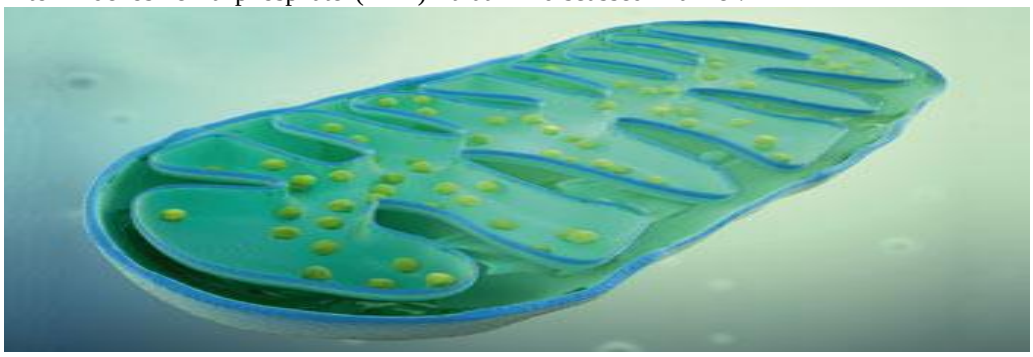


Figure 4 Mitochondria [9]

Similar to traditional batteries, these consists of two electrodes, the cathode holds the conversion of Oxygen to water while the anode stocks the immobilised mitochondria.The battery is completely renewable and biodegradable, and is stable at room temperature and a neutral pH for up to 60 days. Further research is still going on for increasing the surface area and the load density of the mitochondria as well as to make the battery size as compact as possible for commercialisation.[9]

3.4 BATTERY POWERED BY VIRUSES

In a conventional lithium-ion battery, lithium ions flow between a negatively charged anode, graphite, and the positively charged cathode, usually cobalt oxide or lithium iron phosphate. In 2006, Angela M. Belcher and her team from MIT, US had engineered**M13 viruses** that could build an anode by coating themselves with cobalt oxide and gold and self-assembling to form a nanowire. While in 2009, they genetically engineered **M13 viruses** that could first coat themselves with Iron phosphate then grip carbon nanotubes to form a network of highly reactive material. Combining carbon tubes increases the cathode's conductance without increasing the battery weight much.

These batteries were found to have fewer charge cycles as compared to the present Lithium-ion batteries, i.e. they do not lose their capacitance up to 100 charge-discharge cycles. The technology is yet to go commercial since the research team is working on even better batteries using materials with higher voltage and capacitance, such as manganese phosphate and nickel phosphate.[10]

ADVANTAGES OF BIO-BATTERIES

1. They are**light-weight**, compact and portable.
2. These little bags of energy can be instantly and **easily charged**without any external power source.
3. Run on easily **accessible fuels** such as sugar, blood, alcohol, ethanol etc.
4. They can operate at room temperature.
5. Bio-batteries are **non-toxic** since they lack the use of harmful chemicals.
6. Bio-batteries are **cheaper** than fuel cells that operate on expensive metals like platinum, etc. (*See also*[11])

3.5 ENERGY FROM BIOMASS

The term "**biomass**" refers to organic matter that has stored energy through the process of photosynthesis. Biomass power is sourced from plants – crop and forest residues, corn stalks and kernels, energy crops, virgin wood, perennial grasses, and fast-growing trees like poplars, etc. It can either serve as a source for obtaining liquid fuels that can replace oil or for heat or electricity production for daily needs.

Biomass energy can either be a boon or a bane depending on how and where is it produced. It can be produced both in ways to reduce global warming or add to it. It can either account for the environmental treatment or degrade our lands and water, threaten biodiversity and also affect human health. The challenge today is to produce energy in such a way that it reduces global warming, protects the environment

and serves as a better alternative compared to the fossil fuel that it replaces.

Today's biomass energy comes from annual row crops, like corn and soybeans, agricultural wastes, like rice husks, pressed sugar cane, wood, whole trees, forests - a highly controversial source of biomass. Researchers are developing ways to produce energy from efficient, fast- growing, and higher-yielding "energy crops" such as willow, miscanthus, andswitch grass.The waste can be treated to produce energy in the following ways

1. **Burning** the biomass in power-plants which gives out lesser harmful emissions when compared to coal.
2. Biomass can also be subjected to **enzymatic digestion** that gives out methane gas which in turn can be used to generate power.
3. Biomass can be **fermented** to produce fuels like ethanol that in turn can be used as fuel for vehicles.
4. **Heated** under special conditions, or subject to **gasification** to break down into a mix of gases that can be burned for electricity production or used to make a range of products, from diesel to gasoline to chemicals, etc.

The use of biomass energy has the potential to greatly reduce our greenhouse gas emissions. Biomass generates about the same amount of carbon dioxide as fossil fuels, but every time a new plant grows, carbon dioxide is essentially removed from the atmosphere. The net emission of carbon dioxide will be zero as long as plants continue to be replenished for biomass energy purposes. These energy crops, such as fast-growing trees and grasses, are called **biomassfeedstocks**. The useof biomass feedstocks can also help increase profits for the agricultural industry.

One example of "clean" energy is **Carbo-hydrogen gas** produced from **gasification**.**David Wallman** has patented this process for producing COH_2 from a high voltage discharge through any biomass solution. This gas burns clean, producing water vapour and only the amount of CO_2 that was initially absorbed by the biomass while growing in the ground.

According to Flavin and Lenssen of the Worldwatch Institute , "If the contribution of biomass to the world energy economy is to grow, technological innovations will be needed, so that biomass can be converted to usable energy in ways that are more efficient, less polluting, and at least as economical as today's practices."

Table 1Amounts 10tons of dry, ash-free organic solid wastes produced in the United States in 1971 [12](*Thomas H. Maugh, 1972)*

SOURCE	WASTES GENERATED	READILY COLLECTIBLE
Manure	200	26.0
Urban refuse	129	71.0
Logging and wood manufacturing residues	55	5.0
Agricultural crops and food wastes	390	22.6
Industrial wastes	44	5.2
Municipal sewage solids	12	1.5
Miscellaneous	50	5.0
Total	880	136.3
Net oil potential (10 barrels)	1098	170
Net Methane potential (10 cubic feet)	8.8	1.36

IV. BIO-FUELS

4.1 Bioethanol

Bioethanol is produced by the fermentation of sugars from biomass. With crops with high sugar contents, such as sugar cane or sugarbeet, ethanol can be produced by direct fermentation. With crops that are higher in sugar-containing-materials such as cellulose orstarch, (grains of including maize or wheat and cassava) orby-productsthat contain cellulose (stovers of maize), an additional step is needed to convert cellulose or starch in sugar.

4.2 Biodiesel

Biodiesel is a clean burning fuel, that is essentially the same as petroleum diesel with lesser air polluting properties. Using biodiesel is equivalent to cycling carbon instead of releasing the stored carbon into the atmosphere. [13](*Krishna Murthy T P et al, 2013)* It is an **eco-friendly alternative fuel** that can easily be sourced from various domestic renewable resources such as animal fats and vegetable oils, both edible and non-edible. The oils that can be used for the same are rice bran oil, coconut oil, Jatropha oil, Curcas, Castor, Mahua etc.

Technically, biodiesel is **monoalkyl esters of fatty acids,** derived from vegetable oil or animal fat. These oils are essentially made up of triglycerides that are in turn very similar to the petroleum-derived diesel, hence known as **Biodiesel**. Its low carbon-content helps it beat heating oil as an alternative fuel. It is a biodegradable fuel which is safe to handle.It is non-toxic and can degrade vigorously in the environment.

The merit of biodiesel is that it can be used in any diesel engine at various ratios with negligible or no modifications. This means that biodiesel is compatible with the on-going IC-engine technology and related infrastructure.[13]

4.3 ADVANTAGES [14]

1. Essentially, is the same as petroleum derived diesel, with much reduced greenhouse emissions.
2. Biodiesel issustainable, renewable and non-toxic.
3. Biodiesel is plant-based, hence doesn't emit sulphur/CO when burnt. Thus, is biodegradable and eco-friendly.
4. Also, biodiesel is considered Carbon-neutral since the amount of carbon dioxide released during combustion is impounded back from the atmosphere for the growth of oil crops.
5. The biodiesel molecules are simple hydrocarbon chains without any aromatic rings linked in, insuring complete combustion and high efficiency of the engine.
6. It is a good lubricant.
7. It can to used in any proportion along with the petro-diesel or all by itself, it still has an excellent smooth drivability with very less smoke produced.

The on-going research in this field is on finding more suitable crop sources to outsource the fuel from, to boost the oil yield for biodiesel production.

V. CONCLUSION

Today biomass sources have come out to be more effective due to the lack of sufficient conventional fossil fuels, their sky-high prices and rising green-house emissions. Also, most of the existing oil reserves are concentrated in the Middle-east, and are eventually diminishing.

Thus, in future, alternative fuels should offer the possibilities to be consumed as the current fuels within prevailing infrastructure, to contribute in reduction of greenhouse gases, to foster the development of new technologies of the recent combustion systems and energy generetics (i.e. fuel cells), to be affordable, sustainable and should be renewable.

Bioenergy presents an rousing sustainable alternative for fossil fuels, which can secure the energy crisis and save the planet from the abrupt environmental catastrophe.Bioenergy is deemed to have the potential to provide a renewableand carbon-neutral energy through sustainable means. [15] Research in the same could be a breakthrough, and a boon to the environment, which could put an end to the worries about non-renewable and vanishing sources of energy.

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