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ORGANIC GROWTH

Vol 17

RENEWABLE ENERGY

Don't talk about it be about it!

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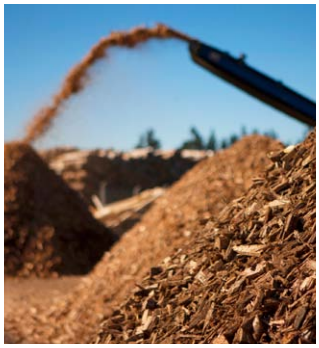

Foreword

It has been the quest of humans to use energy efficiently from the time of foraging to today. Transitioning from somatic to extrasomatic energy sources – the discovery of fuel as an energy source other than food – has changed the course of human evolution. We cannot exist without easily exploitable energy; our way of life is now dependent on this.

Fossil fuels release of large amounts of energy in a short time, for now there are abundant and cheap resources available. Based on the 2015 production values and known reserves there were 114 years of coal, 52.8 years of natural gas and 50.2 years of oil still remaining[1]. Some fossil fuel resources will be exhausted as early as in the lifetime of some Generation X and Millennials, while some may last longer. The inevitable reality of finite sources of energy running out have encouraged researchers to find and develop alternative sources of energy that can potentially replace fossil fuels.

In the last 45 years there has been only a 5% shift in fossil fuel consumption from 86% in 1970 to 81% in 2014[2]. These numbers do not reflect the overall increase in energy demand over the years. The cumulative effects of fossil fuel use and the resultant emissions have compounded natural climate shifts, with a total global temperature increase of approximately 1°C from pre-industrialization (1850-1900)[3] – a shift that has led to a surge in unexpected weather events and resource crunches globally.

Anthropogenic changes wrought through high levels of fossil fuel consumption have far reaching impacts on ecology, agriculture, water resources, human health and economies. The energy consumption data of 2017 (Figure 1) shows that fossil fuels still contribute to 85% of primary energy sources[4].

The average growth in primary energy consumption for the year 2017 was 2.2%, the fastest growth since 2013 breaking

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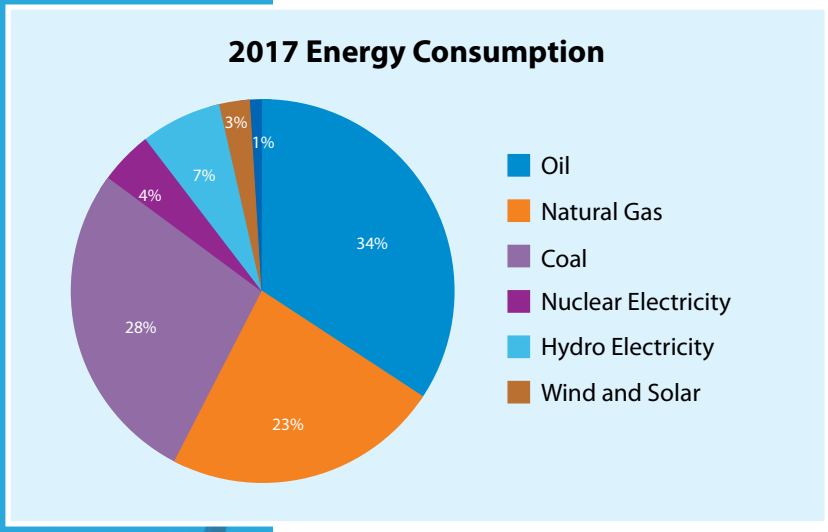
[1] *BP (2016). BP Statistical Review of World Energy 2016*

[2] *World Energy Council, World Energy Issues Monitor; 2018*

[3] *IPCC Special Report: Global Warming of 1.5° C, 2019*

[4] *BP (2017). BP Statistical Review of World Energy; 2017*



a record of a 10-year average of 1.7%. It is estimated that the growth in energy demand will rise by more than quarter by 2040 largely due to higher income levels and an explosion of urban populations in developing economies by an estimated 1.7 billion people, with India as the forerunner[5].

India is the world's 4th largest energy consumer using 754 Mtoe and contributing to 5.6% of the total world's energy consumption. India is preceded by China, the world's largest energy consumer using 3132 Mtoe (23% global consumption), the United States of America consuming 2235 Mtoe (17% global consumption) and the EU 1689 Mtoe (13% global consumption).

In the year 2017 there was 1.6% increase in carbon emissions, for the first time after three consecutive years of no rise. Coal consumption showed a 1% growth, first time since 2013, amounting to 25mtoe more than the pervious years. The escalation in usage was largely due to consumption in India which increased coal usage by 18mtoe that accounted for 72% of the incremental value[6].

In 2017 India's carbon emissions were 2344 million tons of carbon dioxide, contributing to 7% of the world's total carbon emissions. The average growth rate of carbon emissions has reduced to 4.4% from 6% (average from 2006-2016) in the year 2017.

In 2016-2017, 84% of India's energy came from fossil fuels. 53% was from Coal[7]. While India's dependence on fossil fuels is immense, the government is making substantial efforts to grow the renewable sector.

The Indian Government announced, in 2015, a target of 175GW of installed capacity of renewable energy by the year 2020. Towards this goal the government has achieved 62.84GW (last recorded December 2017): 18% of the total goal. India also holds the 4th and 6th position in wind and solar power respectively. In rural areas decentralized electrification using renewable technology has provided economical options for providing lighting, cooking and productive energy needs[8]. Continued efforts in this direction will decrease India's dependency on fossil fuels and bolster its transition to complete renewable, clean energy use.

The future survival of the planet depends on humanity's ability to undo the worst of the violence it has wreaked on global ecologies. Controlling and averting further damage through destructive human activity and fossil fuel consumption by transitioning to environmentally friendly renewable, clean energy is the way forward, which all governments and intergovernmental bodies are slowly working towards. Greater coordination between governments, international, local, regional and sub regional level is imperative for these efforts to come to fruit.

– Ranjit Barthakur
Chairman, APPL Foundation

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[5] *World Energy Outlook, International Energy Agency; 2018*

[6] *BP (2018). BP Statistical Review of World Energy; 2018*

[7] *Energy Statistics, Central Statistics office, Ministry of Statistics and Program Implementation, Government of India, 2018*

[8] *Annual Report, Ministry of Renewable Energy; 2017-2018*

The History of Energy

770,000 BC

Humans in modern-day Israel discover how to make fire.

2000 BC

Chinese begin burning coal for heating and cooking.

1600s - 1700s

British discover conversion of coal into coke, making it major fuel for 18th, 19th and 20th century industry.

1860

France's Auguste Mouchout builds first solar energy

1892

First use of geothermal energy to heat buildings in Boise, Idoho.

1950

The first nuclear power plants are built in Obninsk, USSR and in Shippingpot, Pa.

1980

Scientists begin to amass evidence that burning of fossil fuels is driving potentially calastrophic global climate change.

2000c

Global all production peaks at 70 billion barrels a day in 2006 and is expected to drop sharply in coming decades.

And there is no light – Energy Crisis!

Just as "and there was light" what if suddenly there is no light? Wonder how it will be if we are surrounded by darkness? Well that can be the case in near future. Thanks to electricity our world is lit up day and night. But beware electricity which is mostly generated in thermal power stations with coal as energy source is counting days. The natural reserve of nonrenewable fossil fuel coal is depleting rapidly, therefore threatening mankind with looming darkness. Scared what's going on? Let's dig deeper! The handiwork of nature has created humongous repository of energy. Fossil fuel as they are known has been formed from the fossilized remains of dead plants by exposure to heat and pressure in the Earth's crust over millions of years. Although fossil fuels are continually being formed via natural processes, they are

generally considered to be non-renewable resources because they take millions of years to form and the known viable reserves are being depleted much faster than new ones are being made.
With the advent of technology and scientific know how, we have extracted and exploited the source of energy which is better known as fossil fuel to function daily life. Fossil fuels as petroleum, natural gas and coal are today the primary source of energy. So dependent we are on fossil fuel and its product i.e; energy derived from it, that civilization without it seems inconceivable. Keeping in mind that the reserve of fossil fuel is limited and non-renewable makes it a highly prized commodity. Every nation requires fossil fuel but concentration of reserves in certain geographical locations, leads to the dependence of most nations on a handful of its producer. Thus a thriving economy has developed around the trade of fossil fuel which has impacted international relations and contributed to the rise of conflict.
Over the last two centuries, energy needs have skyrocketed dramatically, especially because of the transportation and industry sectors. Current consumption model relies almost entirely on the use of non-renewable energy sources. At the current rate of consumption, oil will be the first fossil fuel to run out. According to projections, there would be between 40 and 60 years of proven reserves of conventional oil. Natural gas could be exploited for another 70 years. For coal, there would be around two centuries of reserves. Moreover energy demands are and will be amplified by the demographic - the world's population should reach nearly 10 billion people in 2050 - and economic boom of growing areas. According to the International Energy Agency (IEA), global energy demand could increase by more than 50% by 2030 in the absence of public policies in this area. Therefore, the future availability of fossil fuel is a rising global concern. The present situation has been equated to a crisis, better known to us all as "Energy Crisis".
The crisis around fossil fuel has contributed to many other grim concerns. The massive use of traditional

According to projections, there would be between 40 and 60 years of proven reserves of conventional oil. Natural gas could be exploited for another 70 years. For coal, there would be around two centuries of reserves.

The word "Energy" takes us back to our school day science class lessons. Sound and light that surrounds us, electricity to running of fueled vehicles and humans walking on the Earth involve various forms of energy. Another very important aspect of energy is how we harness it for our use from various sources. The source of energy classifies energy into two major categories. Let's know more about them.

Non Renewable Energy

A non-renewable resource (also called a finite resource) is a resource of economic value that cannot be readily replaced by natural means at a quick enough pace to keep up with consumption. Most sources of non-renewable energy are fossil fuels, such as coal, gas and oil. There are numerous downsides to non-renewable energy, one being negative environmental impact.

Coal

Coal comes from the remains of plants that died hundreds of millions of years ago. It has the highest level of carbon of all fossil fuels

Oil

Oil also known as petroleum – can be extracted and refined in order to make products such as gasoline, diesel and jet fuel.

Natural Gas

Natural gas was formed from the remains of tiny sea plants and animals that died millions of years ago. It is mainly composed of methane. Natural gas can be used to fuel industry and machinery, as well as for a wide variety of heating purposes.

Nuclear Energy

Nuclear energy is released when atoms' nuclei are fused together (fusion) or split apart (fission). Nuclear power plants produce electricity through nuclear fission.

Renewable Energy

Renewable energy is any natural resource that can replace itself quickly and dependably. Renewable energy sources are abundant, sustainable and environmentally-friendly – making them a great choice for us humans and our planet!

Wind

The energy in wind can be harnessed by large blades on wind turbines, which use it to generate electricity for residential and commercial purposes.

Solar

Solar energy comes from the sun. It's the primary source of energy for all living things on Earth, and can also be converted into electricity through solar cells.

Biomass

Biomass is organic matter, such as wood, crops, seaweed and animal waste. It gets its energy from the sun and can be used to produce electricity.

Hydro Power

Biomass is organic matter, such as wood, crops, seaweed and animal waste. It gets its energy from the sun and can be used to produce electricity.

Geothermal Energy

Geothermal energy comes from the heat generated by the Earth, such as volcanoes or geysers. It can be used to produce electricity, and provide heat and hot water.

energy sources leads - among other things - to the increase of greenhouse gas emissions such as carbon dioxide (CO_2), resulting in global warming and harming the environment and biodiversity. Therefore, the energy crisis is closely linked to the environmental crisis. Energy security is one of the major concerns of the main economic centers of the planet. In fact, energy conditions the possibility of growth, which is essential to the market economy and its development model. The energy crisis could thus have a dramatic impact on the global economy. Besides, when energy markets fail, an energy shortage develops.

Energy shortages and resulting economic factors may create socio-political issues.
It is the energy crisis which urges us to look towards alternative sources of energy. Undoubtedly renewable sources such as solar, wind, geothermal, hydro and biomass is the way towards a clean and green future in the arena of energy. The world is upscaling the usage of renewable energy to diminish its dependent on non-renewable sources and lessen the impact of energy crisis. It is time for us as individuals to be a part of this multifaceted crusade so that we might safely conclude “still there is light”!

The massive use of traditional energy sources leads - among other things - to the increase of greenhouse gas emissions such as carbon dioxide (CO_2), resulting in global warming and harming the environment and biodiversity.

Green Energy

the renewable power for our planet

– Arvind Awasthi

Worldwide investments in renewable technologies amounted to more than US$286 billion in 2015, with countries such as China, United States, and the European Union heavily investing in wind, hydro, solar and biofuels. Globally, there are an estimated 7.7 million jobs associated with the renewable energy industries, with solar photovoltaic being the largest renewable employer. As of 2015 worldwide, more than half of all new electricity capacity installed was renewable.

Mother Nature's Power

Many persons do not understand what green energy or renewable energy mean's and presume that is a power source in the distant future and that coal and oil will remain the backbone of power for the planet for the next century.

Green power is a subset of renewable energy and represents those renewable energy resources and technologies that provide the highest environmental benefit. The EPA (Environmental Protection Agency of the USA) defines green power as electricity produced from solar, wind, geothermal, biogas, eligible biomass, and low-impact small hydroelectric sources.

Renewable energy is energy that is collected from renewable resources, which are naturally replenished on a human timescale, such as sunlight, wind, rain, tides, waves, and geothermal heat. Renewable energy often provides energy in four important areas: electricity generation, air and water heating/ cooling, transportation, and rural (off-grid) energy services.

Renewable energy contributed 19.3% to humans' global energy consumption and 24.5% to their generation of electricity in 2015 and 2016, respectively. This energy consumption is divided as 8.9% coming from traditional biomass, 4.2% as heat energy (modern biomass, geothermal and solar heat), 3.9% hydroelectricity and 2.2% is electricity from wind, solar, geothermal, and biomass. Worldwide investments in renewable technologies amounted to more than US$286 billion in 2015, with countries such as China, United States, and the European Union heavily investing in wind, hydro, solar and biofuels. Globally, there are an estimated 7.7 million jobs associated with the renewable energy industries, with solar photovoltaic being the largest renewable employer. As of 2015 worldwide, more than half of all new electricity capacity installed was renewable.

The main advantage is that Renewable energy resources exist over wide geographical areas, in contrast to other energy sources, which are concentrated in a limited number of countries. Rapid deployment

of renewable energy and energy efficiency is resulting in significant energy security, climate change mitigation, and economic benefits. In international public opinion surveys there is strong support for promoting renewable sources such as solar power and wind power.

At the international level, at least 30 nations around the world already have renewable energy contributing more than 20 percent of energy supply. National renewable energy markets are projected to continue to grow strongly in the coming decade and beyond. Some places and at least two countries, Iceland and Norway generate all their electricity using renewable energy already, and many other countries have the set a goal to reach 100% renewable energy in the future.

For example, in Denmark the government decided to switch the total energy supply (electricity, mobility and heating/cooling) to 100% renewable energy by 2050. At least 47 nations around the world already have over 50 percent of electricity from renewable resources, with Iceland generating all its electrical power from renewable energy, though this does not include non-electrical energy (e.g. transport and heating).

While many renewable energy projects are large-scale, renewable technologies are also suited to rural and remote areas and developing countries, where energy is often crucial in human development.

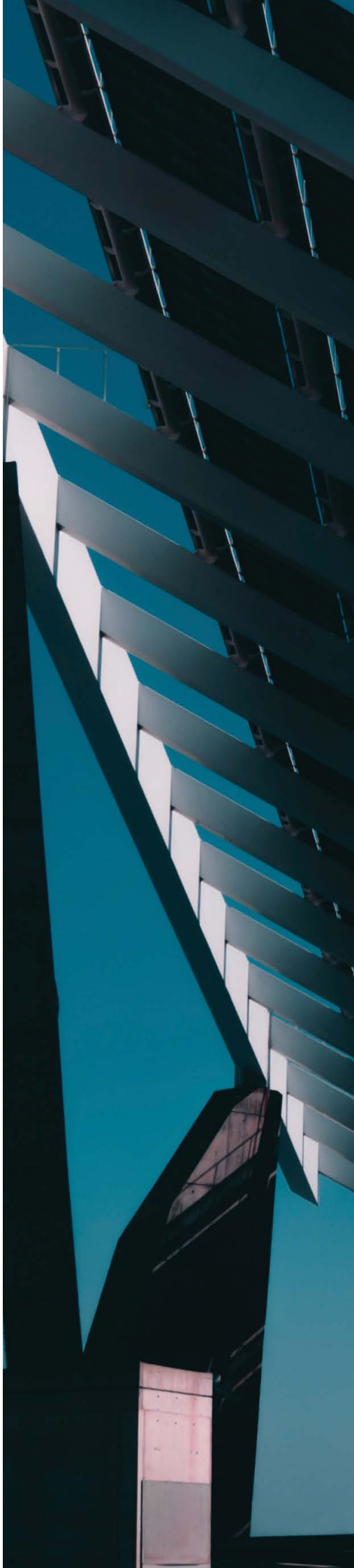
Former United Nations Secretary-General –Mr. Ban Ki-moon has said that renewable energy has the ability to lift the poorest nations to new levels of prosperity. As most of renewables provide electricity, renewable energy deployment is often applied in conjunction with further electrification, which has several benefits: Electricity can be converted to heat (where necessary generating higher temperatures than fossil fuels), can be converted into mechanical energy with high efficiency and is clean at the point of consumption. In addition to that electrification with renewable energy is much more efficient and therefore leads to a significant reduction in primary energy requirements; because most renewables do not have a steam cycle with high losses (fossil power plants usually have losses of 40 to 65%).

Renewable energy systems are rapidly becoming more efficient and cheaper and their share of total energy consumption is increasing. Global installed electricity generating capacity in 2017 was 2.2 TW. Growth in consumption of coal and oil could end in some countries in the Western world by 2020 due to increased uptake of renewables and natural gas.

World power Generation in 2016 for Various Fuels

- Coal – 38 % (Highest)
- Natural Gas – 23%
- Hydro-electric – 16 %
- Nuclear Fission – 11 %
- Oil – 4 %
- Non – Hydro Renewable – 8%

There are many forms of renewable energy. Most of these renewable energies depend in one way or another on sunlight. Wind and hydroelectric power are the direct result of differential heating of the Earth's surface which leads to air moving about (wind) and precipitation forming as the air is lifted. Solar energy is the direct conversion of sunlight using panels or collectors. Biomass energy is stored sunlight contained in plants. Other renewable energies that do not depend on sunlight are geothermal energy, which is a result of radioactive decay in the crust combined with the original heat of accreting the Earth, and tidal energy, which is a conversion of gravitational energy.



Solar Energy

This form of energy relies on the nuclear fusion power from the core of the sun. This energy can be collected and converted in a few different ways. The range is from solar water heating with solar collectors or attic cooling with solar attic fans for domestic use to the complex technologies of direct conversion of sunlight to electrical

Wind Power

The movement of the atmosphere is driven by differences of temperature at the Earth's surface due to varying temperatures of the Earth's surface when lit by sunlight. Wind energy can be used to pump water or generate electricity, but requires extensive areal coverage to produce significant amounts of energy.

Hydroelectric-Energy

This form uses the gravitational potential of elevated water that was lifted from the oceans by sunlight. It is not strictly speaking renewable since all reservoirs eventually fill up and require very expensive excavation to become useful again. At this time, most of the available locations for hydroelectric dams are already used in the developed world.

Biomass-Energy

Biomass - Energy is the term for energy from plants. Energy in this form is very commonly used throughout the world. Unfortunately the most popular is the burning of trees for cooking and warmth. This process releases copious amounts of carbon dioxide gases into the atmosphere and is a major contributor to unhealthy air in many areas. Some of the more modern forms of biomass energy are methane generation and production of alcohol for automobile fuel and fueling electric power plants.

Hydrogen & Fuel Cells Energy

These are also not strictly renewable energy resources but are very abundant in availability and are very low in pollution when utilized. Hydrogen can be burned as a fuel, typically in a vehicle, with only water as the combustion product. This clean burning fuel can mean a significant reduction of pollution in cities. Or the hydrogen can be used in fuel cells, which are similar to batteries, to power an electric motor. In either case significant production of hydrogen requires abundant power. Due to the need for energy to produce the initial hydrogen gas, the result is the relocation of pollution from the cities to the power plants. There are several promising methods to produce hydrogen, such as solar power, that may alter this picture drastically.

Geothermal Power

Energy left over from the original accretion of the planet and augmented by heat from radioactive decay seeps out slowly everywhere, every day. In certain areas the geothermal gradient (increase in temperature with depth) is high enough to exploit to generate electricity. This possibility is limited to a few locations on Earth and many technical problems exist that limit its utility. Another form of geothermal energy is Earth energy, a result of the heat storage in the Earth's surface. Soil everywhere tends to stay at a relatively constant temperature, the yearly average, and can be used with heat pumps to heat a building in winter and cool a building in summer. This form of energy can lessen the need for other power to maintain comfortable temperatures in buildings, but cannot be used to produce electricity.

Can A Country Achieve 100% Renewable Energy?

If you think 100% renewable energy will never happen, think again. Several countries have adopted ambitious plan to obtain their power from renewable energy. These countries are not only accelerating renewable energy installations but are also integrating renewable energy into their existing infrastructure to reach a 100% renewable energy mix.

11 countries leading the Charge on Renewable Energy:

Costa Rica

Thanks to its unique geography and commitment to the environment, small but mighty Costa Rica has produced 95% of its electricity from hydro, geothermal, solar and wind over the past four years. Next on the horizon: Costa Rica aims to be entirely carbon-neutral by 2021.

Nicaragua

This country generated of its electricity from renewables in 2017. In 2012, Nicaragua invested the fifth-highest percentage worldwide of its GDP in developing renewable energy. Next on the to-do list: The country is aiming for 90% renewables by 2020, with the majority of electricity coming from wind, solar, and geothermal sources.

Scotland

Great Scot! The answer to Scotland's energy needs is blowing in the wind. In October, wind power generated 98% of Scotland's electricity needs. Scotland is building the world's largest Floating wind farm in the sea.

Germany

This country is a world leader in renewable energy and in the first half of 2018 it produced enough electricity to power every household in the country for a year. The country has also set an ambitious target to get 65% of their electricity from renewables by 2030. For a relatively cloudy country of over 80 million people, Germany is looking forward to a seriously bright future with solar energy!

Morocco

With ample sun, Morocco decided to go big. Bigger than anyone else in the world, in fact. The largest concentrated solar plant earth is nearing completion in Morocco. With its accompanying wind and hydro plants, the mega-project is expected to provide half of Morocco's electricity by 2020.

Uruguay

Uruguay is now almost 100% powered by renewables almost after less than 10 years of concerted effort. The country invested heavily in wind and solar, rising from just 40% renewables as recently as 2012. The secret? "Clear decision-making, a supportive regulatory environment, and a strong partnership between the public and private sector."

Denmark

This country gets over half of its electricity from wind and solar power and in 2017, 43% of its electricity consumption was from wind – a new world record! That's the highest percentage of wind power ever achieved worldwide. The country aims to be 100% fossil-fuel-free by 2050.

China

Wondering how the world's largest carbon emitter can also be a leader in renewable energy? It may seem counter-intuitive, but in 2017 China had by far the largest amount of solar PV and wind capacity installed of any country – by a long shot. China has also committed to generating 35% of its electricity from renewables by 2030 and cleaning up its polluted air. In 2017 China accounted for 45% of Global Renewable's Investment.

USA

In the US, a new solar energy system was installed every two minutes and 30 seconds in 2014, earning the US fifth place on the installed solar PV capacity global rankings. America also has the second-highest installed wind energy capacity in the world after China. The USA solar Industry now employs more people than coal and Nuclear Combined.

Sweden

In 2015, Sweden threw down the gauntlet with an ambitious goal: to eliminate fossil fuels from electricity generation by 2040 within its borders, and has ramped up investment in solar, wind, energy storage, smart grids, and clean transport. And the best part? The Swedes are challenging everyone else to join them in a race to become the first 100% renewable country. Now that's a competition where everyone wins!

Conclusion

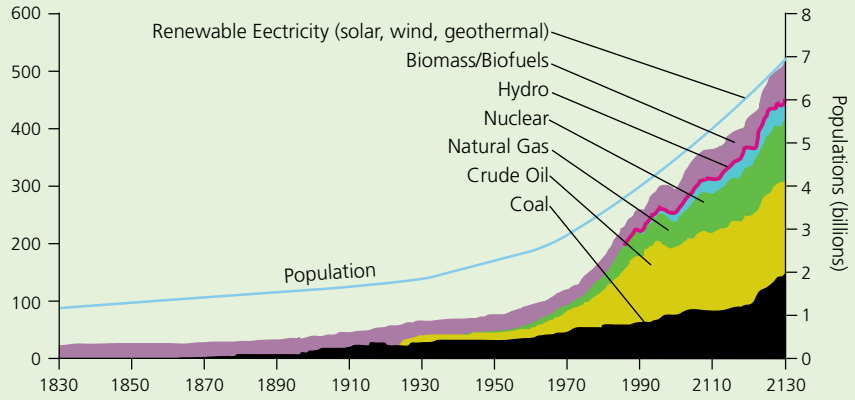
One common theme among all these success stories is that when leaders actively set ambitious goals for renewable energy generation and support them with investments, growth comes fast. The second lesson: there's no one-size-fits-all solution to making the switch. Some countries, like Kenya, have ample geothermal and can ramp up fast. Others, like Denmark, have been steadily improving their wind power generation for over a decade. Still others, like Morocco, are betting big on solar while planning for backup from other renewables.

IN QUEST OF GREEN ENERGY

– R K Ghosh
Effluent & Watertreatment Engineers (P)Ltd

In nature, everything runs on energy. The sun rays combined with nutrients, water and carbon dioxide enable plant to process the primary productivity. The growth of civilization has been triggered on growth of energy. Our energy development trajectory from using sources such as the wind, water power and finally to fossil carbon, and electricity enabled large increase in per capita economic output. Low cost fossil fuelled energy is a foundation of growth and prosperity. The concentration of each source of energy is highlighted in the following figure. In the process we tend to ignore the problems associated with more fossil fuel. In quest of better living standards, we have polluted the nature. The reference of each source of power is tabulated.

Global Energy Consumption and Population, 1830-2010



Source: BP, Smil, Fernandes, IHS Energy, UN, US Census Bureau

carbon dioxide is the major contributor to greenhouse gases. Carbon dioxide today is 30% higher over time and is principally due to burning of fossil fuels. Due to global warming, sea level has increased by 1ft and expected to increase by 3 ft by the end of the present century due to warming of the sea and melting of ice caps. This would lead to flooding of coastal land and uncertain weather, leading to drop in

Technology[2]	Conversion Eficiency[3]	Emissions		
		NO_2	SO_2	CO_2
	(percent)	(grams per kilowatt-hour)		
Pulverized Coal-Fired Steam Plant (without scrubbers)	36	1.29	17.2	884
Pulverized Coal-Fired Steam Plant (without scrubbers)	36	1.29	0.86	884
Fluidized Bed Coal-Fired Steam Plant	37	0.42	0.84	861
Integrated Gasification Combined-Cycle Plant (coal gasification)	42	0.11	0.30	758
Aeroderivative Gas Turbine	39	0.23	0.00	470
Combined-Cycle Gas Turbine	53	0.10	0.00	345

In July, 2013, a remarkable conference took place in French National Assembly in Paris. Current and former Government Ministers of different countries met under the aegis of French President Francois Holland to explore modern economic hearsay. The assessment which came as a part of the concern how world economy is driven largely by the unsustainable burden.

- Five assessment reports issued by the Intergovernmental Panel on Climate Change between 1990 and 2014 document, with steadily increasing certainty, the growing human influence on Earth's climate.
- The 2005 Millennium Ecosystem Assessment concluded that roughly 60 percent of the services provided in nature to humans are in decline.
- Work since 2009 on "planetary boundaries" has identified factors that drive nine major environmental phenomena – including climate change, biodiversity loss, and nitrogen pollution – and suggests that in several cases the boundaries have already been crossed.

But mankind has been aware about the impacts of climate change and has been trying to find alternate sources of energy from 1971.

The world first took note of environmental issues at the United Nation Conference on Environment held in Stockholm in 1972. It is accepted that farm production. There is, thus, an urgent need to halt the rise in temperature due to global warming.

The future of fossil energy on which the world economy and development is a focal point of interest for both the layman as well scientists and politicians. It is becoming increasingly important for governments to arrive at a consensus that will allow them to tackle this problem as soon as possible. The effects of prolonged usage of fossil fuels has caused environmental damage, drastic changes in climate patterns resulting in internal as well as international migration as well as civil unrest. Attention is being focused on renewable sources of energy as supplies of fossil fuels are getting

CHOICE IS YOURS
NON RENEWABLE OR RENEWABLE

ENVIRONMENT

Impact of using non-renewable energy sources is the emission of greenhouse gases, in particular carbon dioxide and methane, which contribute to climate change

In the US, CO_2 emissions from the electric power sector calculated in 2015 indicate that 71% were attributable to coal. While for example natural gas produced around 28% of carbon dioxide emissions.

Renewable power is considered a green and clean form of energy. Take any of the inexhaustible power sources, sunlight, wind, water, biomass; they generate zero harmful emissions or pollutants in the environment. This means a smaller carbon footprint and an overall positive impact on the natural environment.

RESERVE

The BBC reported that at the rates of non-renewable uses in that year, the world would run out oil in 40 years, gas in 50 years and coal in 250 years.

If it could be properly harnessed, there's enough sunlight that falls on the earth in just one hour to meet the world energy demands for a whole year!

HEALTH

Burning fossil fuels can lead to lung problems and asthma attacks in humans. A study concluded that pollution from coal-powered plants shortened nearly 24,000 lives a year in the U.S.

Mining for coal or drilling for oil can be very dangerous, resulting in a large number of diseases, injuries and deaths every year.

Use of clean energy does not pollute air and water does it erases the negative health impact created due to usage of non-renewable energy sources.

HUMAN

Between one-quarter and one-half of interstate wars since 1973 have been linked to oil.

The oil industry can cause or exacerbate conflict in multiple ways: competition over shipping lanes and pipelines, oil-related terrorism, petro-aggression, and resource scarcity in consumer states are all potential sources of international conflict.

Renewable Energy creates 5 times more jobs than fossil fuels

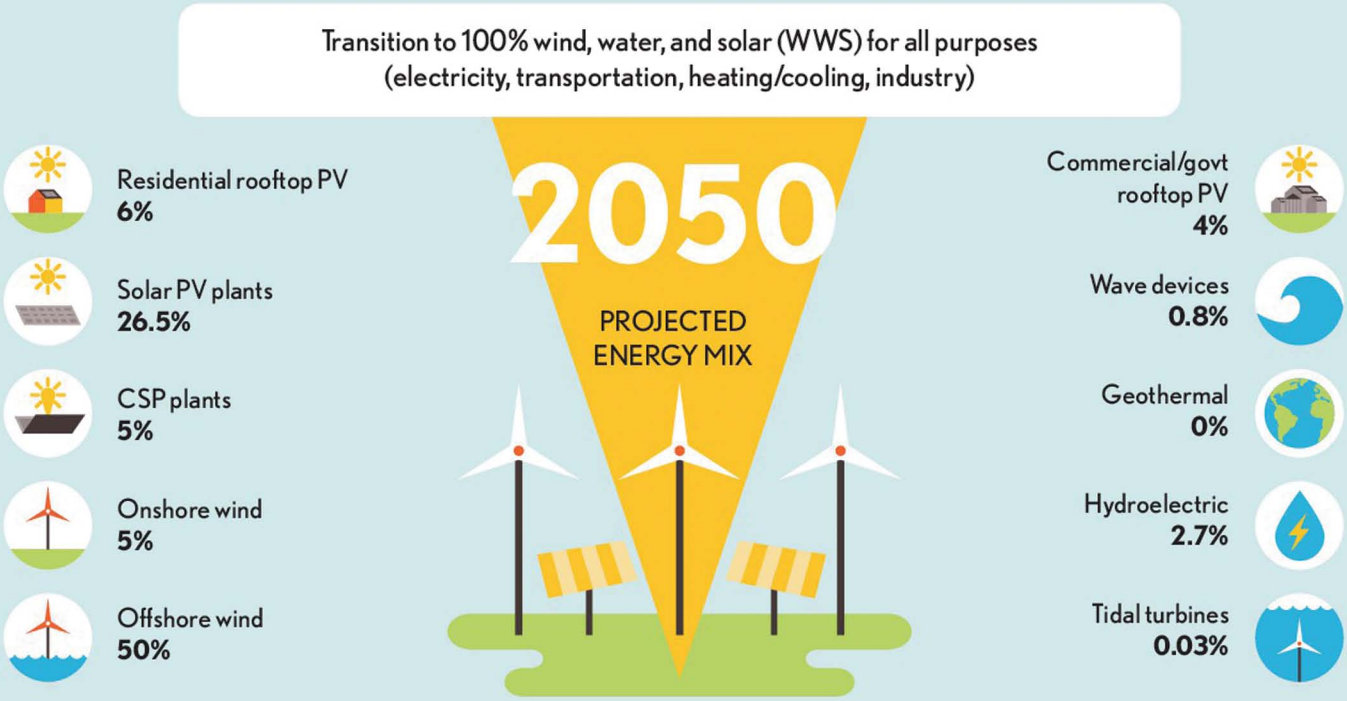
Using renewable energy can help you save money long term. Not only will you save on maintenance costs, but on operating costs as well.

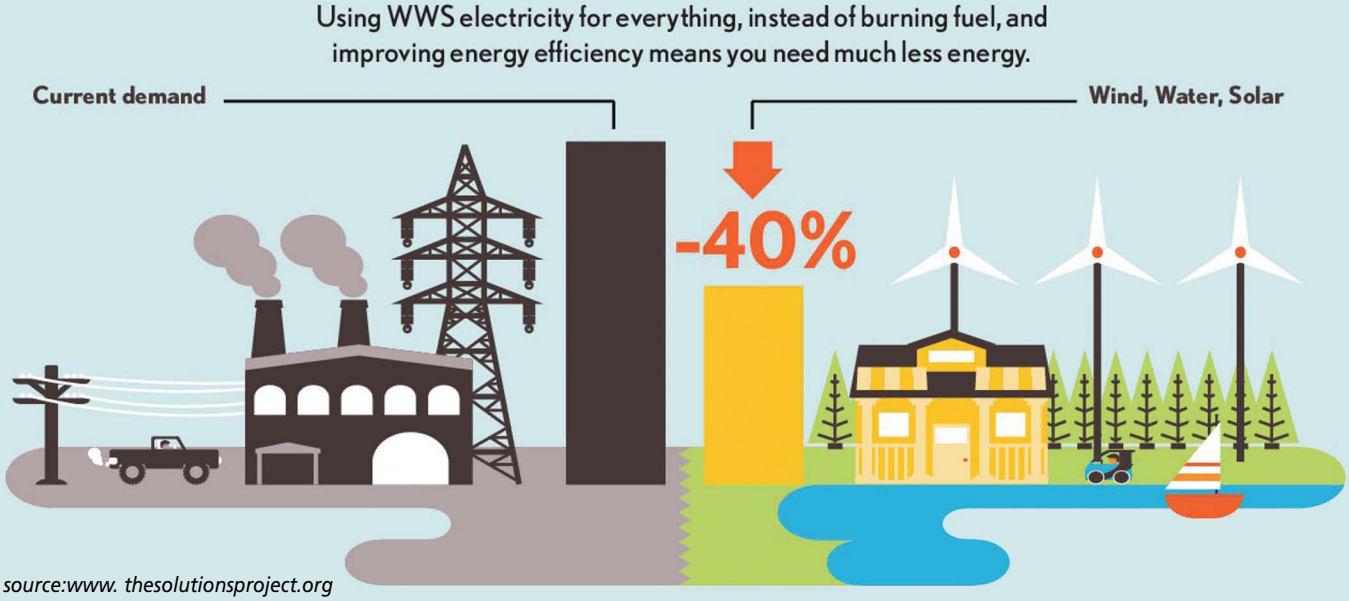
Renewable energy generation mainly takes place in remote settings. This means that local towns would get a fair share of power generated, ultimately, catalyzing the regeneration of those depressed areas both socially and economically.

THE SOLUTIONS PROJECT

An initiative which believes everything in our lives could be powered by clean, renewable energy

The Solutions Project is an organization first conceived in 2011 by prominent figures in science, business and the entertainment media with the goal of utilizing the combined efforts of individuals in the fields of science, business and culture to accelerate the transition to 100% renewable energy use in the United States. Based on the results of academic research, the organization maintains that America is capable of meeting its entire energy needs through renewable energy sources, and that this goal can be achieved by the year 2050.





source:www. thesolutionsproject.org

limited. Though these sources are available globally in some form or the other, they present several drawbacks. Storage as well as transportation are either too costly or difficult, if not impossible. Much of this is also weather dependent and unavailable around the year. Though research is being conducted and wind farms, solar panels, biomass and geothermal units are becoming a common sight, they haven't progressed significantly to address the need and the imminent shortages that traditional fuels have and are providing.

Around 1971, scientists from the US Government had projected that breeder reactors would make obsolete any energy source that cost more $5 per barrel by 1991 costs. Nuclear energy once seen to be the solution to conventional power producing units, is being bypassed. Disposal of nuclear waste is problematic with far reaching consequences, both to mankind, as well as the larger environment. The accidents at Chernobyl, Long Island and the most recent one at Fukushima have exposed the dangers that such incidents can and do cause. What then lies ahead for the global hunger for power? Scientists have been grappling with solutions that will not only cause little or no environmental damage but tackle the need for safe and easy presentation.

During the eighties, scientists had come up with the generation of hydrogen gas by splitting hydrogen from H2O. This can be produced by using spot sources and can be transported wherever required. This concept was known as Solar Hydrogen and mooted in the late 1980s. This development prompted BMW and Mercedes to run prototypes on hydrogen gas.

Unfortunately though this seemed an alternative but its use wasn't carried forward neither were enough experiments done to map its limitations. Given the present state of world political affairs, the time is possibly ripe to give hydrogen gas a chance.

Barefoot College **Solar Mamas**

Knowing Barefoot College

Barefoot College is a blended Social Enterprise that has been providing services and solutions to the challenges facing rural poor communities for more than 43 years, with the objective of making them self-sufficient and sustainable, valuing and respecting the knowledge and wisdom they already possess. The College was founded in 1972 by Sanjit "Bunker" Roy, following the lifestyle and work style of Mahatma Gandhi. It has grown substantially over the years, with a diverse and inclusive team of dedicated individuals, led by CEO Meagan Fallone, who continue to derive inspiration and leadership from the Founder. At its core is a decentralized management philosophy and a focus on capacity building from within, which has become known widely around the world, as the "Barefoot Approach" to community development. The Barefoot solutions can be broadly categorized into the delivery of Solar Electrification, Clean Water, Education and Livelihood Development. The college has been and is fully committed to Empowering Women as change agents, entrepreneurs and environmental stewards. The college believes that placing women at the heart of the development process is the most reliable and effective way to impact and deliver transformation and impact.

in full swing during 2008. It is supported by the Ministry of External Affairs, Government of India under the Indian Technical and Economic Cooperation (ITEC) programme.
Trainees are often illiterate or semi-literate grandmothers who maintain strong roots in their rural villages of and play a major

During the training the participants learn by doing without being trained theoretically. Once trained as solar engineers, the so-called "Solar Mamas" or "Barefoot Grandmothers" return to their villages equipped with the skills and equipment to electrify more than 50 homes each.

Solar approach of Barefoot College

Barefoot college has placed Solar as a primary solution in its approach. Barefoot College trains women, especially grandmothers from rural villages of developing countries of Africa, America, Asia and Pacific Islands, to become solar engineers. A six-month program is conducted twice a year is a collaborative effort of Barefoot College, ITEC and the respective Governments and NGOs (Ground Partners) of the participating countries. The International Solar Training Program as it is known began

Renewable energy in India

TAMIL NADU

Largest wind farm in India with ability to generate 1500 KW power is located at Muppandal.

KARNATAKA

Largest solar powered water heating system is in the city of Bangalore.

WEST BENGAL

Over 3000 household in the Gosaba island of Sunderban electrified generated from biomass fueled plant which is run by a cooperative.

MADHYA PRADESH

Since 2005, households in Kasai village are using electricity generated from biomass for domestic and commercial purpose.

MAHARASHTRA

First commercial bio gas bottling plant set up near Nashik by Ministry of New and Renewable Energy

JAMMU & KASHMIR

Hydro power lighting households of Udmarro, 150 kilometers from Leh.

ANDHRA PRADESH

Kurnool hails the credit of housing the second largest solar park in the world.

CHHATTISGARH

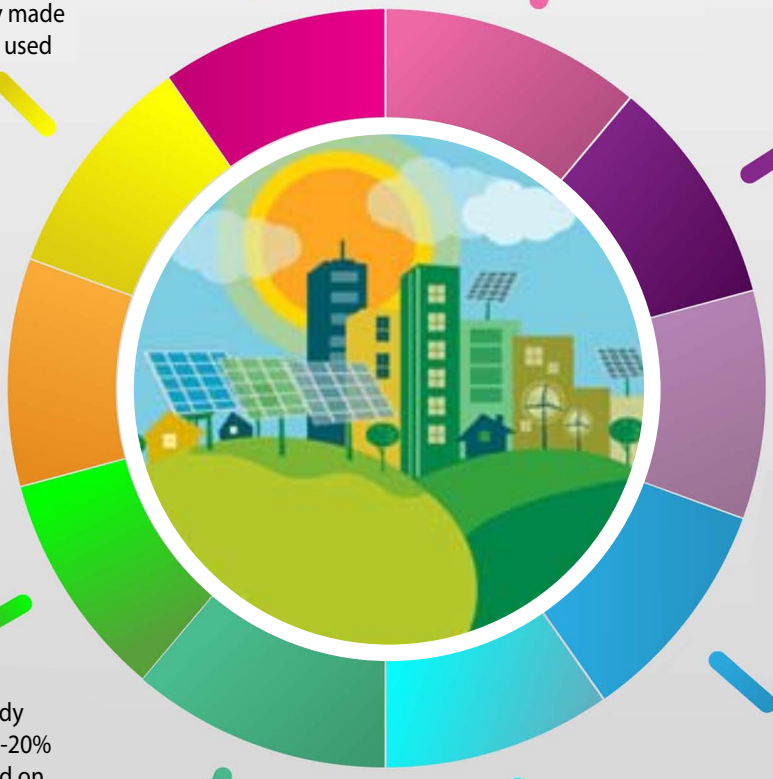
114 villages electrified through solar power by Private Government Partnership run programme.

BIHAR

65 plants generating electricity from rice husk is benefitting 1,80,000 people.

Solar Energy Innovations

Long term investment in solar energy can provide clean, green and renewable electricity for decades



01

One KW of energy produced by solar panels prevents 300 lbs of CO_2 from being emitted.

02

Solar powered, glow in the dark bike lanes have been developed, allowing people to see their way at night.

03

Space missions have been using solar power since 1958.

04

Solar energy is used to remove salt from sea water to make it safe to use and drink.

05

Solar flooring can now be used with a LED backlit system to maintain visual asthetics whilst reducing the building's eco impact.

06

Home furnishing giants IKEA plan on investing millions in renewable energy to cover 70% of their energy use by 2015.

07

A company in Japan has developed a, 'lunar solar power generation concept,' that utilises energy from solar panels on the moon!

08

Solar modules produce electricity even on cloudy days, usually around 10-20% of the amount produced on sunny days.

09

Solar cells power mobile phones and tablets.

10

An engineer has devised a solar powered roadway made from strong glass to be used instead of concrete.

role in community development, bringing sustainable electricity to remote, inaccessible villages. Women build solar electrification system (e.g: LED lamps, Charge controller, Home Lighting System, Solar Lantern) during the programme. The equipment's they build are shipped to their villages where it used for electrifying the community. They learn to set up "Rural Electronic Workshops" (REW) in their villages to store components and equipment needed to repair and maintain solar units. During the training the participants learn by doing without being trained theoretically. Once trained as solar engineers, the so-called "Solar Mamas" or "Barefoot Grandmothers" return to their villages equipped with the skills and equipment to electrify more than 50 homes each. This initial training and power source then ripples out in other areas offering other solutions. Barefoot College Solar Engineers learn the skills of solar electrification, water heating, and filtering water through solar powered desalination. "The power of the sun not only fuels a village but serves as a catalyst to create employment, boost income, reduce carbon emissions, save trees, and most importantly, to provide self-reliant solutions within village communities," Fallone said.

Solar water heaters

Since 2000, The Barefoot College has been developing and installing solar water heaters to provide rural communities access to a sustainable, smoke-free source of hot water. The programme also generates community engagement and contributions from rural youth, who learn to build and install the heaters. Solar water heaters are made by rural Barefoot fabrication engineers and use sunlight instead of wood or gas to heat the water. They provide a continuous supply of warm water for people living hot or cold climates. Community-manufactured solar water now serve thousands of people living in rural, remote villages in eight states of India.

The Barefoot solutions can be broadly categorized into the delivery of Solar Electrification, Clean Water, Education and Livelihood Development.

Solar powered water desalination

India's first ever solar powered reverse osmosis plant produces

3,600 litres of clean water daily and provides drinking water for over 1,000 villagers. The system provides potable water through reverse osmosis: brackish water flows at a high pressure through a thin membrane. The purified water is free of salts and contaminants, which are stored in tanks and collected from pipes in the evening. The plant reduces the salinity of locally available water, making it safe to drink and free of any salty taste. It is powered by a 2.5-kilowatt solar generator that creates an uninterrupted supply of water without relying on the standard electric grid.

Parabolic solar cookers

In November 2003, The Barefoot College created the Society of Women Barefoot Solar Cooker Engineers in Tilonia, Rajasthan. It is the first association of illiterate and semi-literate women who fabricate, install and maintain parabolic solar cookers in their homes. The parabolic solar cooker is constructed from 300 mirrors that reflect the sun's rays onto the bottom of a cooking pot to cook food quickly and sustainably. Women who once spent long hours searching for firewood can spend their time on other productive activities. Communities with solar cookers can expand their livelihood opportunities and limit the negative effects of deforestation and pollution.

3301 Solar Mamas across 96 countries have successfully installed solar systems at 56,408 households. As a result it has enabled 66,964 tonnes of harmful carbon emissions being avoided by replacing kerosene with solar as a source of clean energy for light, heat and cooking. Many more women hold the promise of becoming Solar Mamas and being a part of this movement facilitated by Barefoot College. The magic is waiting to happen, what we need is to come together and make it happen.

ROLE OF NGO'S

in alleviating rural energy poverty for sustainable growth

– J K Mehta
Secretary General, South Asia Forum for Energy
Former Regional Manager (South Asia), World Energy Council

Overview of Energy Sector in India

India is a country with more than 1.2 billion people accounting for more than 17% of world's population. It is the seventh largest country in the world with total land area of 3,287,263 sq kilo meters. India measures 3214 km from north to south and 2993 km from east to west. It has a land frontier of 15,200 km and coastline of 7,517 km. India has 29 states and 7 union territories. It faces a formidable challenge in providing adequate power supplies to users at a reasonable cost. Growth of power sector is the key to the economic development of our country. Growth in production of electricity has led to its extensive use in all the sectors of economy. The world is looking at India and China as the most happening countries of the 21st Century.

A lack of ground level assessment of the availability of resources and skills in villages and the appropriate technology and specification creates challenges in many village electrification schemes to meet the needs of the

local population and improve their quality of life. Furthermore, methodologies for measuring energy access for the most part do not include grid as well as off-grid solutions. In practice, it would be necessary to take more rational steps – to quickly roll out a more standardised process to gather information about the current situation, and to cluster villages with similar needs. It is very important to understand and appreciate the skills available locally, or which can be provided to effectively manage energy access projects. Also, in some cases, once the energy reaches the people it releases suppressed demand, increasing the gap between what is available and what is desired, and consequent conflicts, as well as at times, the closure of projects. People living in poverty often pay a higher price per unit of energy services than do the rich. They also spend more time obtaining these energy services and rely on resource-scarce and polluting ways of converting energy for services like cooking, drinking water, heating and lighting, all of which have associated health impacts Achieving sustainable energy for all is an ambitious but achievable target. The need of the hour is to move from Advocacy to Action, to remove conceptual cobwebs, to collaborate for some out of the box innovative strategies, policies and initiatives and make the difference in the lives of people who have yet to receive modern energy services.

It is not only important that we reach out to the energy starved people in the farther most corner of the country, but we must also ensure its sustainability with minimal adverse impact on environment and the energy supply should be acceptable and affordable to the local people.

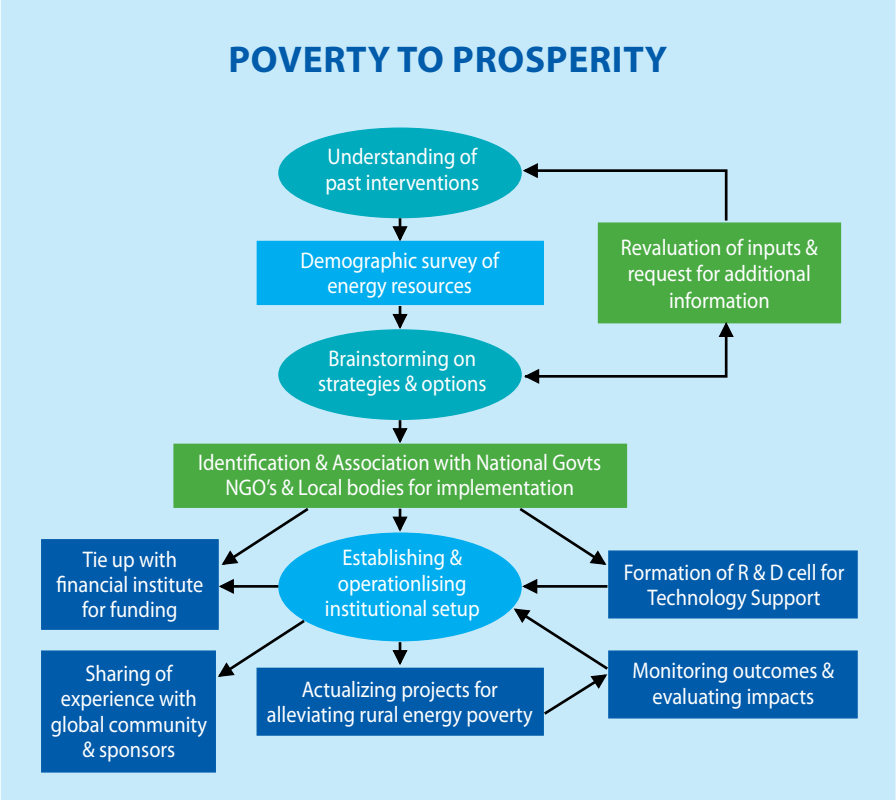
Role of NGO's in Promoting Renewable energy in rural sector and poverty alleviation

Throughout the last few decades, role of NGO's is extremely significant in creating awareness at grass root level about benefits of renewable energy for poverty alleviation. They have brought about some of the best employment opportunities, livelihood programs, self help groups and also empowerment programs. Many families both in rural and urban areas have enjoyed some of the most viable and consistent benefits from these NGO's.

Apart from several developmental approaches, these NGO's also offer proper public and socio-economical services to the poor. This is all the more viable in countries like India where most of the poor do not have proper access to the various public services. In fact, NGO's offer the direct provision of various social and economic services which offer a complete solution for development of villages.

There are several cases in India of NGO's using innovative and simple but rugged techniques for providing energy access in remote areas through renewable sources of energy available locally. It is also known that the cost of decentralized renewable energy becomes competitive with conventional grid connected power when it comes to electrifying remote villages far away from grid. It is also a fact that renewable energy technologies , which permit local control of the energy resources and power generating systems, are suitable for smaller applications and can offer a viable means of providing electricity and clean fuel to the presently un-served people, besides, creating employment and entrepreneurship opportunities, mostly in remote and rural areas.

When addressing the issue of rural energy access through renewable energy projects, it is important to understand the various players or stakeholders who should be involved for the success of any off grid distributed renewable energy



programme. These include
- Local bodies/Gram Panchayats
- NGOs, Social Workers or Self Help Groups
- Local administration and government agencies
- Technology providers and equipment manufacturers
- Local entrepreneurs to run the project
- Funding agencies, government banks, corporates etc.
- End users i.e. the affected people at the bottom of the pyramid.

NGO's play an important role in catalysing the various stakeholders to provide access to energy for poverty alleviation at affordable cost through low carbon, renewable resources which also has direct linkage with environment and economy. NGOs play a very important role in poverty alleviation in rural areas which can be done effectively using low carbon development strategies bringing relief and other basic amenities to individuals suffering from extreme poverty. The NGOs enjoy a direct connect with the rural people through their network and hence have greater acceptability of their proposals and initiatives empowering both men and women thereby considerably improving their lifestyle. A very important aspect of poverty alleviation is identifying entrepreneurs and volunteers at grass root level who can take up various poverty alleviation programmes supported by the government under direct guidance of NGOs.

Assessing Energy Access challenges

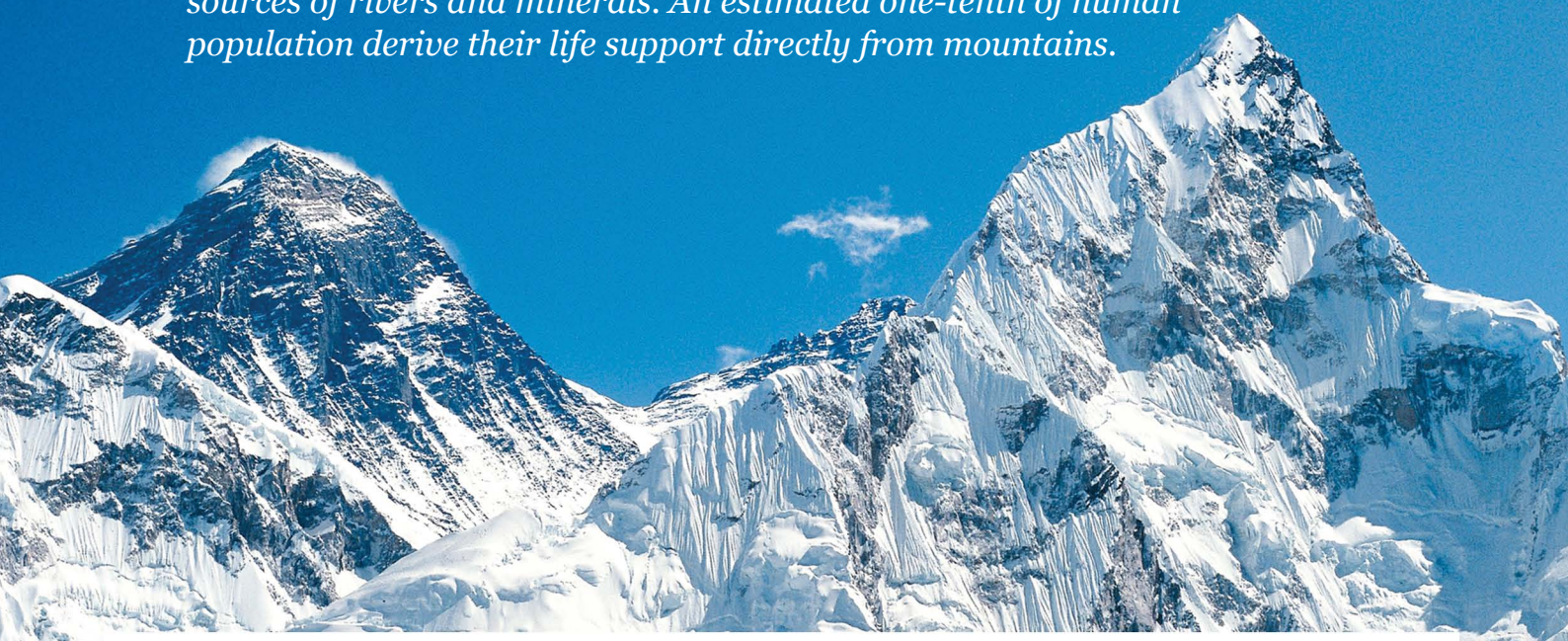
For implementing an effective Village electrification project NGO's should first understand the following support system:
- Physical maps of the area (geological maps) showing topography, forest cover, water bodies etc.
- Socio – political Map / Census data helps in identifying different groups, fixed and migratory communities, Number of households, adults, women, children , social and cultural values etc.
- Pre existing energy infrastructure such as proximity to electricity grid/sub stations, gas pipelines, solid fuel availability and delivery system.
- Availability and proximity to motor able roads, railway tracks, waterways etc.
- Availability of Schools, Banks, post office, Primary health centres, ponds, wells, tanks etc.
- Level of education and skill sets of local people will help in understanding the most effective means of communication like posters, leaflets, talks and drama etc.
- Income levels in community and how is the wealth held – in cash, fixed assets like land, building, capital goods, livestock etc.
- Decision making process in community, stakeholders, gatekeepers, influence groups
- Predominant commercial activity /business in the community such as making handicrafts from local produce, pottery, carpet making etc.
- Whether income is mostly locally generated or comes from elsewhere e.g. migratory workers in other states or foreign countries.
- How does income vary across the year e.g. with agriculture harvesting, remittance from abroad or regular salary payments from local industry and offices.
- What is the current level of expenditure by local people per month to meet their energy needs (in cash or kind).
- An understanding of the ability to pay by local people and their willingness to pay
- It helps to understand the pattern of expenditure by local people as it helps in understanding their priorities.
- Sense of ownership and attitude towards theft and pilferage by local community.
- Modalities for collection of revenue. Who will collect? Where will the cash be kept? periodicity of collection regular or harvest linked (payable when able)

The above data can be collected with the help of a Survey Form which can be used to understand the need of rural people in villages so as to facilitate prioritising the initiative.NGO's can play the key role in collection of above information through appropriate survey /consultation at Village level and also to identify Local Entrepreneurs willing to take up energy access projects on a sustainable business model. The key to success in establishing sustainable renewable energy projects would rest with identifying willing and committed local entrepreneurs and then enabling and empowering them to take up Energy access Projects using locally available resources. We would also need to impart requisite skills to the Local Entrepreneur and do hand holding till the energy access project becomes sustainable.

CHOOSE PLAN GREEN

– **Tanika Jalan,** *Intern, Balipara Foundation*

One of the most fragile environments on Earth are mountains. What lies between their high ridges and rugged landscape makes them a treasure trove of endemic plant and animal species, sources of rivers and minerals. An estimated one-tenth of human population derive their life support directly from mountains.



The Himalayan range does not form a major watershed despite its grandiose scale. Many rivers cut through it, especially on the Eastern part. Collectively the rivers provide water for approximately two-thirds of the world's population. These arterial lifelines finally flow into the Indus basin or Ganges-Brahmaputra basin.

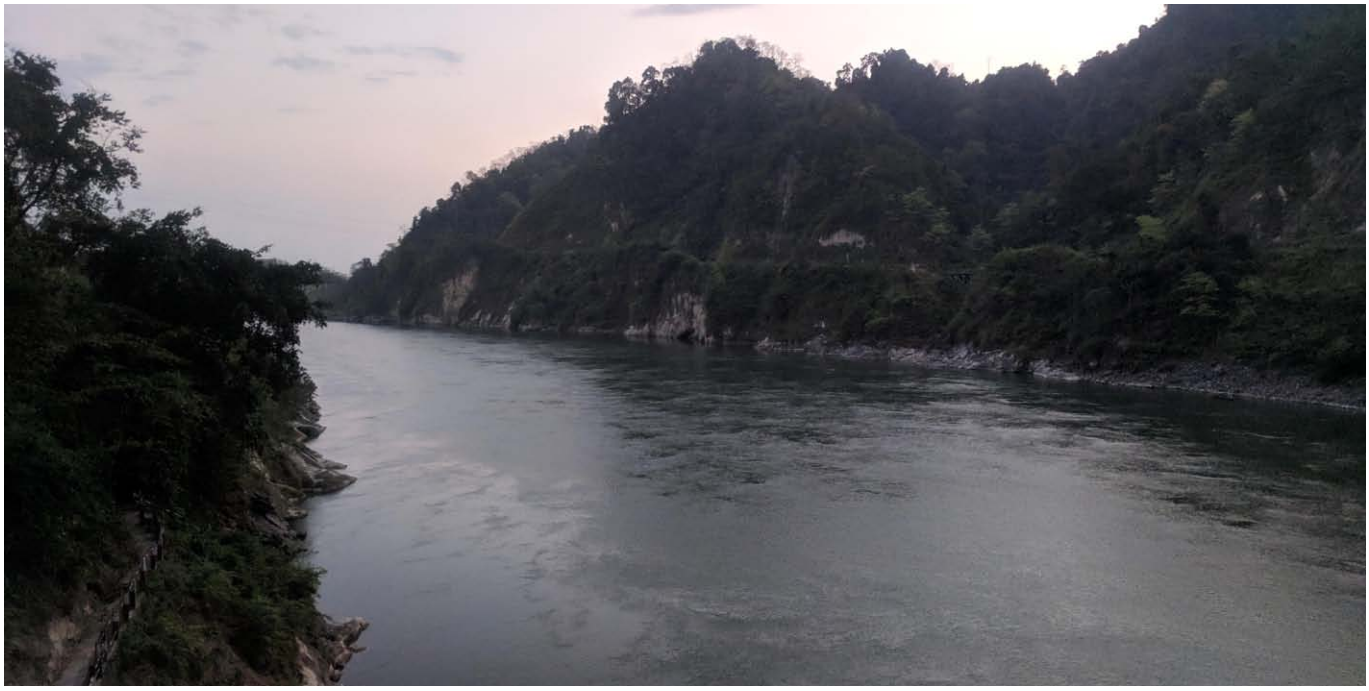
The Eastern range of the mountains are more biodiverse in comparison to the Western end. It is home to over 10,000 plant, 900 bird and 300 mammal species. This is largely due to condensation of large volumes of water that monsoon winds from the Bay of Bengal and the South China Sea bring in leading to a moister and more biodiverse repository.

The Eastern Himalayan region commences from Kaligandaki Valley in Central Nepal to North west Yunnan, China – this covers Bhutan, the East Indian states and North hills of Bengal, Southeast Tibet, parts of Yunnan China and Northern Myanmar. The entire region covers an area of nearly 525,000 sq.km.

Climate Change and Energy

The ability to adapt naturally of many ecosystems in the 21st century are likely to be superseded by combination of change in climate, land use change, overexploitation and other global drivers if carbon footprints continue at or above the current rates.

A decade ahead, 80% of energy consumption is still dependant on fossil fuels. This anthropogenic and ecological stress is affecting the Eastern Himalayan region adversely.



Downstream communities are highly dependent on upstream ecosystems to provide them with water. Changes in global climate conditions indicate the monsoons will be more intense, negatively affecting ground water recharge, soil moisture intake and accessibility of water to plants. The dry seasons will get drier with droughts resulting in far more water stress in the future. The alterations in monsoon timings and length too will effect agriculture and ecosystems impacting human health and the economy too.

Demographic Profile of the Eastern Himalayan Region

The river basins of the Eastern Himalayas are home to over a billion people. The growth in population in this region averages 2.1 % a year. The 2.1% growth average will take around 33 years to double but the 4.83% of Kailali in Nepal will take just 14 years to double.
The demographic changes in the region will accelerate demand for natural resources, more land for development, conversion of forests to agricultural land, overgrazing and will also create human wildlife conflict. These developments will also increase the demand for energy.

Energy Consumption in the Eastern Himalayan Region

There has been little detailed research on the energy consumption patterns for the Eastern Himalayas as a whole. Generalizations have been made from scattered studies on various pockets of the region.

States	Total villages as per 2011 census	Inhabited villages electrified (No)	Inhabited villages electrified %
Arunachal Pradesh	5258	4029	76.63
Assam	25372	24640	97.51
Manipur	2379	2299	96.64
Meghalaya	6459	6229	96.44
Mizoram	704	686	97.44
Nagaland	1400	1394	99.71
Tripura	863	863	100
Total	42435	40140	94.83

More than 80% of the population in these regions lives in rural mountainous regions. They rely on traditional biomass fuels for cooking. Over all over 400 million people in these countries do not have access to electricity.
Data shows that 94.83% of the villages in the North East Indian States are electrified. Many electrified villages that have a connection, have regular power cuts, unplanned load shedding and blackouts.
Bhutan has a population of 6,92,695 where 34% reside in urban areas and 66% in rural. Approximately 99% of households in Bhutan have access to electricity. 98% of rural households have access to electricity whereas 100% of urban households have access to electricity. Though the reliability is not 100%. In rural areas 64.3% households faced power

failures lasting at least for an hour in the last 7 days while 46.6% of the urban areas faced the same. 98.4% of people use electricity for lighting and 94.9% use it for cooking. For heating still 25% of the population is using traditional bukharis. 95% households in the urban areas use LPG for cooking whereas only 57.8% rural households use LPG. 33% still rely on traditional fuelwood for cooking. Nepal produces 1044.6 MW of electricity. The current requirement is 1508.2 MW of electricity a deficit of 463.3 MW. 95.7% of the urban areas are electrified and only 63% rural areas. Household energy requirement contributes to 45% of the total energy requirement. It is estimated that 3 out of 10 families are without any electricity supply. Leaving 68.9% of the country to rely on traditional forms of energy .

Biomass Consumption in the Eastern Himalayas

Burning firewood or agricultural waste produces many pollutants some of which are carcinogenic. Many respiratory diseases and infections arise from inhaling the smoke produced. The increase in demand was expected to rise to 83% in 2021. This demand cannot be met by growing stock causing degradation of land and deforestation. It was observed that cooking required the maximum energy followed by heating.
The firewood consumption of patterns of three tribal communities of Meghalaya were studied, Northeast India, Khasi, Garo and Jaintia reveals that 5.81 kg/capita/day, 5.32 kg/capita/day and 3.9 kg/capita/day, respectively. Due to their poor socio-economic conditions these tribal communities cannot afford to rely on commercial fuels . Firewood dried and stored for the monsoon season
In Kanchenjunga Transboundary Conservation Landscape 90 percent of households still use fuelwood as their main source of energy for almost all domestic purposes. The annual consumption of fuelwood is 4 -5 kgs/capita/day for these regions. This high consumption is similar to the tribal villages of Meghalaya.
To curb this large consumption of fuelwood alternate, accessible and clean sources of energy need to be considered.

Hydropower as an Alternate Energy Source

The Eastern Himalayas have around 15,000 glaciers that contain around 12,000 km3 fresh water . They are also the source of three of the largest rivers in the world, Yangtze, Indus and Ganges. Water from these rivers and their tributaries makes this area's potential for hydroelectric power extremely high.
China is the current world leader in hydropower generation current installed hydropower capacity, 341 GW contributing to 19.2% of the country's electricity needs . The largest of these is The Three Gorges Dam constructed on the Yangtze with an installed capacity of 22,500 MW, the largest in the world.
India ranks 5th for exploitable hydroelectric potential. 1,48,700 MW of economically exploitable hydro projects are plausible in India. 1512 sites have been identified with hydro-potential for small, mini and micro schemes which can yield an approximate 6782 MW of energy. In addition to this 56 pumped storage projects with an approximate capacity of 9400 MW have been identified.
If India's total economically exploitable hydropotential was to be achieved the total generation of electricity would be approximately 2,50,000MW.
The Brahmaputra basin alone would contribute 66,065 MW, 44.4%, (exclusive of small and mini micro schemes and pumped storage). Currently, 14.8% of the country's electricity demands are met by hydroelectricity with approximately 49GW of installed power capacity Nepal's total energy production is 1044.6 MW and hydropower contributes 94.8% (990.5 MW) of energy. 82.4% of hydropower is generated by the Gandaki province in central Nepal and Province 3 in Eastern Nepal. 939.5 KW of electricity has been generated from small and micro hydro plants in Nepal.
Bhutan and Myanmar generate 1615 MW and 3140 MW of energy from hydro power.

Hydro Electricty Limitations

Hydropower is a clean source of energy with huge generation capacities, there are limitations to use its maximum potential. These are:

- Non-competitive pricing of hydropower due to large demand and consumptions of fossils.
- Many invisible costs such as, environmental clearances and building on tough terrains.
- Submergence of arable lands and biodiversity hotspots. Will also affect fisheries.
- Large population displacement, proper rehabilitation and resettlement.
- Most river systems in the region are transitional and will require adequate agreements and policies.
- Extreme weather conditions- flooding, droughts and storms due to erratic rainfall patterns and unprecedented rates of glaciers melting.
- Regular seismic movements in the area require plants to withstand high intensity earthquakes.

Renewable Energy

Other clean sources of energy that have potential to electrify the area are:

Biogas: Under the National Biogas and Manure Management Program, India a total of 5753 family biogas plants were installed 97.5% of these were in Assam. In Nepal 8436 biogas plant and 10018 improved stoves were installed . Bhutan Biogas Project has installed 2921 biogas till date

Micro-Hydro Projects: Micro-hydro projects are those producing 5kW to 100 kW of electricity.

In Nepal remote villages have adopted the Micro-Hydro Village programme initiated by the Rural Energy Development Program. Many villages have benefitted from close proximity and continuous electricity. The total capacity of these projects is 2 to 3 MW serving 30,000 households in 10 districts. The outcome of these projects showed 11% less respiratory diseases in women and children and household incomes increased by an average of $ 1.4.

In the North East Indian States a total of 212 small hydro projects have been installed producing 315.5 MW of energy. An additional 38 projects are in the implementation stage that will produce 119 MW of energy. Yet 83% of potential from this region is untapped.

Wind Power: In India wind power has the potential of 300 to 500 MW even at low hub heights of 50 to 80 meters. The largest potential is in Arunachal Pradesh with over 200 MW potential. So far 52 Wind Resource Assessment stations have been installed in this region no wind power has been harnessed.

In Nepal 26.5 MW of energy has been harnessed from solar and wind power. In 2016 Bhutan installed two wind turbines of 60 kW to power over 300 households.

Small Wind Energy Hybrid Systems: 383 kW of these have been installed in North East India.

Solar power: In North East India it is the most underutilized. The potential for the region to have up to 43000 MW of solar power is virtually untapped. 17.1 MW is the current installed mainly in Assam (65%) and Tripura (29%). In Nepal 16,572 solar plants have been installed. Land for 3 solar parks with an ability of generating 149 MW of power have been identified in Meghalaya, Assam and Nagaland, India. In addition off grid solar PV systems are the following:

Solar PV Systems and Solar PV Plants North East India

Lanterns (nos)	149,153	43% in Tripura
Home Lights (nos)	93,243	35% in Tripura
Street Lights (nos)	18,144	34% in Nagaland and 28% in Mizoram
Pumps (nos)	317	48% in Tripura
Stand Alone Power Plants (kW)	9017.6	Maximum are installed in Assam (18%), Mizoram (19%), Nagaland (17%) and Manipur (13%)

Conclusion

Special attention has been drawn to the energy potential of this region. The Ministry of Renewable energy, India has allocated Indian Rs. 4.13 billion towards the same in the North Eastern States. China aims at spending $ 360 billion by 2020 and Nepal has allocated Nepali Rs. 5 billion for the same.

For development in the renewable sector local, national and intergovernmental bodies require working on long term solutions, by creating an ease of coordination between authorities, creating incentives for developers and de-risking investments. Along with this a multifaceted plan needs to be envisaged that includes a mix of large mid and small scale projects to meet household, industrial and agricultural needs; a Green Plan.

Let's make Earth a **safer** planet to live on

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