ENERGY ECONOMICS

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What is the best definition of energy?

The most common definition of energy is the work that a certain force (gravitational, electromagnetic, etc) can do. Due to a variety of forces, energy has many different forms (gravitational, electric, heat, etc.) that can be grouped into two major categories: kinetic energy and potential energy.

FORMS OF ENERGY

Energy exists in many different forms. Examples of these are: light energy, heat energy, mechanical energy, gravitational energy, electrical energy, sound energy, chemical energy, nuclear or atomic energy and so on. Each form can be converted or changed into the other forms.

Although there are many specific types of energy, the two major forms are Kinetic Energy and Potential Energy.Kinetic energy is the energy in moving objects or mass. Examples include mechanical energy, electrical energy etc.Potential energy is any form of energy that has stored potential that can be put to future use. Examples include nuclear energy, chemical energy, etc.

Chemical energy

Chemical energy is energy stored in the bonds of chemical compounds (atoms and molecules).Chemical energy is released in a chemical reaction, often in the form of heat. For example, we use the chemical energy in fuels like wood, coal by burning them.

Electrical Energy

Electrical energy is the energy carried by moving electrons in an electric conductor. It is one of the most common and useful forms of energy. Example – Lightning. Other forms of energy are also converted to electrical energy. For example, power plants convert chemical energy stored in fuels like coal into electricity through various changes in its form.

Mechanical Energy

Mechanical energy is the energy a substance or system has because of its motion. For example machines use mechanical energy to do work.

Thermal energy

Thermal energy is the energy a substance or system has related to its temperature, i.e., the energy of moving or vibrating molecules. For example, we use the solar radiation to cook food.

Nuclear energy

Nuclear energy is the energy that is trapped inside each atom. Nuclear energy can be produced either by the fusion (combining atoms) or fission (splitting of atoms) process. The fission process is the widely used method.

Uranium is the key raw material. Uranium is mined from many places around the world. It is processed (to get enriched uranium, i.e. the radioactive isotope) into tiny pellets. These pellets are loaded into long rods that are put into the power plant's reactor. Inside the reactor of an atomic power plant, uranium atoms are split apart in controlled chain reaction. Other fissile material includes plutonium and thorium.

In a chain reaction, particles released by the splitting of the atom strike other uranium atoms and split them. The particles released by this further split other atoms in a chain process. In nuclear power plants, control rods are used to keep the splitting regulated, so that it does not occur too fast. These are called moderators.

The chain reaction gives off heat energy. This heat energy is used to boil heavy water in the core of the reactor. So, instead of burning a fuel, nuclear power plants use the energy released by the chain reaction to change the energy of atoms into heat energy. The heavy water from around the nuclear core is sent to another section of the power plant. Here it heats another set of pipes filled with water to make steam. The steam in this second set of pipes rotates a turbine to generate electricity.

WHAT IS THE IMPORTANCE OF ENERGY SOURCES

The earth provides enough to satisfy every man’s needs but not every man’s greed said Gandhiji. Hard facts on why energy conservation is a must are outlined below.We use energy faster than it can be produced - Coal, oil and natural gas - the most utilised sources take thousands of years for formation.

- Energy resources are limited - India has approximately 1% of world’s energy resources but it has 16% of world population.
- Most of the energy sources we use cannot be reused and renewed - Non renewable energy sources constitute 80% of the fuel use. It is said that our energy resources may last only for another 40 years or so.
- We save the country a lot of money when we save energy - About 75 per cent of our crude oil needs are met from imports which would cost about Rs.1, 50,000 crore a year
- We save our money when we save energy - Imagine your savings if your LPG cylinder comes for an extra week or there is a cut in your electricity bills
- We save our energy when we save energy - When we use fuel wood efficiently, our fuel wood requirements are lower and so is our drudgery for its collection

- Energy saved is energy generated - When we save one unit of energy, it is equivalent to 2 units of energy produced
- Save energy to reduce pollution - Energy production and use account to large proportion of air pollution and more than 83 percent of greenhouse gas emissions

NONRENEWABLE ENERGY SOURCES :-

Not all nonrenewable energy sources come from fossil fuels. Uranium forms as mineral deposits and is a nonrenewable energy source mined from underground locations that becomes fuel for use at nuclear power plants. Fossil fuels such as hydrocarbons consist of coal, crude oil, fuel oil, and natural gas formed from the carcasses of dead plants and animals. Because all these fuels don't replenish in the short term, taking eons to form, scientists consider them nonrenewable.

Renewable Energy Supplies :-

Renewable energy comes from sunlight, wind, geothermal, moving water, biomass and biofuels. Environmentalists tout the importance of renewable energy sources because they represent clean energy with a lower impact on nature. Clean energy sources also cost less: The power source is free, and it costs less to install a wind turbine or a solar array than it does to drill for oil. Wind and sun don't disappear with use, as they continually regenerate. Hydroelectric plants on dams and rivers can generate a significant amount of electricity and will continue to do so as long as water continues to flow. Other sources include fuels like ethanol. It comes from plants and the energy of heat generated by wood burning. Inventors and scientists have also found ways to generate power from the force of the waves in the ocean.

RECYCLING OF ENERGY

Top 10 Most Important Items to Recycle

- ALUMINUM. Aluminum cans are 100 percent recyclable, and they can be recycled over and over again. ...
- PET PLASTIC BOTTLES. ...
- NEWSPAPER. ...
- CORRUGATED CARDBOARD. ...
- STEEL CANS. ...
- HDPE PLASTIC BOTTLES. ...
- GLASS CONTAINERS. ...
- COMPUTERS.

Energy efficiency and pollution prevention

There is substantial evidence that human activities which are producing greenhouse gases and other air pollution are significantly affecting climate, ecosystems and public health. Energy production from fossil fuels for electricity and transportation cause approximately 80% of greenhouse gases (GHG). Minnesota 2000 Toxic Release Inventory data shows that, among reporting manufacturers, electric utilities are responsible for 85% of the total amount of mercury released to air. Fossil fuel used for transportation, the other large source of GHG, caused 9 million pounds of benzene emissions the same year. Use of fossil fuel in transportation is also the largest cause of ground level ozone, or smog, in Minnesota.

The MPCA promotes increased use of fuels and technologies which reduce or eliminate these emissions through pollution prevention; at the source of their generation. The information referenced on this page primarily focuses on key opportunities which reduce these pollutants through this means.

ENERGY ISSUES

Global Warming and Climate Change in Minnesota

On a global basis, we know that in recent years the surface of the Earth is warming. Read this introduction to the causes and effects of global , and learn what can be done.

ENERGY OFFICE

The state's Energy Division exists to ensure reliable, affordable and environmentally sound energy supplies for Minnesota's residential, industrial, commercial and small business utility consumers — now and into the future. Their web site offers resources for energy policy, reports, and educational materials for consumers.

Power for change

The energy a product uses throughout its life span is often that product's most significant environmental impact. Careful consideration should therefore be given to how much and what type of power a product will use. Experimental new uses are continually being found for fuel cells because of their high efficiency. With the decrease in power requirements of portable consumer electronics comes the opportunity to use "human" or "self-power" from hand-wound springs or from electricity created by compressing a crystal. |

ENERGY EFFICIENCY

This nonprofit organization is dedicated to advancing energy efficiency as a means of promoting both economic prosperity and environmental protection. Energy efficiency information on buildings, utilities, industry and transportation.

This program of the DOE Industrial Technologies Program works with industry to identify plant-wide opportunities for energy savings and process efficiency. It includes best practices and equipment for energy efficient motors, air compressors, pumps and steam.

The Energy Star web site lists energy-efficient products in many categories for consumers, offices and buildings. Rebates are frequently available from local electrical service providers.

An online resource for questions and products for consumers, builders, business and communities.

Vehicle fuels

Fuel Economy

U.S. Department of Energy resource which provides mileage ratings for cars, SUVs, light trucks and vans.This program supports public-private partnerships that deploy alternative fuel vehicles and build supporting alternative fuel infrastructure. The site features information about local coalitions and clean corridors, alternative fuel news and events, fleet success stories, support and funding, tips for starting a coalition in your area, available alternative fuel vehicles, related links and more.

A comparison of the availability, performance, emissions and costs of conventional diesel versus conventional natural gas buses. Newer technologies, such as hybrid electric-diesel, hybrid electric-natural gas, and fuel cell buses, are also discussed. (2000)

ENERGY CRISIS CAUSES, EFFECTS AND REMEDIES

Ever since the inception of industrial revolution in Great Britain in 1760’s, the role of coal as hydrocarbon energy completely redefined its usage as an emerging energy resource in the world. The global inclination shifted its gears from general purpose applications comprising of simple hand tools and basic home-made machines to highly profiled special purpose machines.

The word ‘CRISIS’ is extracted from the Latin and Greek word ‘KRISIS’ meaning decision (to decide). According to the Merriam Webster dictionary of English, “Crisis refers to a difficult of dangerous situation that needs serious

attention". In other words, a situation that introduces specific difference between supply and demand of a product is referred to as crisis. Similarly, a situation dealing with definite difference between power supply and power demand is termed as energy crisis.

Energy sources may broadly be classified into two major categories that are: conventional energy sources and renewable energy sources. Conventional energy sources have been utilized for power generation and industrialization for centuries. These energy sources are mainly dependent on fossil fuels namely: coal, oil and natural gas.

Renewable energy sources are the ones that are inexhaustible, clean, pollution free, and environmental friendly. These energy sources include: hydro power (water energy), wind energy, geothermal energy, solar power and tidal energy. In the last decade electricity generation has drastically switched gears from conventional to renewable with regard to the associated advantages. China, European Union and the United States are key stakeholders in this run chase.

Energy crisis is the result of limited/narrow utilization of alternated energy sources and fossil fuel extravaganza. The planet earth is suffering from disproportionate energy mix. Owing to intemperate dependence on fossil fuels even for the next two decades, fossil fuels are subjected to depletion.

Around 41% of total electricity generation across the globe relies on coal fired power plants. Despite severe environmental threats leading to global warming via greenhouse gas effect, the share of such utilization is unparalleled in advanced countries like China, Australia and other European states. We have just witnessed 23rd International Climate Change Conference in Paris where global leaders gathered together to justify on their participation and contribute in resolving issues dealing with severe climate change. China in particular must come forward with a strategy to fight global warming as it has been declared as largest contributor to Carbon dioxide emissions according to the United Nations Organization breaching all national and international environmental standards.

In Pakistan, the coal resources are estimated to be 186 billion tons and 12 explored blocks at Tharparker, Sindh alone. According to Thar Coal and Energy Board, these blocks can carry proven reserves of 39 billion tons, however percentage of electricity generation from coal is only limited to 0.1% with heavy reliance on imported furnace oil.

The mechanical division extends to share the highest part of distributed power usage; global industry yet utilizes more than 50% delivered energy in 2040. In spite of international policies imposing regulations to limit conventional energy use worldwide, CO emanations increase ranging from 31 billion metric tons in 2010 to 36 billion metric tons in 2020 and 45 billion metric tons in 2040; a 46% increase. As reported in the International Energy Outlook, the global power consumption will rise

by 56% between 2010 and 2040. An aggregate of global power usage steps from 524 quadrillion British Thermal Units (BTUs) in 2010 to 630 quadrillion BTUs in 2020 and 820 quadrillion BTUs in 2040.

The world is yet to completely recover from the damage caused through global energy recession in 2008-2009. As this scenario seems long lasting, many unsettled financial questions increase uncertainty. In the United States and Europe alone liability matters remain mostly unfixed and is the major reason to indecision for imminent progress. Cost-effective reforms in the United States have been below average and the region's profitable well-being has sustained to falter. Japan has been recuperating from consecutive recession dilemma after the colossal earthquake hit the region in 2011. In addition to it, political instability in various African and Gulf countries has been the reason for economic instability. Political and regional changeover as a consequence to the Arab outbreaks, including Egypt, Syria and Yemen have suffered to maintain piece. Because of this, the oil prices were about 90$ per barrel to 130$ per barrel well into 2013.

The entire world today is focusing to switch their total electricity generation to renewable. This global inclination is owing to utilization of clean, alternate and reusable energy sources. Denmark has just produced 140% of its electricity needs with renewable wind power. The Scottish Government aims to generate 50% of Scotland's electrical power from renewable energy by 2015, and 100% by 2020.

The United States Energy Information Administration (EIA) crafted a report titled as, "International Energy Outlook 2013". This report states that about 11% of the world energy consumption is from renewable energy with an elevation of 15% in 2040. EIA further adds that about 21% of the global power generation was from alternate energy with a progress of nearly 25% in 2040. Clean alternate energy and nuclear power are the world's most dissolute energy sources each increasing by 2.5% per year.

It may be analyzed that energy production is not at all in strict correspondence with energy consumption as far as distributed generation is concerned. The United States owns less than 3% of the global oil reserves and only 3.5% of gas reserves. Japan extracts majority of its energy potential from outside and so as China. As a matter of fact, the largest oil and gas reserves are found in gulf countries and Russia however these are not bulk consumers at all. This irregular resource orientation leading to unfixed supply and demand gap is the one cause of energy crisis.

In order to effectively resolve the global energy challenge, the world needs to rephrase its diplomatic interest on resource orientation, especially countries like the United States, China and Russia who have involved in brutal war engagements for oil in the past. Secondly since the fossil fuel prove to be an excellent catalyst to environmental pollution leading to global warming and ozone layer damage, therefore it necessitates to paving path to renewable energy and energy efficient systems. Moreover, "Renewable energy is now not just the most effective means of

addressing the climate crisis. Cost no longer be used as an excuse to delay action" states International Renewable Energy Agency (IRENA). "Our world has seen mounting evidence that climate change is one of our greatest global challenge. But in the 18 years since first international binding climate agreement was forged in Kyoto in 1997, clean energy solutions have also seen dramatic growth" states Solar Energy Industries Association of the United States of America.

As far as energy crisis in Pakistan are concerned, similar strategy may be adopted as in general. According to the Planning Commission/USAID, Islamabad Chamber of Commerce and Industry Report, "As of June 2013, the electricity demand stood at about 11000 MW against generation of about 8000 MW. As a result the utilities were resorting to about 10 hours of load-shedding across the country. According to the same report one of the major causes of energy crisis in Pakistan is Circular Debt. It refers to debt prevailing among different departments of the government over the power usage charges. For Example: Pakistan Electric Power Company supplies to all the government organizations but all these do no completely pay for the power they use. This implies that recovery rate is not 100%. PEPCO has to pay several independent power plants (IPPs) associated with Central Power Purchasing Agency (CPPA), but it does not get money to pay to IPPs. IPPs in turn have to pay to fuel companies to purchase fuel which they cannot pay. Therefore this is a circle of debt due to which production of IPPs suffer. The circular debt may be owing to insufficient payment by DISCOs, transmission and distribution losses, unfavorable generation mix of the GENCOs. Supply corporations are resorting to extreme power losses, owing to number of issues however power thefts and bill default by the users of electricity are standouts. Pakistan have lost RS/= 90 billion in past five years only because of energy theft and power loss. Imbalanced resource mixture with substantial dependence on gas (47.5%), Oil (30.5%), Coal (11.07%) and LPG (1.53%) is another significant factor to be taken into consideration.

Pakistan today produces merely 35% of electrical power generation via hydel energy. Presently Pakistan is generating approximately 6560 MW in contrast to 45000 MW hydro-electricity prospect. Pakistan severely requires a foolproof integrated energy planning and demand forecasting system that not only ensures proper check and balance of available energy resources but also monitors and plays effective role in shrinking the supply demand gap. Today, the Government of Pakistan's efforts to load-shedding free Pakistan must be taken into consideration. A monumental (Neelum-Jhelum) Hydro-power project comprising of 969 MW installed capacity is under construction. The project is going to be completed till March, 2018 provided its implementation continues with regards to its scheduled timeline. Multiple steam generating power plants based on Re-gasified Liquefied Natural Gas are being constructed at Bhikki (Sheikupura), Balloki (Kasur) and Haveli Bahadur Shah (Jhang) each comprising of total installed capacity of approximately 1365 MW.

In summary it may be concluded that renewable energy may implicate higher installation cost than fossil fuels but keeping in mind the alleviating environmental standards, renewable energy does not only seem a pragmatic solution but also

gateway to balanced energy mix. With exceedingly surging demands in next three decades, limited supply of energy would only bring economic demise enclosed with regional conflicts. Therefore, it is high time to search for clean and recycled form of energy to recuperate the global energy emporium.

Benefits of Energy Access

Energy can be a powerful vehicle for the provision of essential services such as education, healthcare and clean water. The time burden associated with essential tasks is an important signifier of energy-poverty yet energy technologies can reduce the disproportionate time spent by poor households on basic activities. Access to energy services can help communities meet basic needs and stimulate social, economic and environmental development.

Livelihood Benefits

Energy access has the potential to alleviate poverty through stimulating rural livelihood options. This can occur via the establishment of new energy-based industries, creating employment in manufacture, construction and maintenance. Energy access can allow households to engage in a more diverse range of income-generating activities as well as make pre-existing activities more efficient. In particular, this diversification will make rural families far less dependent on natural resources as their sole form of income. Nearly 60% of the population in low income countries rely on agriculure, forestry and fishing for their livelihoods. This figure rises to over 90% in some countries. With the necessary infrastructure to ensure sustainability, new livelihoods developed via energy access can have a huge impact on long term poverty reduction.

Health

In rural areas both directly- by powering healthcare facilities- and indirectly, by providing cleaner fuel sources and reducing debilitating labor.
The inefficient combustion of solid fuels combined with inadequate ventilation contributes to poor health in many households. These high levels of indoor air pollution often result in decreased pulmonary function, particularly amongst women and children. According to the WHO approximately 1.5 million premature deaths are attributable annually to indoor air pollution, making it the second largest environmental health risk factor in the world. Indoor air pollution is also responsible for 38 million **disability adjusted lost years (DALY)**, where one DALY represents one healthy year of life lost by an individual due to disease or adverse health conditions, which in turn has numerous impacts on income generation, livelihoods and education.

Furthermore, this dependency on biomass resources such as fuelwood and the lack of intermediary means of transportation means that increasingly large

distances are travelled with these heavy loads, often resulting in debilitating back conditions, particularly impacting women and children. This is also having widespread implications for the natural environment in vulnerable regions, with biomass fuel sources rapidly depleting, placing even greater pressure on the poor just to meet basic needs.

Clean Water

Energy based technologies can help ensure that communities have access to one of the most basic necessities, clean water, by aiding in both the distribution and purification of water supplies. 17% of the world's population do not have access to an improved water source with this value rising to over 45% in sub-Saharan Africa

This lack of a limits agricultural activity and results in easily preventable diseases, poor hygiene and inadequate sanitation. The World Health Organization found unsafe water, hygiene, and sanitation to be the world's largest environmental health risk factor annually responsible for over 1.7 million deaths. can aid in redistributing the water supply to the areas in which it is most needed whilst application of simple solar distillation techniques can improve water purity.

Education

The impacts of energy access on education are often indirect, with one linkage being to the issue of time burden. Improved energy resources can reduce the time and labor required to achieve certain tasks such as collecting fuelwood and water as well as mechanizing many activities. This in turn could lead to increased enrolment of children in schools, since their household roles are no longer as consuming. In addition, access to lighting in the home increases the time available for study and hence may impact on achievement levels. Lighting at the schools themselves can remove restrictions on school times making night classes a viable possibility or allowing schools to double as community centers in the evenings. Electrification can also affect education infrastructure through the integration of modern resources such as computers and internet access.

Requirements to Improve Energy Access

In a broad sense almost all energy investments can be considered as contributing to improved energy access. Political reforms of the energy sector reform can enhance investments in power generation and distribution and in other forms of energy which may benefit the poor. Generation and Transmission projects may form the base for rural electrification. However, most of these investments have only an indirect effect on the access rates. In a more narrow sense only those activities can be considered to target on energy access which directly reach households without modern energy services.

Many of the same elements necessary for any successful development intervention are applicable to the case of sustainable rural energy provisions. Developers should ensure that the technology itself is affordable and appropriate. Participation of the communities in question must be key at all stages and access to energy provisions and services should be equitable. In addition, local capacity

should be built in order to ensure the long term sustainability and replicability of the scheme.

Affordability

Affordability and payment mechanisms are key considerations when assessing energy interventions. The poorest households often spend a disproportionate amount of their income on energy. Amongst those earning less than $3000 annually the percentage of total household expenditure spent on energy can be as high as 12%. In most cases it is the capital costs associated with shifting to a new energy carrier or end use technology that present the greatest barrier for poorer households. To remediate this, many payment mechanisms are possible ranging from subsidies to loans to upfront payments. These mechanisms need to be tailored to the specific needs of lower income households Most still favor conventional centralized energy schemes such as fossil fuel plants or large scale hydro power. However, for the many residing in rural locations a smaller scale decentralized approach is far more likely to meet their needs. It is often particularly when combined with the relatively low energy consumption of these populations. In such situations, decentralized sources are the only feasible option. When combined with the drive for "sustainable energy" renewables become particularly attractive. i.e energy technologies which do not supply to a national grid, can take a number of forms including diesel generators, micro-hydro schemes, wind turbines and solar photovoltaic. The most suitable technology is dependent on a combination of physical, economic and social factors.

Participation

A decentralized approach to energy interventions led by local needs and contexts is important, particularly with smaller communities and rural populations. Starting with the people and not the technology can lead to improved and more widely disseminated energy technologies. Even Principle 10 of the states that "Environmental issues are best handled with the participation of all concerned citizens. Each individual should have (information) and the opportunity to participate in decision making processes." Employing a participatory approach underpins every aspect of ensuring the success of an energy project.

Appropriate Technology

Technology in itself is not the cure-all to rural development issues. In fact, installation of the same technology within different contexts can often yield contrasting results. There is no best-fit solution to energy needs, and carriers must be weighed carefully against the local situation, capabilities and preferences.

For example the initial focus should be on modernizing existing needs before introducing new services. In many rural areas the main household energy need is for cooking purposes. The chief use of electricity is for lighting, which, although important, tends to be a much lower priority amongst households. Despite this rural electrification is often higher on the agenda of many governments and international

agencies, possibly due to the relatively high profile and kudos of electrification programs compared to cooking.

Access and Equity

Access to modern energy services can potentially have a huge impact on poverty alleviation. Despite this not all energy projects have the desired effect on the communities in which they are implemented. Energy planners need to integrate social sustainability factors within projects including: the distribution of households able to access the resources; equality of access within these households; the potential marginalization of certain groups such as women, the young or old, the very poor; and the sustainability of the livelihoods promoted by energy access.

The energy needs of rural communities are not uniform. Income, cultural background, livelihood choices and family structure can all play roles in determining particular requirements and situations.Intra-household energy use is often just as dynamic as that between households and once again a comprehension of specific needs, situations and behaviors is necessary. Women tend to bear the burden of the human energy crisis taking responsibility for activities such as pumping water, collecting firewood and other fuels, cooking and their family's healthcare (see table below). In addition there are often distinctions in access to credit or land as well as training opportunities. As a result men and women may have very different priorities regarding energy services.

Replicability

The replicability of a particular project is also key to ensuring long term success and proliferation especially in terms of the transfer of technology and knowledge to local communities. For example, has capacity been built sufficiently enough that local people are able to take responsibility for the maintenance and upkeep of the project? Have they acquired the necessary skills which will allow them to act as future facilitators on similar interventions in neighboring areas? Have local industries been developed and appropriate technologies been used such that local communities are not reliant on the import of materials?

Energy for Development

Energy access in itself is not a panacea to rural poverty issues. A successful intervention has the potential to stimulate development by modernizing existing needs and introducing new services. However the long term success of any energy project requires social sustainability to play a central role which can only be achieved by starting from the context of the users rather than the technology.