180Degrees
CONSULTING
SGGSCC

FUTURE OF ENERGY

INDUSTRY ANALYSIS REPORT 2021

CONTENTS

EXECUTIVE SUMMARY

Problem Statement

1. Researching about the sources of energy in the modern world and gaining an insight into the potential energy crisis likely to develop in the near future.
2. Analysing the exciting new developments in energy and their feasibility in India.
3. Coming up with a framework to tackle the various problems in energy transition from Fossil Fuels.

Report Deliverables

1. Obtaining people's opinion regarding the state of energy in the current status quo.
2. Understanding their willingness to shift to renewable sources for their daily needs.
3. Enumerating upon the several different types of clean energy sources and their potential in India and around the world.
4. Debating about the methodology to make renewable energy mainstream.

EXECUTIVE SUMMARY

Proposed Solution

The future of energy is a report undertaken to offer an insight into the current state of energy generation and utilization in the world as well as dive deep into the various sources of clean energy for sustainable development. The report goes through the several advantages and constraints into employing these sources of energy generation. During the survey, 180DC SGGSCC tried to find out the general consensus regarding clean energy and their willingness to make use of them in their daily life. This report, after extensive research including primary research, provides a detailed understanding of the energy sector and deliberates on its future.

Our Approach

The future of energy is a report undertaken to offer an insight into the current state of energy generation and utilization in the world as well as dive deep into the various sources of clean energy for sustainable development. The report goes through the several advantages and constraints into employing these sources of energy generation. During the survey, 180DC SGGSCC tried to find out the general consensus regarding clean energy and their willingness to make use of them in their daily life. This report, after extensive research including primary research, provides a detailed understanding of the energy sector and deliberates on its future.

EXECUTIVE SUMMARY

Conclusion

The purpose of this research was to offer a complete overview of the energy sector, understand public's willingness to shift towards cleaner sources of energy along with explaining the current status of energy generation throughout the world.

This report also decodes the various sources of clean and renewable energy along with specifying their availability and sustainability in the near future.

The survey conducted as a part of the primary research which got over a few hundred responses, clearly pointed out that awareness with respect to the need to shift to renewables in the near future does indeed exist and people are willing to incorporate these changes in their day to day life. However, for this to happen, the development of adequate machinery regarding renewables like easier availability of solar panels and electric vehicles at attractive price points need to be fast tracked.

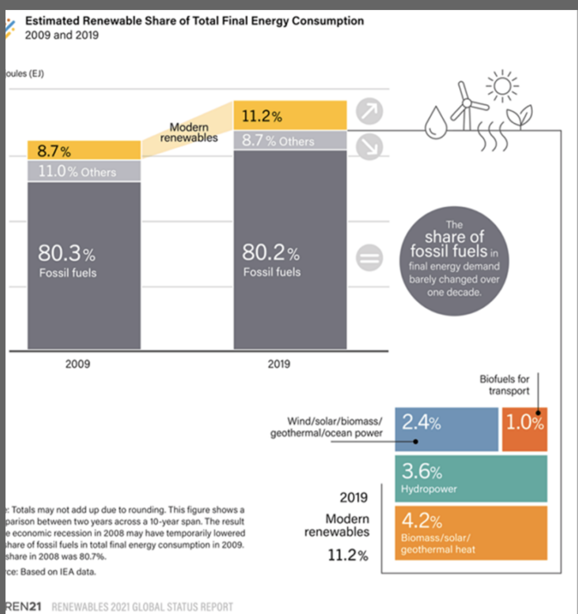
Looking at the present situation, it is evident that relying on fossil fuels is not sustainable and sooner rather than later, a shift to renewables is coming. As a nation as well as a community, we must each go out of our way and bear pain to help the society avert the much feared energy crisis.

RENEWABLE ENERGY- THE CURRENT SCENARIO

Renewable energy is the world's fastest-growing energy source. In 2019, contemporary renewables (biomass, geothermal, solar, hydro, wind, and biofuels) accounted for 11.2 percent of worldwide energy consumption for heating, electricity, and transportation, up from 8.7 percent a decade before (see figure below).

By the end of 2020, renewables accounted for 29% of worldwide power generation. More than 256 GW of capacity was added in 2020, driven by wind and solar PV, representing an almost 10% increase in total installed renewable power capacity.

The International Energy Agency notes that while the development and deployment of renewable electricity technologies is expected to continue at record levels, government policies and financial support are required to incentivize even greater deployments of clean electricity (and supporting infrastructure) in order for the world to meet its net zero climate goals.



Why don't we use renewable source of energy?

In terms of individual countries, transitioning from one energy source to another will surely take time as new power plants and infrastructure are built.

Switching to renewable energy doesn't only entail that a group of people decides on a new way to power their houses; it also implies that entire businesses rethink how they earn money and where they get their energy. It would necessitate the transformation of millions of homes, schools, companies, public buildings, and transportation hubs – and this does not happen overnight.

Renewable energy sources now account for just around 14% of global energy requirements. This is largely due to the fact that the technology required to create vast amounts of renewable energy took years to develop, and most of our engines and systems were designed to run on fossil fuels.

It all comes down to cost and infrastructure

Finally, the most significant impediment to the growth of renewable energy is its high cost and logistical challenges. We will witness a surge in popularity and utilisation of renewable energy sources as the infrastructure for them improves.

While there are significantly more ecologically friendly energy sources than environmentally harmful energy options, fossil fuels are still cheaper, more dependable, and have been around for longer. Green energy, according to many environmental experts, will become more widely employed and hence more available in the future. This will necessitate a significant increase in public knowledge of renewable energy sources as well as a global readiness to invest.

Renewable energy sources that are as economical and dependable as their less ecologically friendly rivals would be great. Using renewable energy through energy companies is the most ecologically responsible decision we can make till such a transition is accomplished. As more individuals choose such enterprises, demand for wind, geothermal, and solar energy will rise, increasing the quantity of clean energy available on the grid.

How to make renewable energy more attractive?

We can start to turn the tide on social acceptability of renewables by making renewable energy more aesthetically appealing, seamless within the environment, and particularly advantageous for everyone. This is how it works:

1. Engineers and designers are a winning combination.

Engineers presently rule the realm of renewable energy project design. Perhaps because some of the technologies are still in their infancy and investment prices are high, the focus is on the technology's utility rather than its aesthetic appeal.

When both aesthetic design and usefulness are prioritised, the results may be breathtaking. NewWind, a French renewable design firm, for example, creates tree-shaped wind turbines in the hopes of providing a "visually appealing, urban alternative to standard turbine forms."

2. Visual content marketing

Visual material may be a terrific method to sell a business while also informing local people about a project's planned advancements. Images, declarations, and plans are no longer sufficient. Investors, like the general public, want to see professionally produced visual content that highlights the project's benefits. Visual material, when done well, has the power to completely change the prospects of a renewable energy project.

This desire is beginning to be noticed by certain visual content companies.

3. Blending in

"It has to be attractive, economical, and perfectly integrated," Elon Musk says of Tesla's new solar roof system, which uses tempered quartz glass to create solar panels that mix in with your home's original roof.

The inadequacy of renewable energy to blend in with its surroundings has led to it being labelled as a visual eyesore. Renewable energy hasn't perfected the art of invisibility yet, whether it's vivid blue solar panels on your roof or 100 metre high white turbines strewn across a landscape.

To overcome this issue, companies like Tesla, Sistine, and Enchron are all working to develop 'hidden' renewables. Projects may mix in better with their surroundings appears to be influential.

4. Changing the stigma

No matter how dreadful some people believe renewable energy is, we may get perspective when we realise how critical it is to our future. Those who are sceptics may experience the beauty of a sustainable planet through communication, good media content, and education. It is our obligation as people who are enthusiastic about renewable energy and its role in our lives to help transform the negative perception of renewable energy and allow people to discover its
hidden beauty.

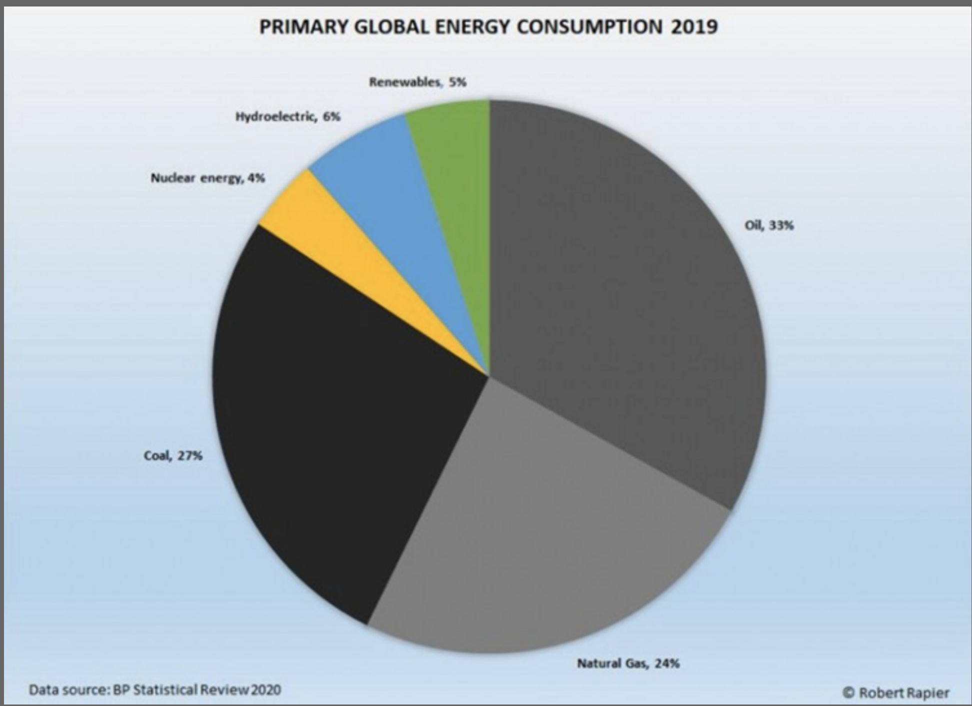
As previously said, the aesthetics of renewable energy should not take precedence at this time. These four principles, on the other hand, may aid in the social acceptance of renewable energy in local communities, which has an influence on the speed with which renewable energy may be deployed.

Due to the time constraints imposed by climate change, individuals and energy corporations should do all possible to transition to a renewable, low-carbon society, which may include making technology more visually appealing.

FOSSIL FUELS

Non-renewable resources are fossil fuels. They have existed for millions of years. Plants and animals were degraded by the heat, pressure, and movement of the strata, resulting in petroleum, oil, coal, and natural gas.

Global demand for fossil fuels has not yet reached its apex. Global energy consumption is increasing year after year, and as a result, the use of fossil fuels is increasing as well. We just do not have enough renewable energy to meet the full demand of our industry and populations.



Fossil fuel supplies, formed millions of years ago but only utilized for about 200 years, are rapidly depleting. It goes without saying that the exact date when these fuels will run out is unknown. It is because we continue to uncover new reserves, but the number of new reserves is decreasing. Reserves are depleted: they can no longer meet the needs of our people at existing and projected levels of use.

Former Saudi oil minister Sheik Ahmed Zahi Yamani said: "The stone age came to an end, not for lack of stones, and the oil age will end, but not for lack of oil."

Fossil Fuel That Will Burnout Soon

According to research based on 2015 data, the current statement of when our reserves will be emptied is this:

- Oil: 51 years
- Coal: 114 years
- Natural gas: 53 years

Oil

In 2018, global oil demand increased by 1.3 percent. Oil currently provides around 40% of the world's energy and 96% of its transportation energy. It has used up 875 billion barrels of oil. Every year, the globe consumes the equivalent of almost 11 billion tonnes of coal. Reserves of crude oil are depleting at a rate of around 4 billion tonnes per year. Many oil wells have already reached their limit, and finding new wells is getting increasingly difficult. There are still 1,000 billion barrels of proven and probable reserves to be found.

Natural Gas

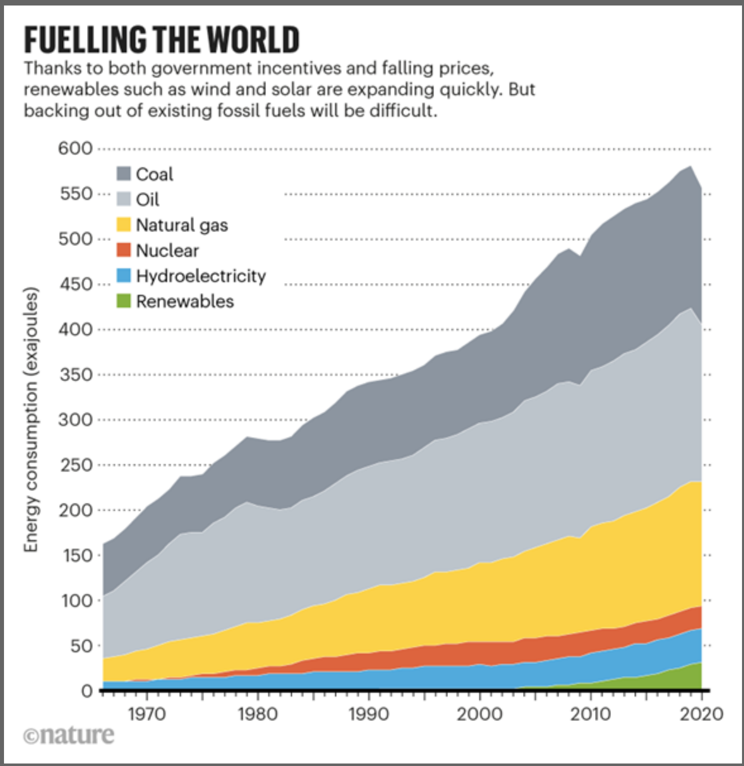
Gas accounted for 23% of total energy consumption in 2018, yet it expanded at a 4.6 percent annual pace. At 23 percent of total energy output, or 6,091 TWh, gas came in second.

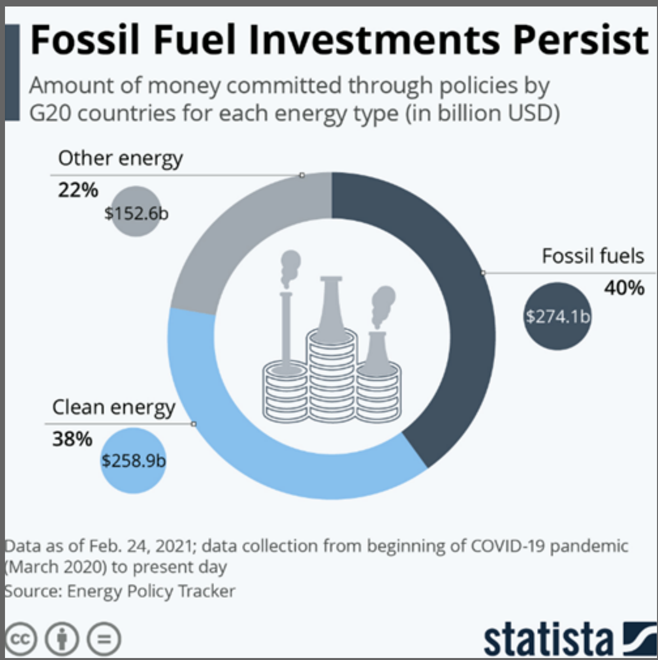
Based on current natural gas production rates and known natural gas reserves, we have approximately 52.8 years of natural gas reserves remaining. By the time oil runs out in 2052, we'll still have gas and coal. However, if we boost gas production to replace the energy void left by oil, those reserves will only last another eight years, bringing us to 2060. We should be aware that consuming gas contributes to global warming by emitting CO_2.

Coal

In 2018, global coal demand increased by 0.7 percent . Coal's share of overall power generation increased by 2.6 percent to 10,116 TWh in 2018, accounting for 38 percent of global generation.

According to the International Energy Agency, worldwide coal consumption grew by 1% in energy terms in 2017, or 50.4 megatons of coal equivalent (Mtce). China and India are once again in the forefront of rising consumption. Coal-fired power generation is the single greatest source of CO2 emissions, accounting for 30% of all energy-related CO2 emissions.





Harmful effects of Fossil Fuels to our Environement

1.Degradation of Land

Fossil fuel extraction necessitates the disturbance of huge tracts of land for infrastructure such as access roads, pipelines, processing facilities, and waste storage, in addition to the main extraction site (such a mine). These actions are so devastating that once the extraction operations are through, the land will be unable to recover, leaving wildlife habitats divided and devastated.

2.Water Pollution

Acid runoff from coal mining activities is washed into streams, which subsequently flow into rivers and lakes. Drilling and fracking for oil also produces massive amounts of wastewater including heavy metals and radioactive elements, which frequently leak out of the underground storage wells.

3.Increase in Temperature

A lot of carbon dioxide is released into the atmosphere when fossil fuels like coal, oil, and natural gas are burned. Because of which heat gets trapped in the atmosphere, resulting in climate change by increasing the temperature.

4.Air Pollution

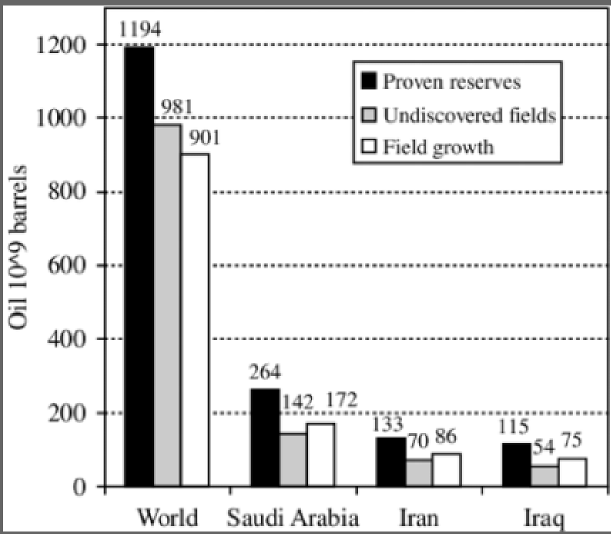
Mercury emissions are produced when coal is burned in power plants. Soot and sulfur dioxide are also produced when coal is burned. Poisonous carbon monoxide and nitrogen oxide from our fossil fuel-powered automobiles, trucks, and boats cause smog in our cities which causes a lot of respiratory problems

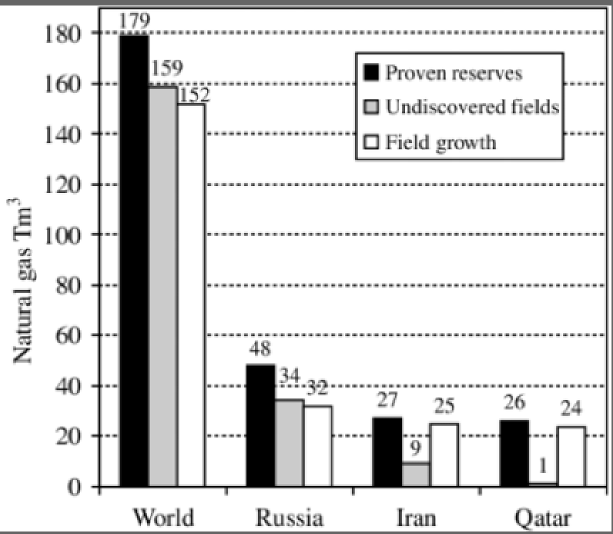
5.Ocean Acidification

The chemistry of the ocean is affected by the carbon emissions The ocean absorbs up to a quarter of all human-generated carbon emissions, and as a result has gotten 30% more acidic since the Industrial Revolution began. When our oceans become more acidic, oysters, lobsters, and other marine animals have less calcium carbonate available to form shells. This might have far-reaching consequences for whole food systems.

POSSIBILITY OF UNDISCOVERED RESERVES

Based on past geological experience, it is believed that other recoverable reserves exist in certain areas although it is not yet proved.
For instance, the Energy Information Administration in the US estimates in their 'U.S. Crude Oil, Natural Gas, and Natural Gas Liquids Reserves 2006 Annual Report' that 130.2 billion barrels of crude oil, 724.8 Tcf of dry natural gas, and 7.7 billion barrels of natural gas liquids remain undiscovered in the US.





The above charts show a comparison of oil and natural gas reserves, proven and undiscovered, of main supply countries of the year 2005, along with the potential field growth.

U.S. Geological Survey's Assessments of Undiscovered Reserves of Williston Basin Province, North Dakota and Montana

Undiscovered Oil Reserves in the Bakken and Three Forks Formations 2021

The USGS assessed 15 Assessment Units or AUs for undiscovered but technically recoverable continuous oil, gas, and natural gas liquid resources for the Bakken and Three Forks Formations in the Williston Basin of North Dakota and Montana

They estimated undiscovered mean resources of 4.3 billion barrels of oil and 4.9 trillion cubic feet of gas (associated) in the area.
The following maps outline the assessment units covered in their study:

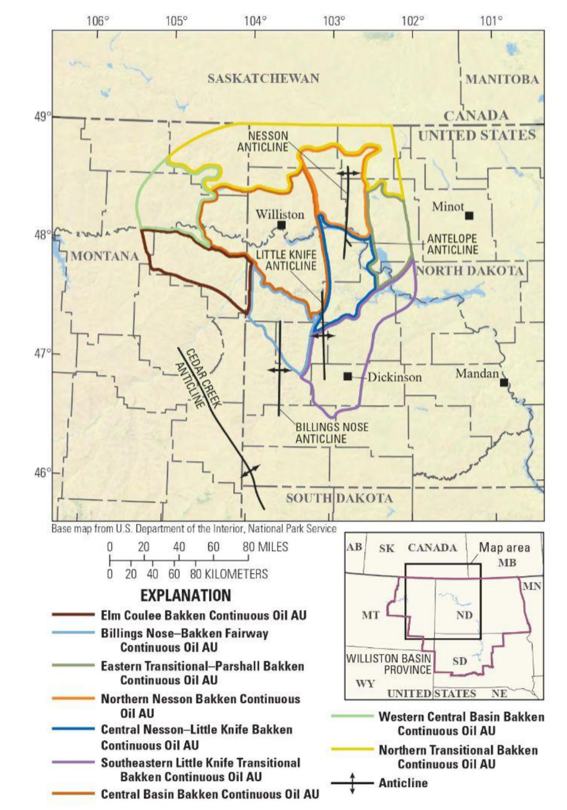


Figure 1. Map showing the Bakken Formation assessment units (AUs), North Dakota and Montana. Major structural features are also shown. Inset map (bottom right) shows the Williston Basin Province boundary.

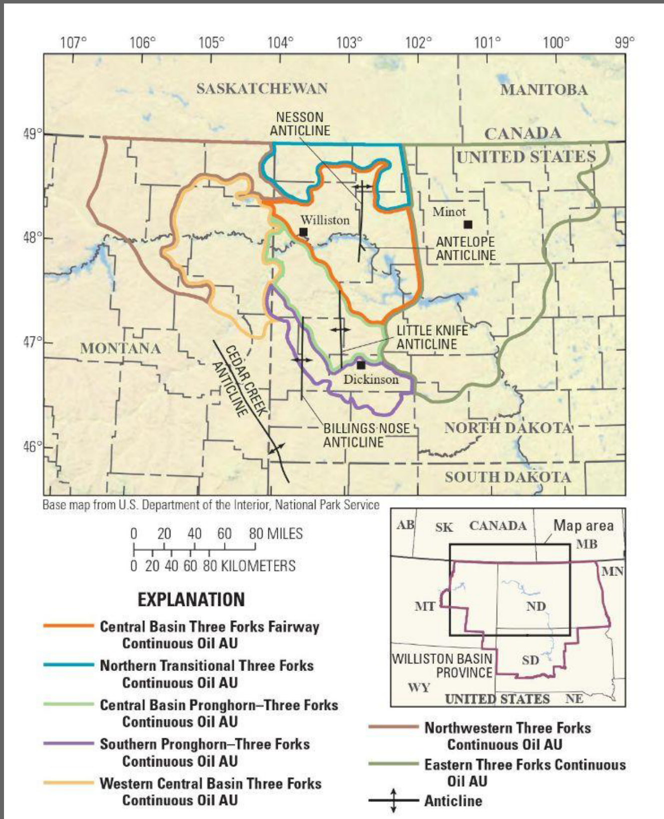


Figure 2. Map showing the Three Forks Formation assessment units (AUs), North Dakota and Montana. Major structural features are also shown. Inset map (bottom right) shows the Williston Basin Province boundary.

Undiscovered Gas Resources in the Williston Basin Province, 2020

The USGS assessed undiscovered conventional gas, continuous gas, and natural-gas liquid resources and estimated a mean of 2,438 billion cubic feet of gas resources in the Williston Basin Province, in North Dakota, Montana, and South Dakota.

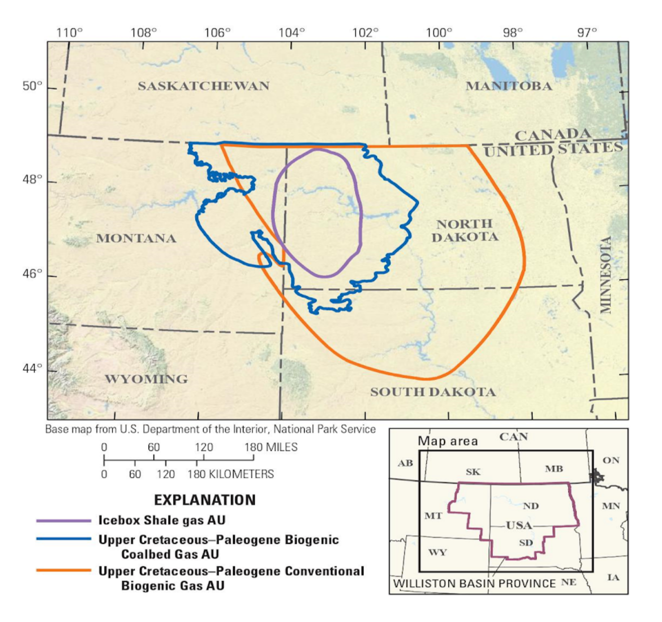


Figure 1. Map showing the location of three gas assessment units (AUs) in the Williston Basin Province, North Dakota, Montana, and South Dakota. Adjacent lines indicate a shared boundary at the outermost line.

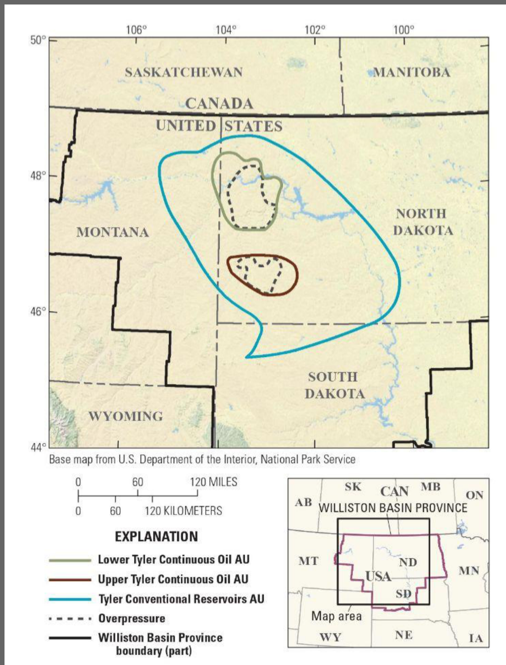


Figure 1. Map showing the location of three assessment units (AUs) in the Tyler Formation in the Williston Basin Province, North Dakota.

Undiscovered Oil and Gas Resources in the Pennsylvanian Tyler Formation, 2020

USGS assessed the potential for undiscovered, technically recoverable conventional and continuous, or unconventional, oil and gas resources in the Pennsylvanian Tyler Formation of the Williston Basin Province. 3 AUs were defined within the Tyler Formation, and each was assessed for undiscovered resources. They estimated undiscovered, technically recoverable mean resources of 161 million barrels of oil and 93 billion cubic feet of gas in the Tyler Formation.

Undiscovered Conventional Oil and Gas Resources of Upper Paleozoic Strata, 2020

The USGS assessed the potential for undiscovered, technically recoverable conventional oil and gas resources in six upper Paleozoic total petroleum systems (TPSs). Eight geologically defined AUs were assessed within these TPSs for undiscovered oil, gas, and natural gas liquids

They estimated undiscovered oil and gas resources of 134 million barrels of oil and 81 billion cubic feet of gas in upper Paleozoic strata of the province.

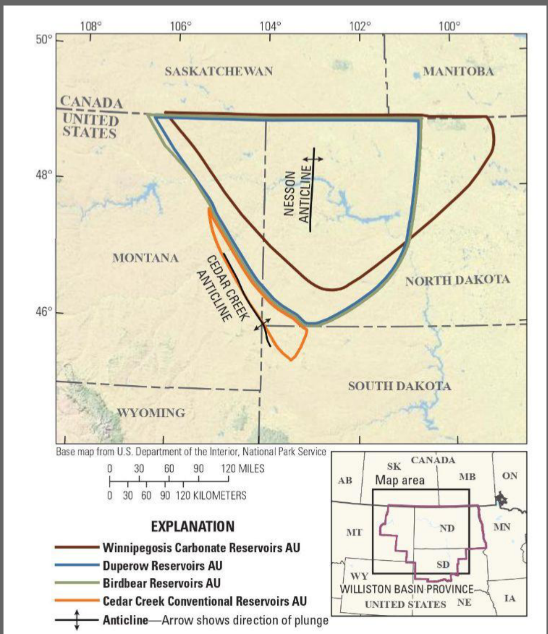


Figure 1. Map showing the location of four assessment units (AUs) in the Winnipegosis, Duperow, and Cedar Creek Paleozoic Composite Total Petroleum Systems in upper Paleozoic strata of the Williston Basin Province, North Dakota, Montana, and South Dakota. Adjacent lines indicate a shared boundary at the outermost line.

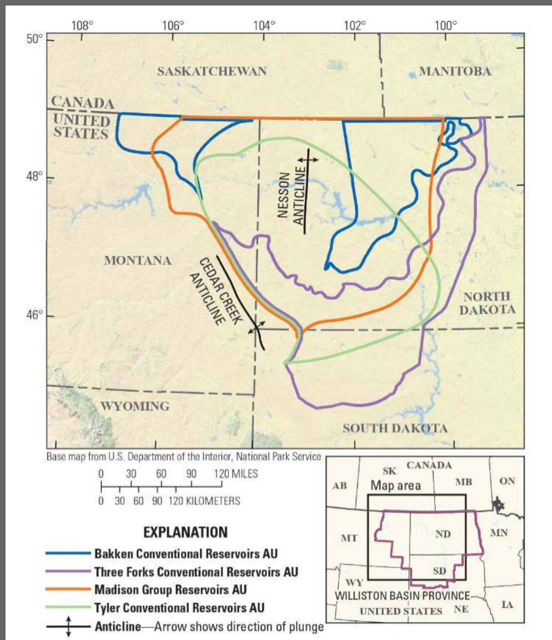


Figure 2. Map showing the location of four assessment units (AUs) in the Bakken, Madison Composite, and Pennsylvanian Total Petroleum Systems in upper Paleozoic strata of the Williston Basin Province, North Dakota, Montana, and South Dakota. Adjacent lines indicate a shared boundary at the outermost line.

The Undiscovered resources of the Arctic

The Arctic is believed to be one of the last frontiers of natural resource discovery, harboring vast reserves of undiscovered oil, natural gas and minerals.

In terms of oil, it's estimated that the Arctic has 90 billion barrels of oil that is yet to be discovered, which is equivalent to: 5.9% of the world's known oil reserves, about 110% of Russia's current oil reserves, or 339% of U.S. reserves.

The Arctic also has an estimated 1,669 trillion cubic feet of natural gas, which is equivalent to: 24.3% of the world's current known reserves, 500% of U.S. reserves, 99% of Russia's reserves, or 2,736% of Canada's natural gas reserves.

However getting these resources is more than just a hassle. It involves mining costs that can easily reach billions, difficulty transporting goods and supplies due to a short shipping season, dangers of crumbling infrastructure due to melting permafrost, summer swamps, icebergs, polar bears and a harsh winter with -50° C temperatures.

India's Undiscovered Reserves

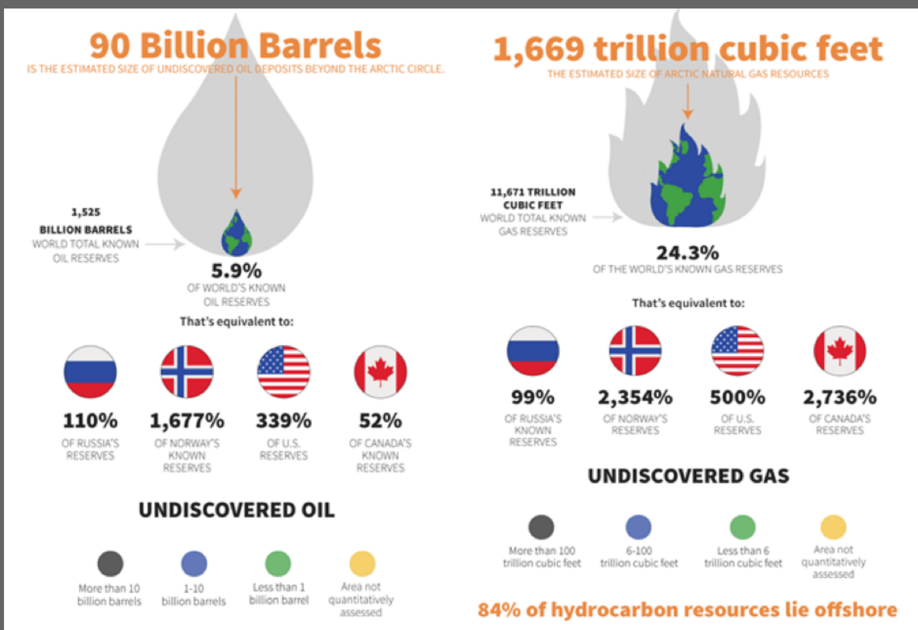
India has a large potential for energy, though most of it is hidden in explored and difficult-to-access basins. Technological advancements can make exploration and discovery of these reserves possible, though there are many logistical and infrastructural challenges.

An estimated 75% of India's sedimentary basins have yet to be adequately explored, with only 7 of the 26 known sedimentary basins producing oil and gas currently.

As per an article by Quartz in 2015, there is an incredible opportunity to narrow India's energy imbalance and reinvest the nearly $306,000,000 spent daily on foreign energy sources.

As per a report published in 2013, balance recoverable reserves of 2110 MMT of oil and oil equivalent gas could be established through exploration by ONGC, OIL and private or joint venture companies. About 60% of the resources, thus, can be placed under the 'yet to find' category.

It is estimated that a number of sedimentary basins in India, including the hydrocarbon bearing ones, have large shale deposits.



Various agencies have estimated the shale gas and oil resource potential in selected sedimentary basins in India:
M/s Schlumberger estimated the presence of 300-2100 TCF of undiscovered shale gas resources.
EIA, USA in 2011 estimated that Cambay Onland, Damodar, Krishna Godavari Onland and the Cauvery Onland basins have about 290 TCF of shale gas resources.
EIA, USA in 2013 estimated that the aforementioned basins have 584 TCF of shale gas and 87 billion Barrels of shale oil resources.
ONGC estimated that Cambay Onland, Ganga Valley, Assam & Assam Arakan, Krishna Godavari Onland and Cauvery Onland basins have about 187.5 TCF of shale gas resources.
Central Mine Planning and Design Institute estimated that Jharia, Bokaro, North Karanpura, South Karanpura, Raniganj, and Sohagpur basins have about 45 TCF of shale gas resources.
USGS estimated that Cambay Onland, Krishna Godavari Onland and Cauvery Onland basins have shale gas resources of about 6.1 TCF.

According to an article published by the Business Standard, India has 42 billion tonnes of oil equivalent reserves, as per a new assessment done in 2018. The estimate was 49% higher than the last assessment, which projected, in 1996, around 28.09 billion tonnes of oil equivalent resources in 15 sedimentary basins in India.

NUCLEAR ENERGY

Nuclear energy is the energy that is released from the nucleus atoms. It can be produced in two ways: fission – when nuclei of atoms split into several parts – or fusion – when nuclei fuse together.

Reactor type	Main countries	Number	GWe	Fuel	Coolant	Moderator
Pressurized water reactor (PWR)	USA, France, Japan, Russia, China, South Korea	304	288.7	enriched UO_2	water	water
Boiling water reactor (BWR)	USA, Japan, Sweden	61	61.8	enriched UO_2	water	water
Pressurized heavy water reactor (PHWR)	Canada, India	48	24.5	natural UO_2	heavy water	heavy water
Advanced gas-cooled reactor (AGR)	UK	11	6.1	natural U (metal), enriched UO_2	CO_2	graphite
Light water graphite reactor (LWGR)	Russia	11	7.4	enriched UO_2	water	graphite
Fast neutron reactor (FBR)	Russia	2	1.4	PuO_2 and UO_2	liquid sodium	none
High temperature gas-cooled reactor (HTGR)	China	1	0.2	enriched UO_2	helium	graphite
TOTAL		438	390.1			

History Of Nuclear Energy

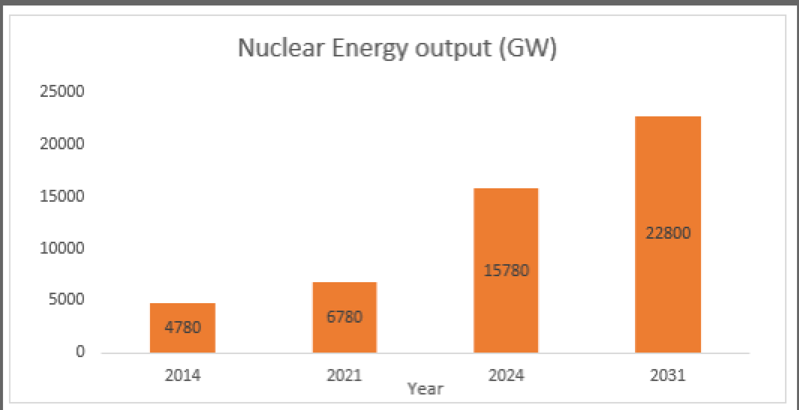
The ideation of tapping into nuclear power began in the early 1930s, when physicist Enrico Fermi first displayed that neutrons could split atoms. He led a team that in 1942 achieved the first nuclear chain reaction, under a stadium at the University of Chicago.

NUCLEAR ENERGY IN INDIA

India is the lone player among developing nations to have generated electricity using indigenously developed and deployed nuclear reactors.

Nuclear energy currently stands as the fifth-largest source of electricity for India.

India stands at seventh position in terms of the number of nuclear reactors, having 23 nuclear reactors in 7 power plants which produces 6780 MW of nuclear power.



What is Nuclear energy? What are the benefits of Nuclear energy?
Nuclear power is a very efficient way of boiling water to create steam which is used to turn turbines and generate electricity. Compared to other forms of renewable energy, Nuclear energy is more beneficial, because of its smaller land footprint and the amount of waste it produces. It uses 360 times less amount of land as compared to wind farms and 75 times less land as compared to solar photovoltaic plants. Also, Nuclear fuel is energy-dense as a 1-inch-tall Uranium pallet is equivalent to 120 gallons of oil and about 17,000 cubic feet of natural gas.

Significance of Nuclear power to India
Nuclear energy is very significant for India. On 3rd December, 2021, Mr. Anil Kakodkar, the former chairman of the Atomic Energy Commission, stated that India can't attain the net-zero target without nuclear power, also stating that the nuclear power grid alone can help India to provide low-cost power and assist in Grid balancing. In the long run, we are planning to increase the percentage contribution of nuclear energy to 25% of the total power capacity. The Jiatapur project established in Maharashtra is projected to bring in 21,000 crores (US$ 2.8 billion) in revenues for the government alongwith creating 50,000 jobs

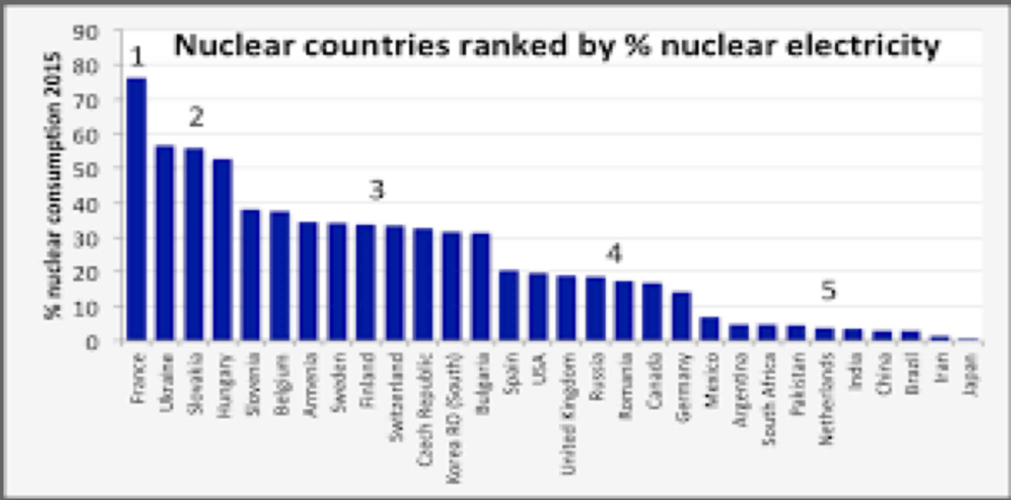
India's Nuclear Energy Program
The primary objective of India's nuclear energy program is the utilization and development of Atomic energy for peaceful purposes. India wanted to develop a cheap and efficient power source and use this energy for various research purposes like basic sciences, astronomy, astrophysics, cancer research and education. India's nuclear program is based on an ambitious three-stage power production program; which is meant to be a closed fuel cycle program in which every stage feeds into the other.

To better understand this, in the first stage of the nuclear fuel cycle, the spent nuclear fuel still contains 96% of reusable material which is used again in the second stage and the spent fuel of the second stage is reused for the third stage, thus creating a closed chain where the fuel is being reused and recycled to maximize efficiency.
We were able to successfully reach the first stage of the nuclear energy program in 2013 with over 22 nuclear reactors in 7 nuclear power plants. These reactors produce 6780 MW of nuclear energy and have already generated 755 billion units of electricity alongwith saving 650 million tons of CO2 emissions.

We are currently on the second stage of this nuclear program. The country is planning to construct 12 new nuclear power reactors by 2024 which will further reduce the price from Rs 4 (US$ 0.05) per unit to Rs 3 (US$ 0.03) per unit and thus, help to drive the country's nuclear ambitions forward. India will have its first-ever northern reactor by 2024. 9 nuclear reactors are already under construction with an additional nuclear capacity of 6700 MW. 12 more reactors have been approved and sanctioned with an additional capacity of 9000 MW. In 2019 , the Government of India had allotted the Department of Atomic energy a budget of INR.10,000 crore (US$ 1.31 billion) and proposed to increase the budget by 10,000 crores every year, for the next 10 years. The approved nuclear power plant in Jaitapur, Maharashtra will produce 9900 MW of energy and will be the world's most powerful nuclear power plant, which will create thousands of jobs. This project is being carried forward in collaboration with the French government.

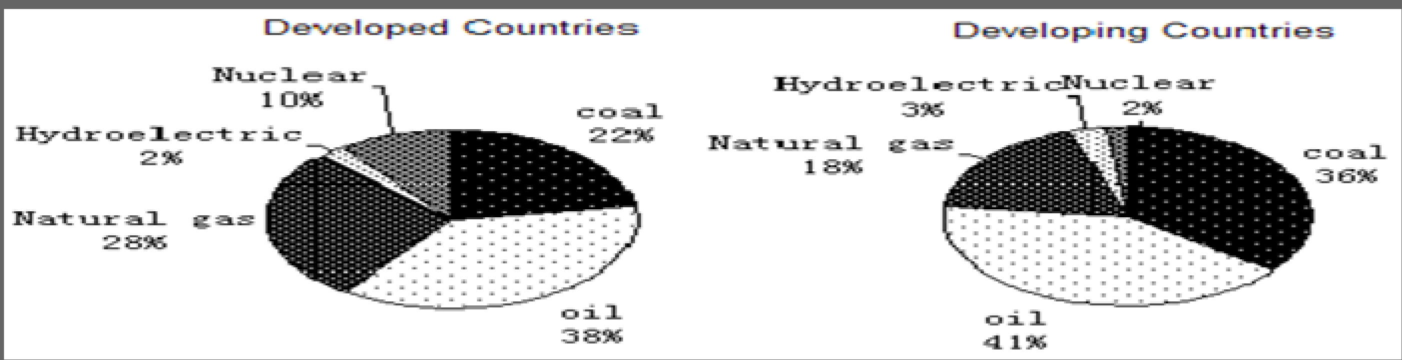
Future of Nuclear energy in India

India's nuclear power could provide a reliable solution to the rising power demand as against wind and solar energy that are not available round the clock. This will lead to a reduction in India's contribution to global Green House Gases (GHG) which stands at 6.55%, with energy sector contributing a little over two-third towards it. The current nuclear power capacity of India which is standing at 6,790 MW is expected to increase to 22,480 MW by 2031. This in turn will be assisting us in meeting the net zero energy targets along with other clean energy sources



NUCLEAR USAGE OF DEVELOPED AND DEVELOPING

Nuclear energy contributes to more than 12% to total electricity generation in industrialized countries, including those in Europe which have centrally-planned economies. However, it still is on the backfoot as an energy source in developing countries



PROS AND CONS

Pro – Low carbon

Unlike traditional fossil fuels, nuclear energy does not emit greenhouse gas emissions like methane and CO2.It produces roughly the same or less emissions as renewable sources , thus making it an environmentally friendly source of energy.

Con – If it goes wrong...

Despite all the safety measures in place for these nuclear plants, in history various factors caused them to go into meltdown, which proved to be devastating for the environment and for local inhabitants who had to flee the affected areas.

Pro – Not intermittent

Nuclear power, however, is not intermittent, as nuclear power plants can run for a year without any interruptions or maintenance, making it a more reliable source of energy.

Con – Nuclear waste

One major side effect of nuclear power is the amount of nuclear waste it produces. Estimates suggest that that the world produces some 34,000m3 of nuclear waste each year which then takes years to degrade.

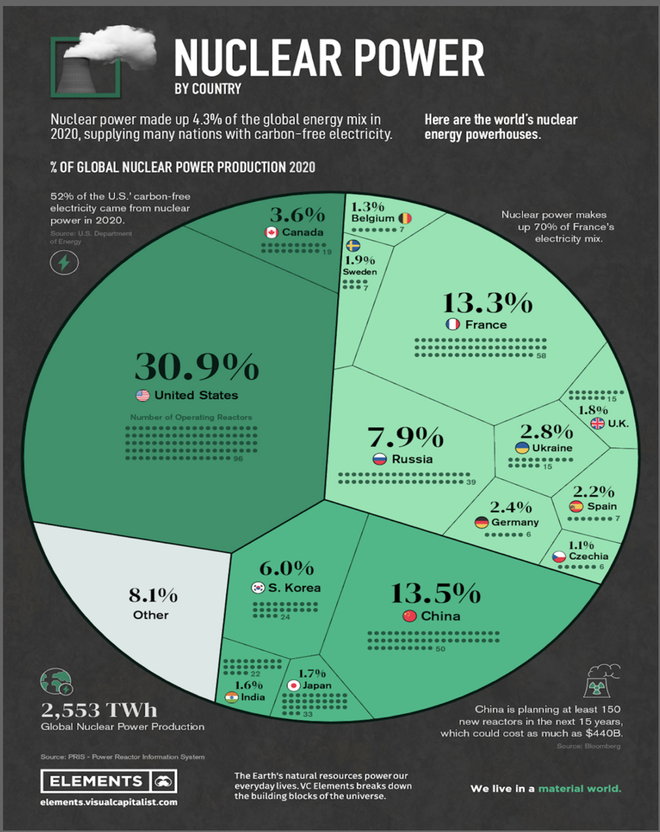
Pro – Cheap to run

Nuclear power plants are cheaper to run than their coal or gas rivals. Estimates claim that even factoring in costs such as managing radioactive fuel and disposal nuclear plants cost between 33 to 50% of a coal plant and 20 to 25% of a gas combined-cycle plant.

Con – Expensive to build

The initial costs for building a nuclear power plant are huge. A recent virtual test reactor in the US estimated rose from $3.5bn to $6bn alongside huge extra costs to maintain the facility.

In recent news, the German government has confirmed that it considers nuclear energy dangerous and objects to European Union proposals. Germany, which is on course to turn off its remaining three nuclear power plants by the end of this year also plans to phase out coal by 2030. On the other hand, its neighbor France aims to modernize existing reactors and build new ones to meet its future energy needs.



SOLAR ENERGY THE SUNNY SIDE OF LIFE

WHAT IS SOLAR ENERGY ?

The radiation from the Sun is capable of producing heat, causing chemical reactions, or generating electricity, this radiation is harnessed to produce Solar energy. The total amount of solar energy received on Earth is vastly more than the world's current and anticipated energy requirements. If suitably harnessed, solar energy has the potential to satisfy all future energy needs, 10 times over.

HISTORY OF SOLAR ENERGY

Solar energy is not a recent discovery, in theory, solar energy was used by humans as early as 7th century B.C. In its most primitive state, energy from the sun has been revered and put to use almost as long as man has walked the earth. The earliest use of solar energy can be traced to ancient civilizations using magnifying glass materials or polished bronze plates to start fires for cooking.

By the 3rd century B.C., Greeks and Romans bounced sunlight off of “burning mirrors” to light sacred torches for religious ceremonies. Chinese civilization documented the use of mirrors for the same purpose later in 20 A.D. Sunrooms were invented in ancient times to capture solar energy for its natural warmth. These usually south-facing rooms have captured and concentrated sunlight from the famous Roman bath houses to Native American adobes, and are still popular today in many modern homes.

Advantages: Six Pros To Going Solar

1. Reduces An Expense
Solar will reduce your electricity bill and give you some control over your fixed costs.

2. Protects You from Rising Electricity Rates
With solar energy, you'll purchase less or no electricity at all, which means you no longer have to be concerned about rising electricity prices. Electricity levels in residential areas have increased by 38% since 1990. Although prices vary from region to region, it's pretty likely that over time, electricity rates will only continue to go up. Investing in solar now will keep you safe from any future increases in electricity rates.

3. The Financial Return Is Front Loaded
With cost-saving incentives like tax credits, grants, and accelerated depreciation, you can quickly recover a large portion of the install cost in the first year.

4. Solar Will Grow Your Bottom Line
The savings generated by a solar system will drop right down to your bottom line.Solar power helps you eliminate cost. Let's compare that to revenue growth, where only a portion drops to your bottom line. For example, a $10k growth in revenue with 10% margins will only add $1,000 to your bottom line. $10k of savings from solar will add $10k to your bottom line. There are no property or labor costs eating into your savings.

5. It's Sustainable and Clean
As long as the sun continues to shine, your solar system will produce clean, emissions-free energy. Solar panels don't use any fossil fuels or give off any emissions while they're producing electricity. Everyone from your children to your customers will appreciate it, a claim supported by Neilsen research.

According to a recent report, 81% of customers feel strongly that businesses should help improve the environment, and 66% of global consumers are willing to spend more money on sustainable brands. Also, saving on your electricity bill will free up your budget so you can re-invest in the future of your business, farm, or home.

6. It's A Set and Forget Solution
There are no moving parts to a solar system, so the maintenance and upkeep will be minimal.

Disadvantages: Five Cons To Going Solar

1. No Electric If the Grid Goes Down
If the electric grid goes down, your solar system will shut down unless you have a battery backup system. Although your solar system can generate electricity from the grid, you won't have electricity in the event of a power outage, unless you've invested in a battery backup.
Due to the safety rules of the solar system connected to the grid, each system must be equipped with immediate shutdown components that will keep the electricity from flowing back into the grid. This means that if the power grid goes down at any time, your system will shut down until power is restored to the grid. This is legally required to protect those working on power lines.

2. The Initial Cost Can Be Intimidating
Solar is a significant investment that requires up-front capital or access to financing in order to save over the long-term.However, costs for installing solar have fallen substantially. From 2010 to 2018, the average installation cost per watt of solar energy has decreased 63.22% for residential projects and 66.3% for commercial projects. And with so many cost-saving incentives on the national and regional levels, solar has never been more affordable.

3. Sunshine Is Required

Your solar panels won't generate electricity if it's very cloudy or at night. Solar panels need sunlight to produce energy. Your system will produce little to no energy on cloudy days and at night. At those times, electricity is cut off from the grid, but that doesn't mean you can't use solar panels to provide 100% of your electricity.

Net Metering allows you to switch from 'solar power' to 'grid power' depending on the production of your solar system. Acting as basically free storage, you're able to trade the value of an unused kilowatt-hour (kWh) produced by your solar system for a kWh from the grid while your system is not producing.

And if you live in an area that isn't well known for sunshine, that doesn't mean solar isn't for you. Your installer should factor in local weather patterns when determining your system's payback, to get a realistic picture of what solar can do for you.

4. Space is Required

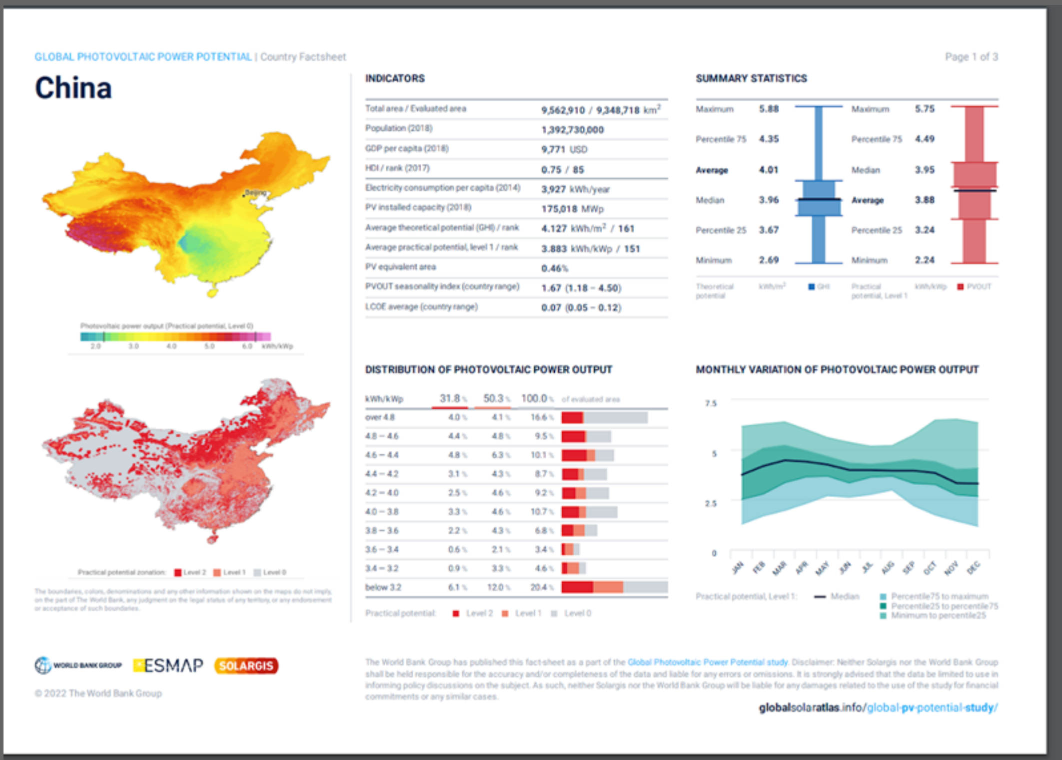
Whether a roof mount or ground mount, space is needed to install the panels.In most cases, solar panels can be installed on your roof, utilizing unused space. However, in some situations, a ground mount may be the better option, although it may be placed in a space that can be used for other purposes.

5. Can Reduce Curb Appeal

Depending on your tastes and where the system is installed, it can stand out.Depending on the placement, type of panels used, and the installation quality, solar systems can stand out and be unattractive. However, there are a few things you can do to take advantage of solar energy's savings while still keeping your business, farm, or home looking good. And when it comes to it, it's been pretty firmly established that solar panels actually add value to your space.

GLOBAL POTENTIAL

SOLAR ENERGY IN CHINA



GLOBAL PHOTOVOLTAIC POWER POTENTIAL | Country Factsheet

Page 1 of 3

China

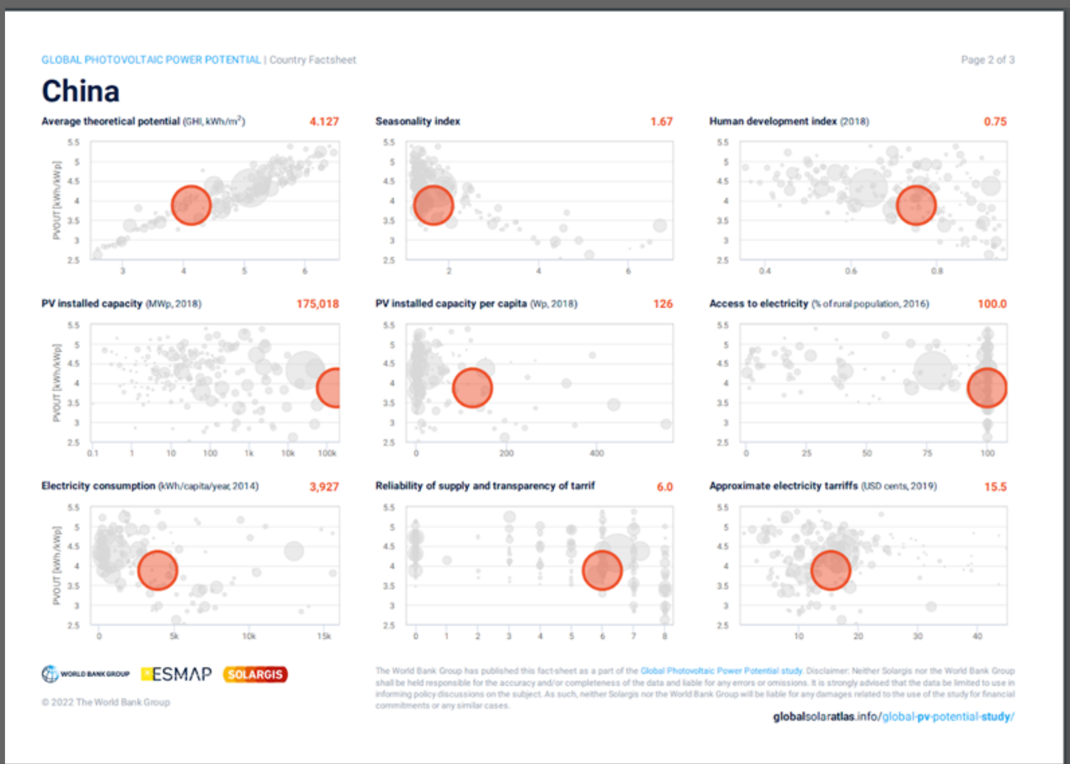
INDICATORS

Total area / Evaluated area	9,562,910 / 9,348,718 km²
Population (2018)	1,392,730,000
GDP per capita (2018)	9,771 USD
HDI / rank (2017)	0.75 / 85
Electricity consumption per capita (2014)	3,927 kWh/year
PV installed capacity (2018)	175,018 MWp
Average theoretical potential (GHI) / rank	4.127 kWh/m² / 161
Average practical potential, level 1 / rank	3.883 kWh/kWp / 151
PV equivalent area	0.46%
PVOUT seasonality index (country range)	1.67 (1.18 – 4.50)
LCOE average (country range)	0.07 (0.05 – 0.12)

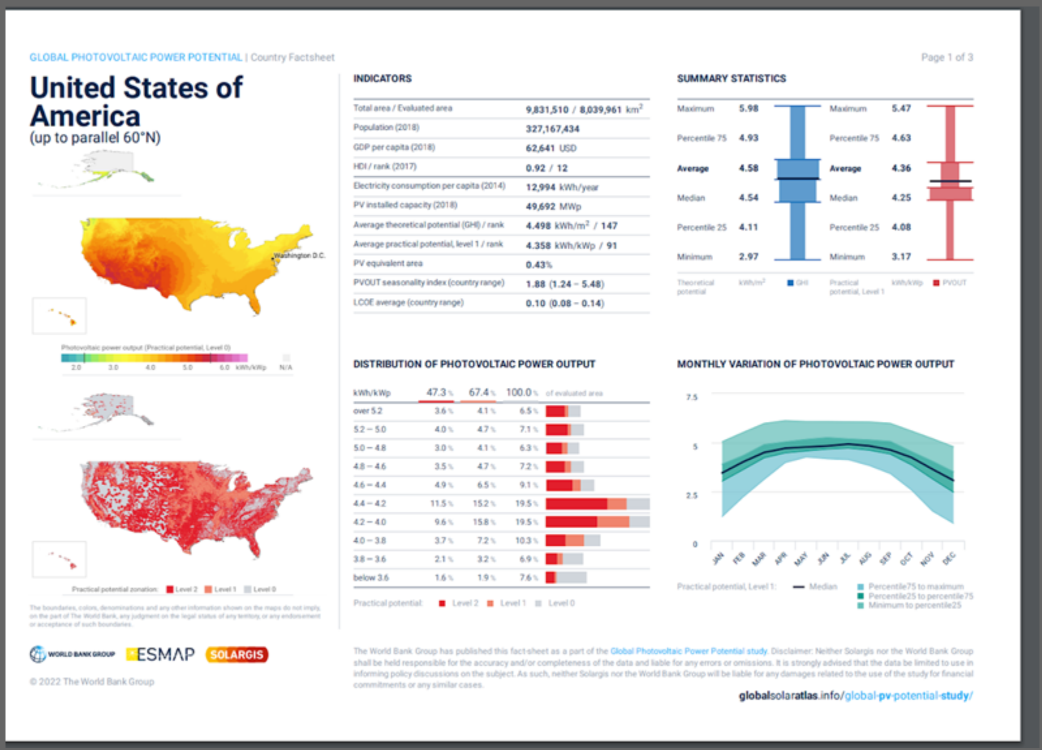
DISTRIBUTION OF PHOTOVOLTAIC POWER OUTPUT

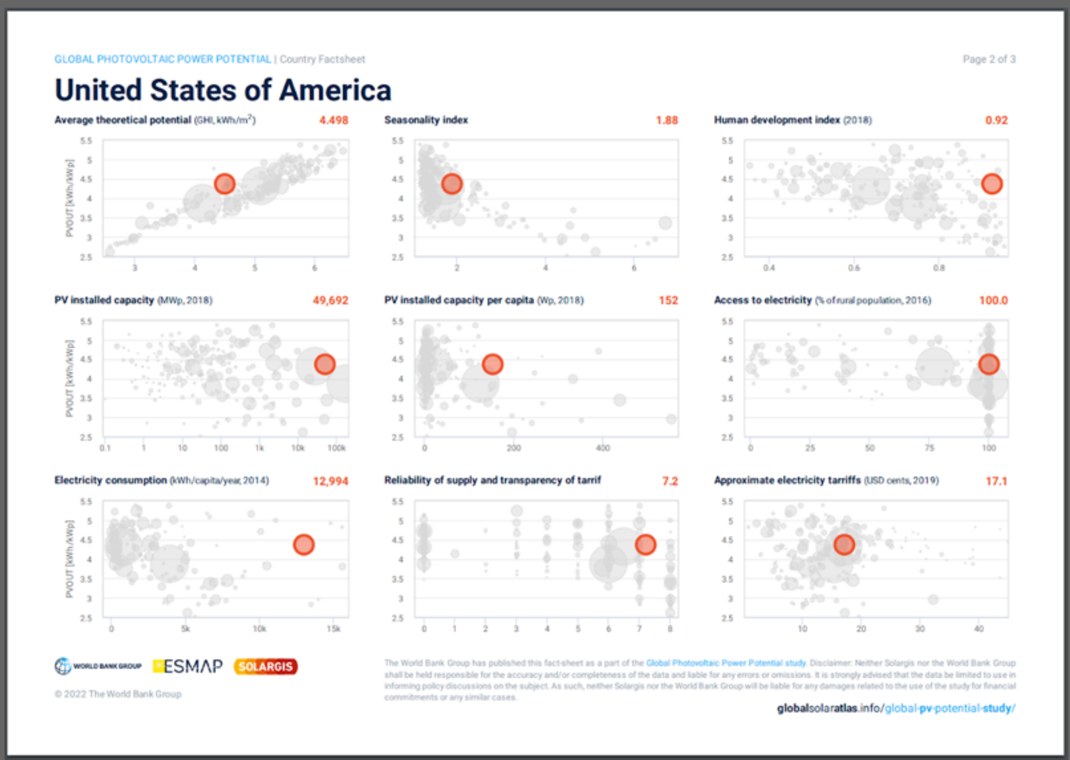
kWh/kWp	31.8 %	50.3 %	100.0 % of evaluated area
over 4.8	4.0 %	4.1 %	16.6 %
4.8 – 4.6	4.4 %	4.8 %	9.5 %
4.6 – 4.4	4.8 %	6.3 %	10.1 %
4.4 – 4.2	3.1 %	4.3 %	8.7 %
4.2 – 4.0	2.5 %	4.6 %	9.2 %
4.0 – 3.8	3.3 %	4.6 %	10.7 %
3.8 – 3.6	2.2 %	4.3 %	6.8 %
3.6 – 3.4	0.6 %	2.1 %	3.4 %
3.4 – 3.2	0.9 %	3.3 %	4.6 %
below 3.2	6.1 %	12.0 %	20.4 %

Practical potential: Level 2 Level 1 Level 0

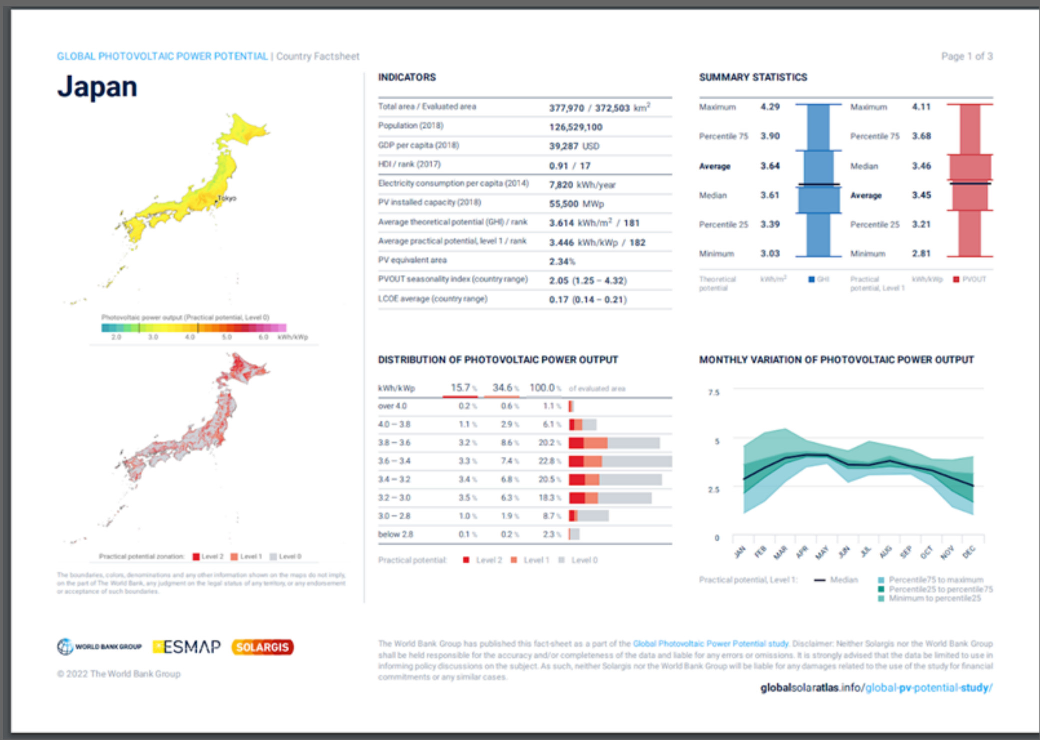


SOLAR ENERGY IN USA

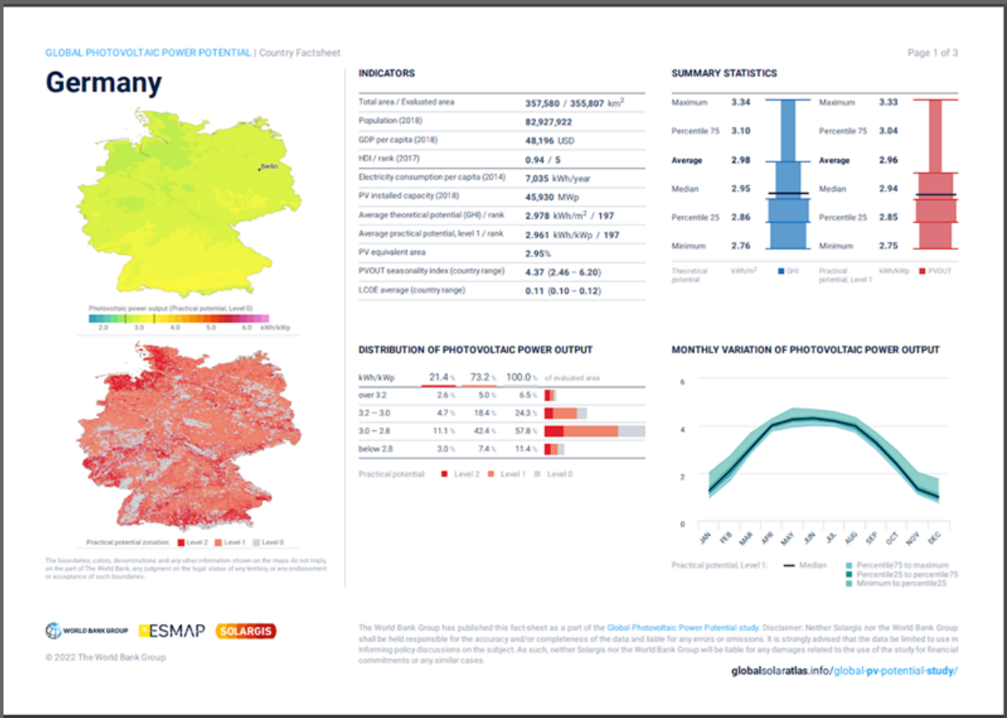




SOLAR ENERGY IN JAPAN



SOLAR ENERGY IN GERMANY



GLOBAL PHOTOVOLTAIC POWER POTENTIAL | Country Factsheet   Page 1 of 3

Germany

INDICATORS

Total area / Evaluated area	357,580 / 355,807 km²
Population (2018)	82,927,922
GDP per capita (2018)	48,196 USD
HDI / rank (2017)	0.94 / 5
Electricity consumption per capita (2014)	7,035 kWh/year
PV installed capacity (2018)	45,930 MWp
Average theoretical potential (GHI) / rank	2.978 kWh/m² / 197
Average practical potential, level 1 / rank	2.961 kWh/kWp / 197
PV equivalent area	2.95%
PVOUT seasonality index (country range)	4.37 (2.46 – 6.20)
LCOE average (country range)	0.11 (0.10 – 0.12)

SUMMARY STATISTICS

	Theoretical potential (GHI, kWh/m²)	Practical potential, Level 1 (PVOUT, kWh/kWp)
Maximum	3.34	3.33
Percentile 75	3.10	3.04
Average	2.98	2.96
Median	2.95	2.94
Percentile 25	2.86	2.85
Minimum	2.76	2.75

DISTRIBUTION OF PHOTOVOLTAIC POWER OUTPUT

kWh/kWp	21.4 %	73.2 %	100.0 % of evaluated area
over 3.2	2.6 %	5.0 %	6.5 %
3.2 – 3.0	4.7 %	18.4 %	24.3 %
3.0 – 2.8	11.1 %	42.4 %	57.8 %
below 2.8	3.0 %	7.4 %	11.4 %

Practical potential: Level 2, Level 1, Level 0

MONTHLY VARIATION OF PHOTOVOLTAIC POWER OUTPUT

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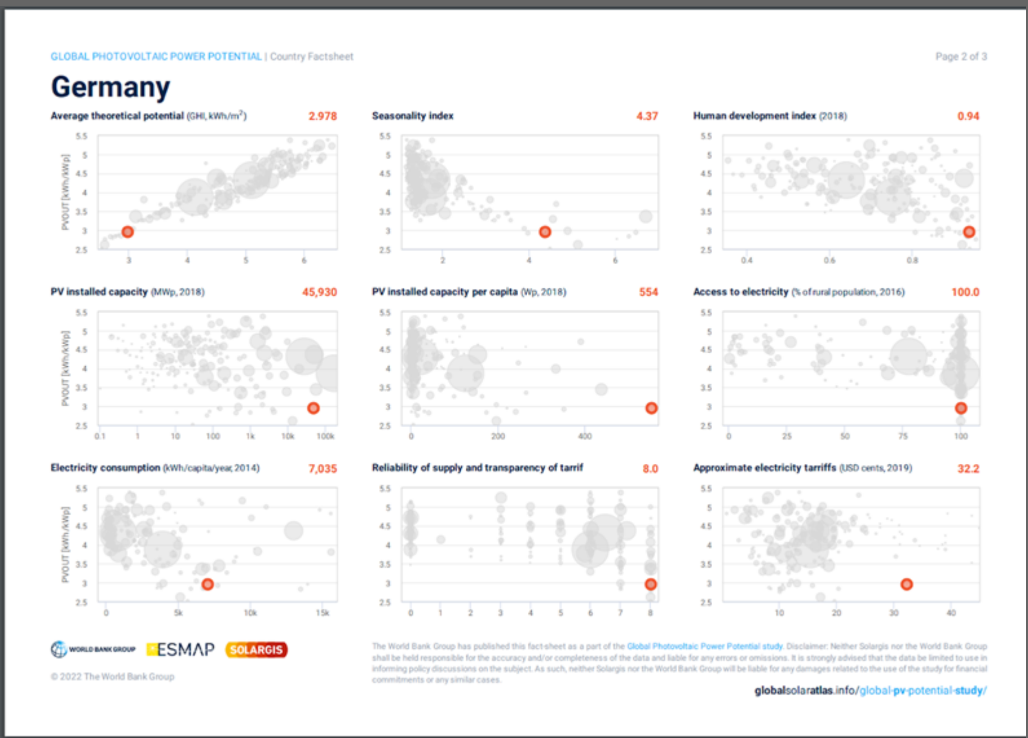

GLOBAL PHOTOVOLTAIC POWER POTENTIAL | Country Factsheet   Page 2 of 3

Germany

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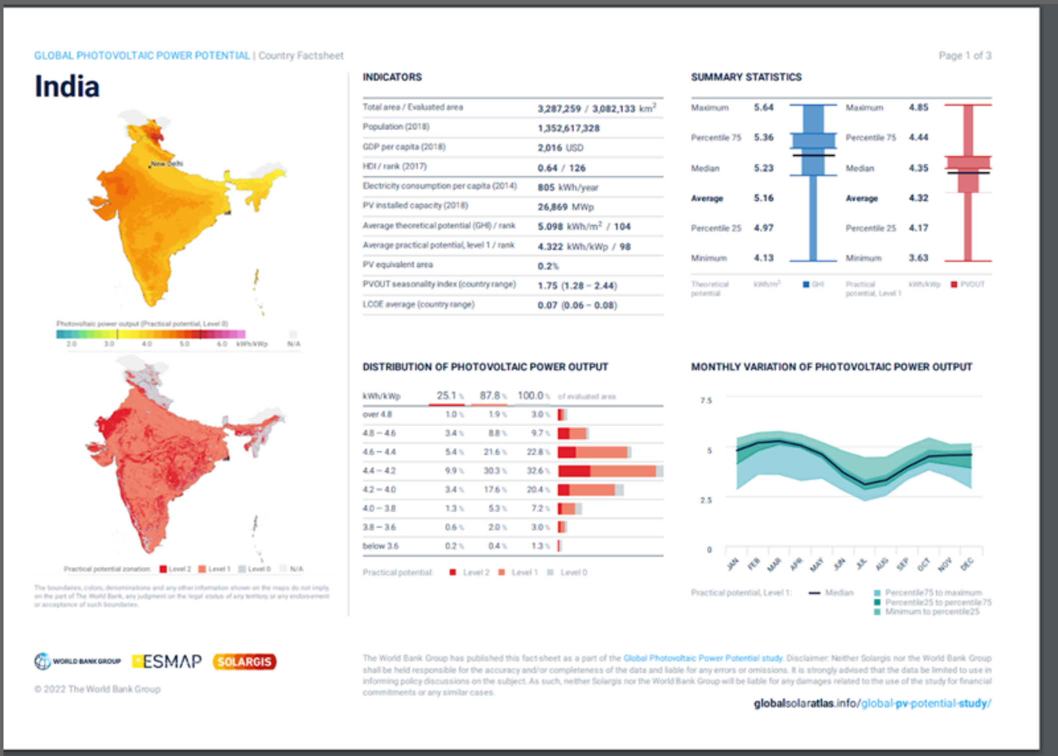
SOLAR ENERGY IN INDIA



GLOBAL PHOTOVOLTAIC POWER POTENTIAL | Country Factsheet

Page 1 of 3

India

Photovoltaic power output (Practical potential, Level 0)

Practical potential zonation: Level 2, Level 1, Level 0, N/A

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INDICATORS

Total area / Evaluated area	3,287,259 / 3,082,133 km^2
Population (2018)	1,352,617,328
GDP per capita (2018)	2,016 USD
HDI / rank (2017)	0.64 / 126
Electricity consumption per capita (2014)	805 kWh/year
PV installed capacity (2018)	26,869 MWp
Average theoretical potential (GHI) / rank	5.098 kWh/m^2 / 104
Average practical potential, level 1 / rank	4.322 kWh/kWp / 98
PV equivalent area	0.2%
PVOUT seasonality index (country range)	1.75 (1.28 – 2.44)
LCOE average (country range)	0.07 (0.06 – 0.08)

SUMMARY STATISTICS

	Theoretical potential (kWh/m^2, GHI)	Practical potential, Level 1 (kWh/kWp, PVOUT)
Maximum	5.64	4.85
Percentile 75	5.36	4.44
Median	5.23	4.35
Average	5.16	4.32
Percentile 25	4.97	4.17
Minimum	4.13	3.63

DISTRIBUTION OF PHOTOVOLTAIC POWER OUTPUT

kWh/kWp	25.1 %	87.8 %	100.0 % of evaluated area
over 4.8	1.0 %	1.9 %	3.0 %
4.8 – 4.6	3.4 %	8.8 %	9.7 %
4.6 – 4.4	5.4 %	21.6 %	22.8 %
4.4 – 4.2	9.9 %	30.3 %	32.6 %
4.2 – 4.0	3.4 %	17.6 %	20.4 %
4.0 – 3.8	1.3 %	5.3 %	7.2 %
3.8 – 3.6	0.6 %	2.0 %	3.0 %
below 3.6	0.2 %	0.4 %	1.3 %

Practical potential: Level 2, Level 1, Level 0

MONTHLY VARIATION OF PHOTOVOLTAIC POWER OUTPUT

Practical potential, Level 1: Median; Percentile75 to maximum; Percentile25 to percentile75; Minimum to percentile25

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GLOBAL PHOTOVOLTAIC POWER POTENTIAL | Country Factsheet

Page 2 of 3

India

Average theoretical potential (GHI, kWh/m^2) 5.098

Seasonality index 1.75

Human development index (2018) 0.64

PV installed capacity (MWp, 2018) 26,869

PV installed capacity per capita (Wp, 2018) 20

Access to electricity (% of rural population, 2016) 77.6

Electricity consumption (kWh/capita/year, 2014) 805

Reliability of supply and transparency of tariff 6.5

Approximate electricity tariffs (USD cents, 2019) 17.0

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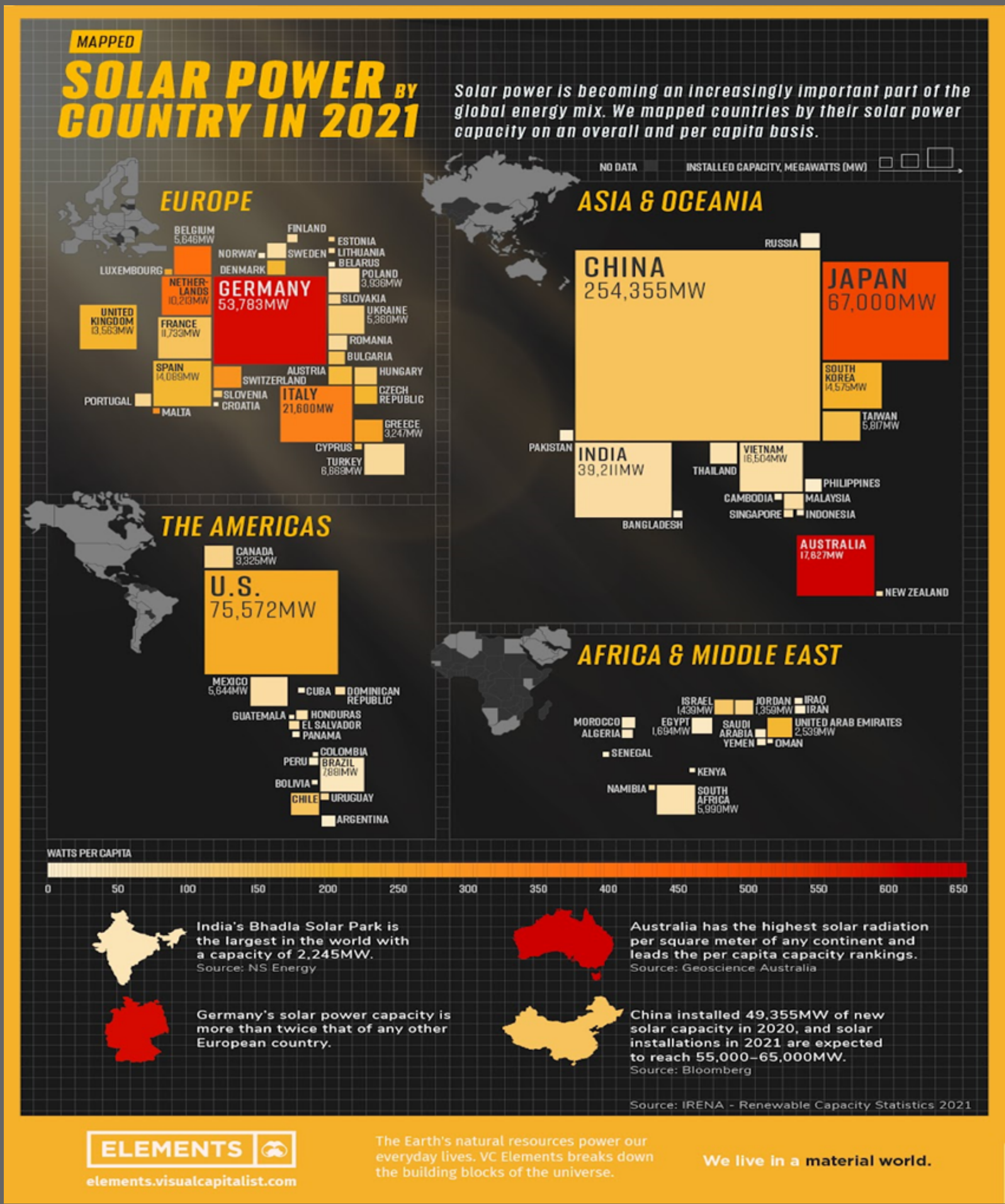
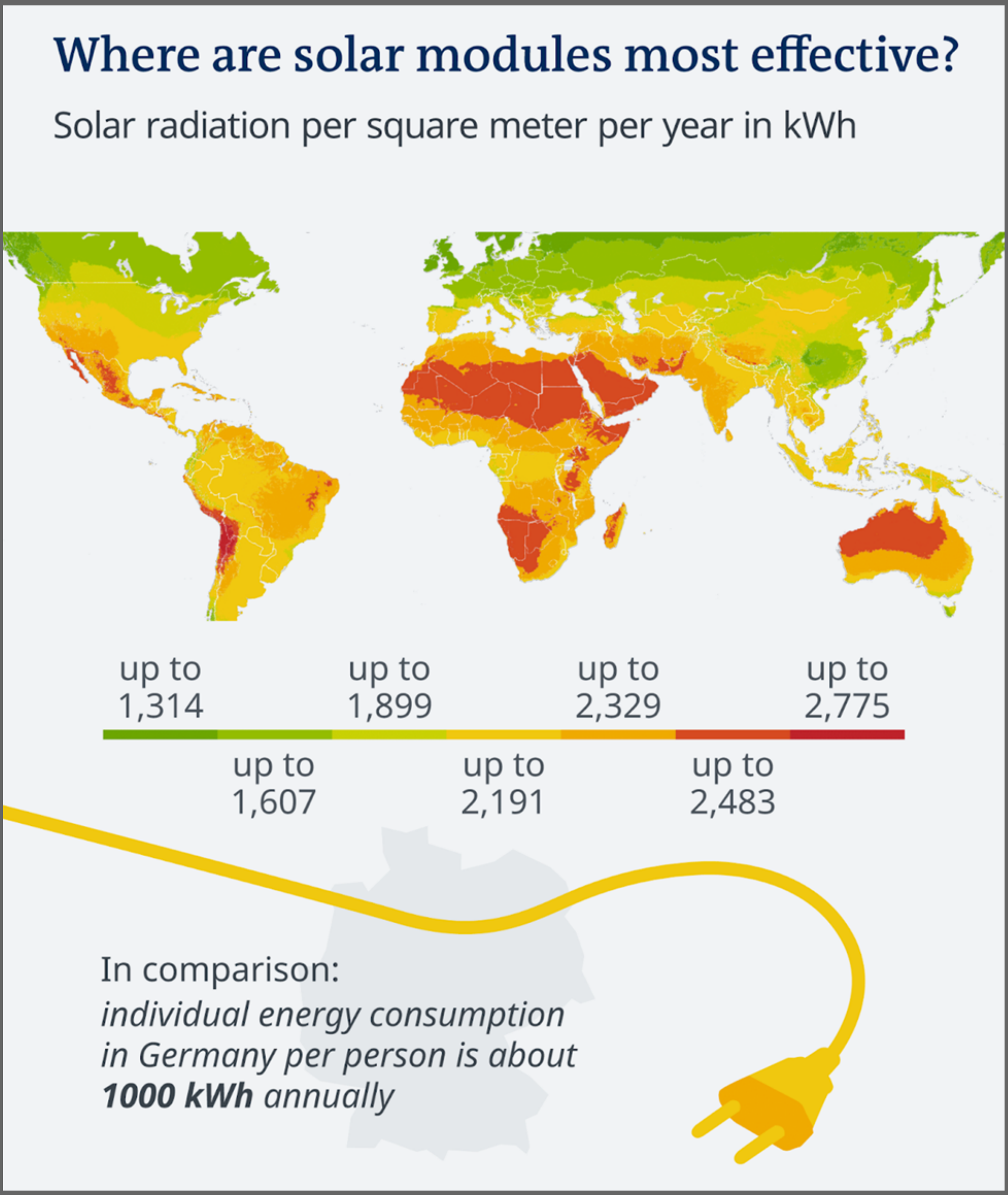
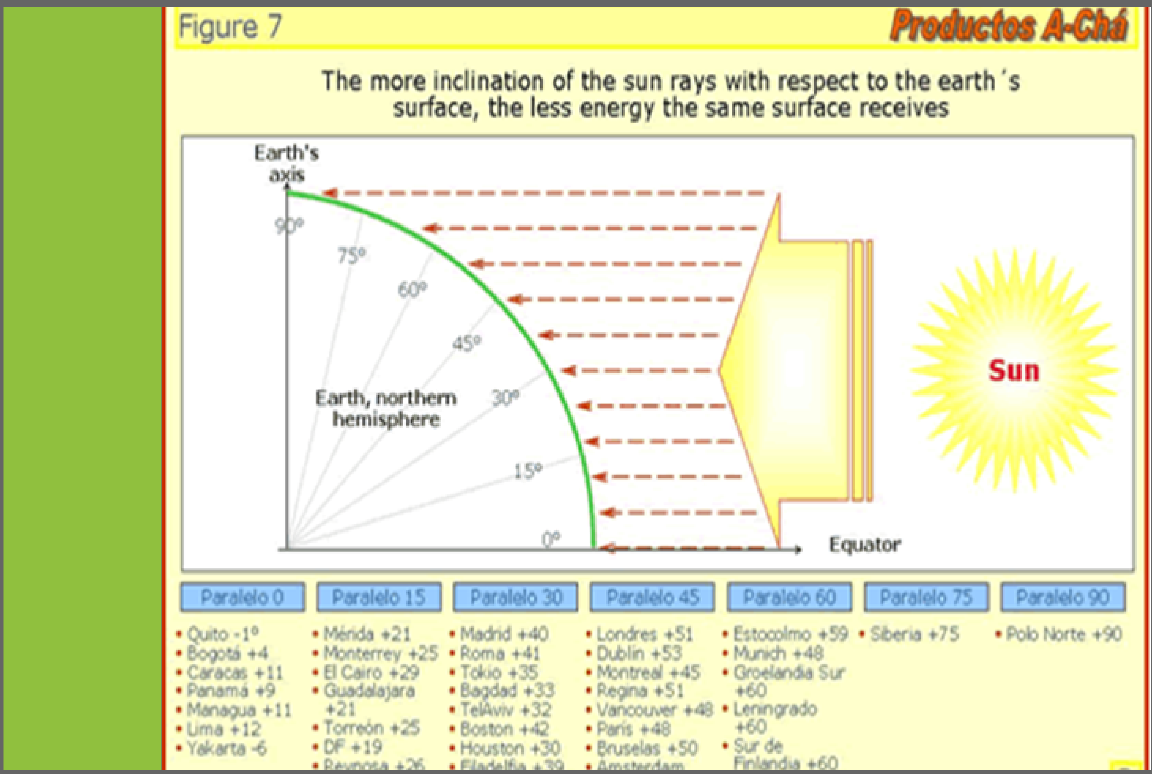
THE USE OF SOLAR ENERGY ACROSS THE GLOBE



THE ACTUAL POTENTIAL OF COUNTRIES TO HARNESS SOLAR ENERGY ACROSS THE GLOBE:



HOW DOES THE LATITUDINAL POSITION MATTER WHILE HARNESSING SOLAR ENERGY?



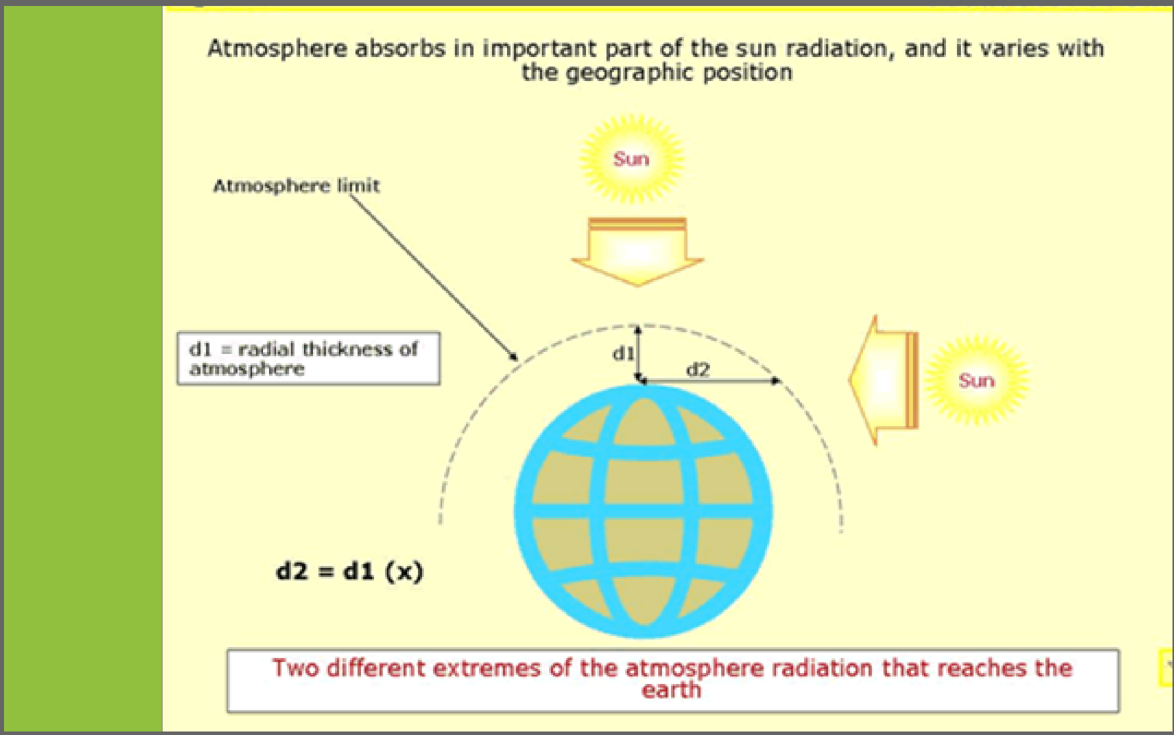
There are two main variables that affect the amount of solar energy delivered at every part of the world:

a) Sun rays inclination at the specific geographical point

b) Thickness of the atmosphere between the specific point and the sun

---

The curvature of the Earth causes the sun's energy to spread out over wider areas with increasing latitude. The amount of solar energy in a given area is highest at the equator and gradually decreases with the increasing latitudes. So much so that the equator is able to harness as much as 98%of the total solar energy.



There can be two extreme thicknesses of atmosphere between the sun and the point on the earth's surface; in one day. At any place between the two trees, there are moments where the sun can be at an angle of 90 degrees at noon (right over our heads), and also at an angle of 0 degrees at sunset.

In places off the mentioned earth's surface, we never have it at 90 degrees, but we do have a maximum angle, depending on the respective latitude. When the sun is at the maximum angle, the energy delivered is highest. This is because the thickness of the atmosphere is or tends to be the lowest. As you must have experienced, at this time it is dangerous for your eyes to look directly at the sun and you should protect your skin against its rays.

NEW AND UPCOMING TECH THAT MIGHT MAKE IT MORE SUSTAINABLE & EASIER TO PRODUCE:

Whenever we talk about solar energy, we picture the good old solar panels on the top of a rooftop. But with new technologies rolling in, we have endless possibilities that could make solar energy much more sustainable.

1. Floating solar farms (aka ‘floatovoltaics’)

“Floatovoltaics” are photovoltaic solar power systems created for floating on reservoirs, dams, and other water bodies.Silicon panels are becoming cheaper and more efficient day-by-day. According to experts, if photovoltaic panels are placed on reservoirs and other water bodies, they offer even greater efficiency as well as a plethora of other benefits.Floating solar farms can generate huge amounts of electricity without using valuable land or real estate. The installation costs of floating photovoltaic panels are less than land-based photovoltaic panels. Also, research showed that the power production of floating solar panels is greater by up to 10% due to the cooling effect of water

2. Solar fabric-

Researchers are developing solar fabrics with a vision of including solar power in each fiber. These solar filaments can be embedded into your t-shirts, winter coats, or any other clothing to help you keep warmer, power your phone, and provide energy for other needs while you're on the go.

There are several areas where researchers have attempted to combine solar fabric and solar panels, which include:

- Building facades that provide both shade and power
- Awnings that lighten up streetlights, and
- Curtains that eliminate power consumption from the grid

3. BIPV solar technology-

Building-integrated photovoltaics or BIPV as the name suggests, seamlessly blend into the architecture of a building in the form of canopies, curtain walls, facades, skylight systems and roofs. Unlike traditional solar PV panels, BIPV can be aesthetically appealing.

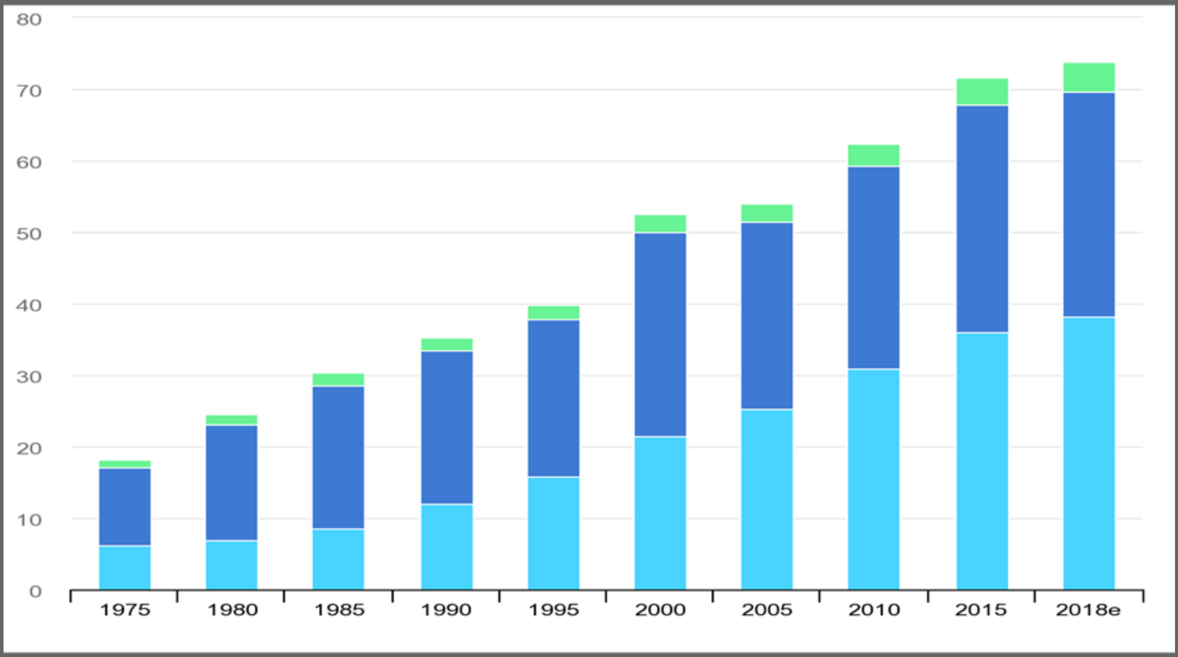
BIPV technology, when used on the building's facades, atrium, terrace floor, and canopies, provides the following benefits:

- Increased energy efficiency
- High thermal and sound insulation
- Clean and free power output from the sun
- Decreased O&M costs
- Zero carbon footprint

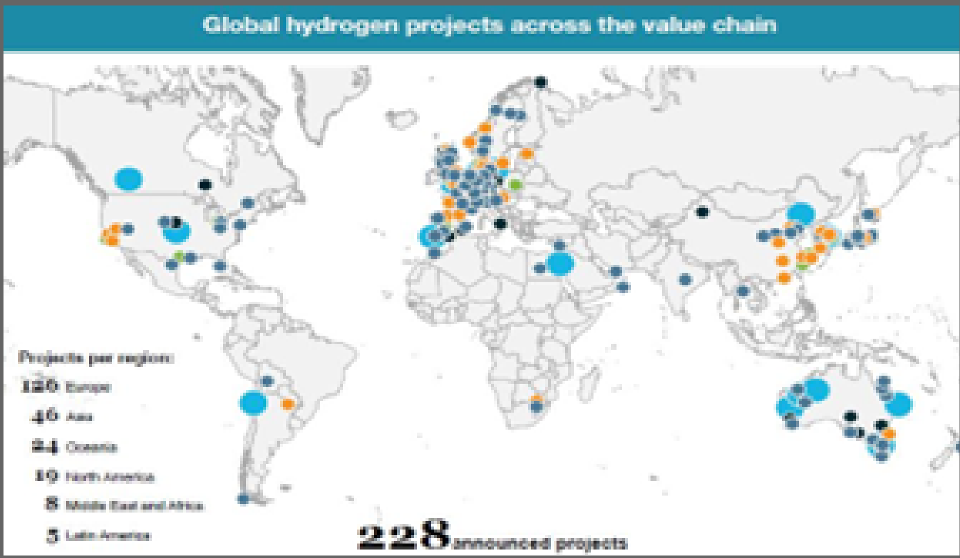
HYDROGEN

Demand for Hydrogen

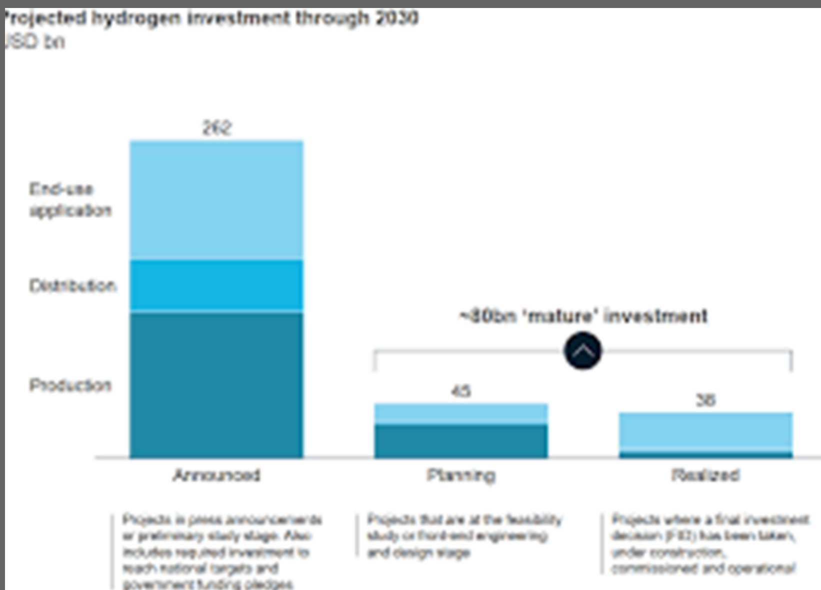
Supplying hydrogen to industrial users is a major business around the world now days. Hydrogen Demand, which has growth of more than threefold since 1975, continues to rise which is almost entirely supplied from fossil fuels, with 6% of global natural gas and 2% of global coal going towards the hydrogen production.
s a consequence, production of hydrogen that is responsible for CO2 emissions of around 830 million tonnes of carbon dioxide per year is equivalent to the CO2 emissions of the United Kingdom(UK) and Indonesia combined



GROWING SUPPORT/ DEVELOPMENT AND INVESTMENT

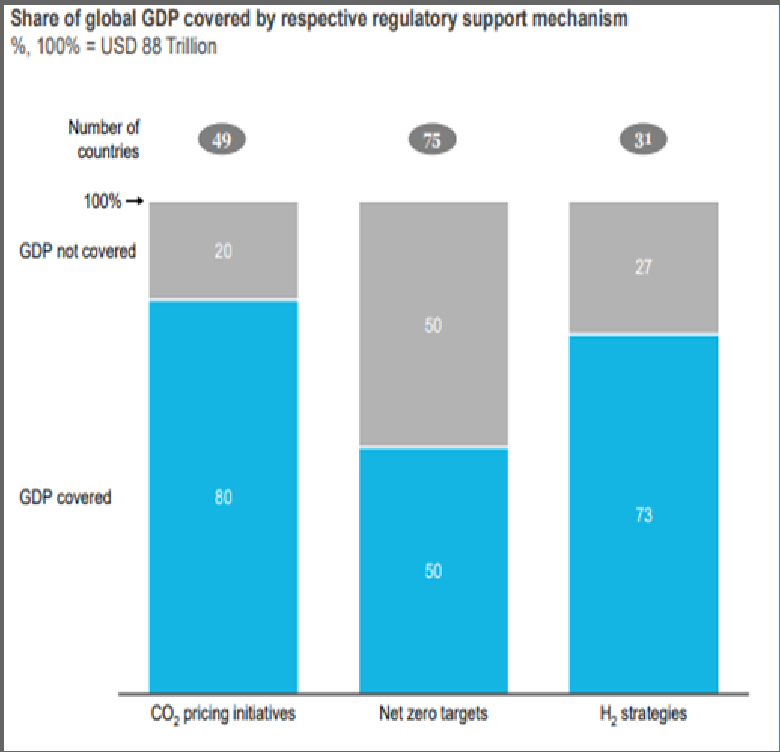


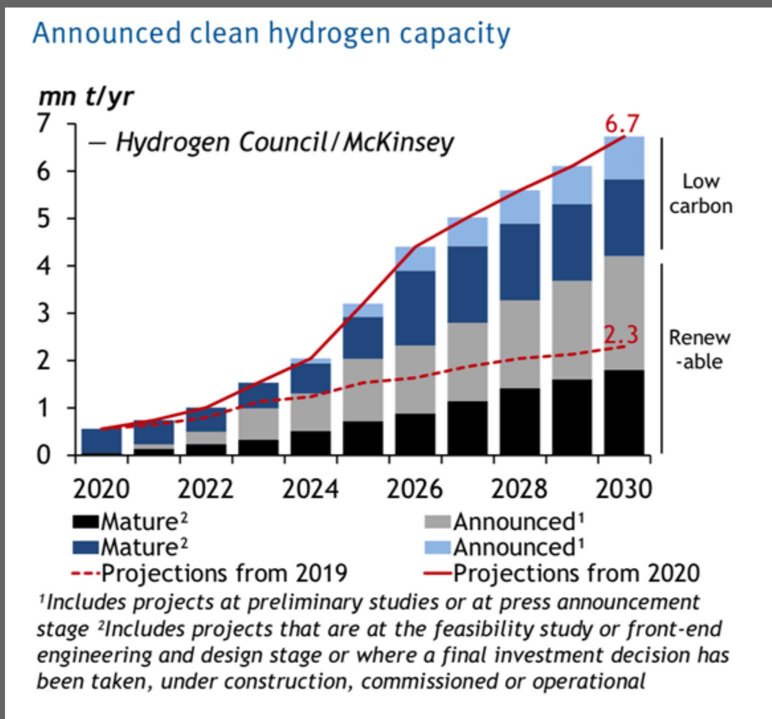
- The numerous countries with polices which directly support investment in hydrogen technologies are increasing, along with the number of sectors they usually target.



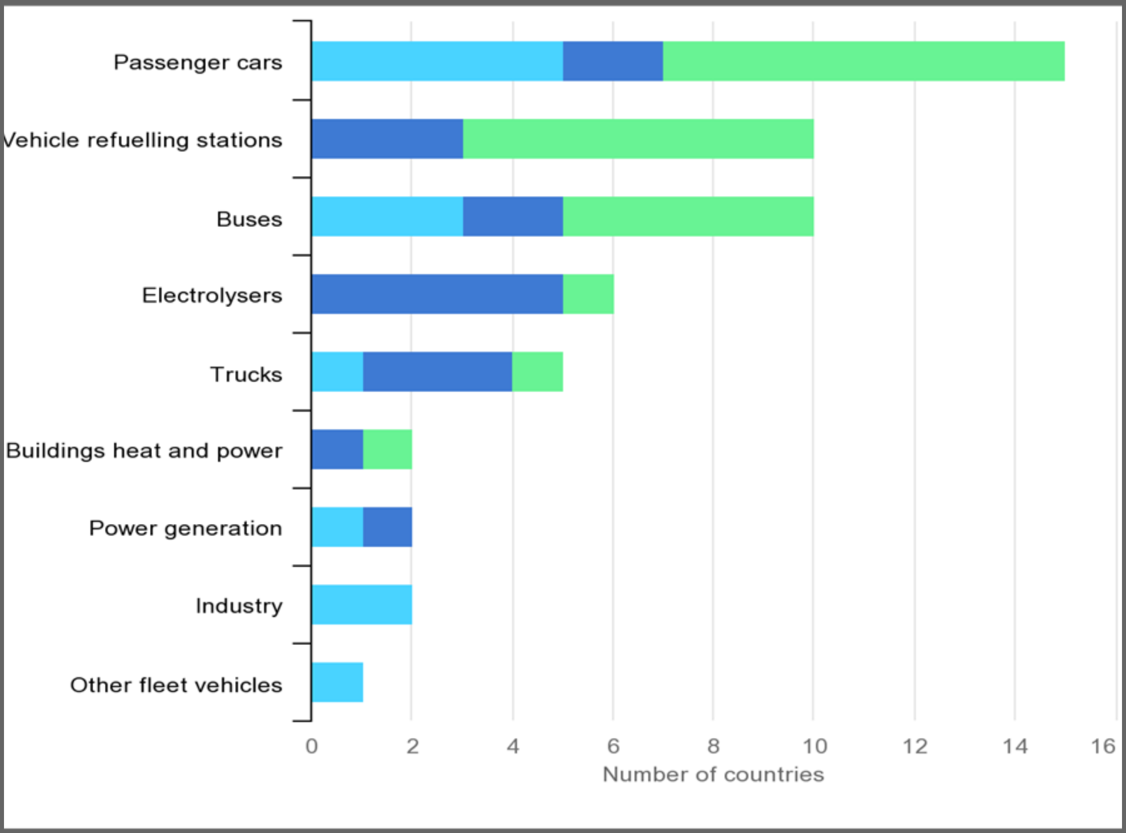
- USD worth more than300 billion in H2 investments through 2030
- There are around 50 targets, mandates and policy incentives in place today that direct support hydrogen and the majority is focused on transport

REGULATION SUPPORTING DECARBONIZATION



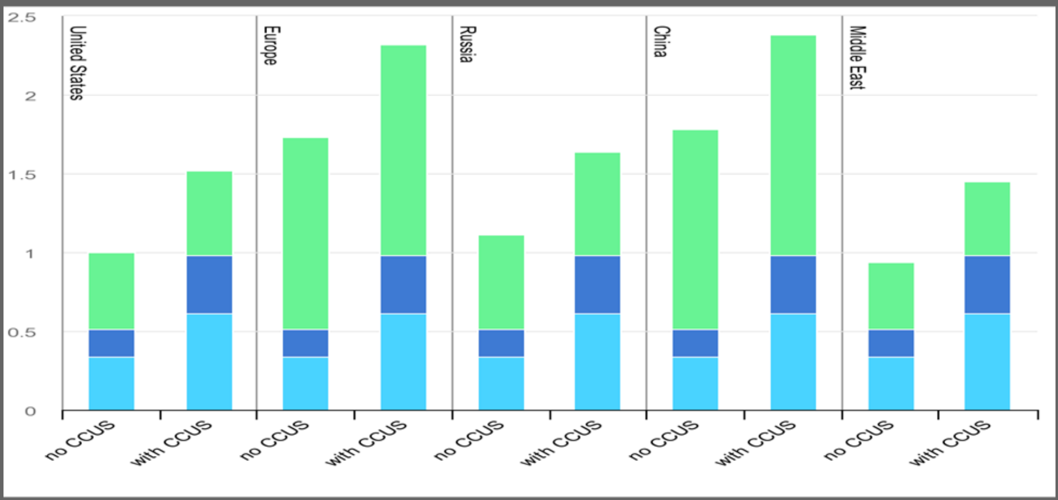


Over the past few years, global spending on hydrogen energy research, development and demonstration by national governments has seen potential growth, but still it remains lower than the peak in 2008.



PRODUCTION OF HYDROGEN

Hydrogen can be extracted from many sources specially fossil fuels and biomass, from water, or from a mixture of both of them. Natural gas is currently the only primary source of hydrogen production, accounting for around three quarters of the annual global dedicated hydrogen production of around 70 million tonnes. This accounts for approx. 6% of lobal natural gas use. Gas is followed by coal, due to its dominant role in China, and a little fraction is produced from from the use of oil and electricity both.

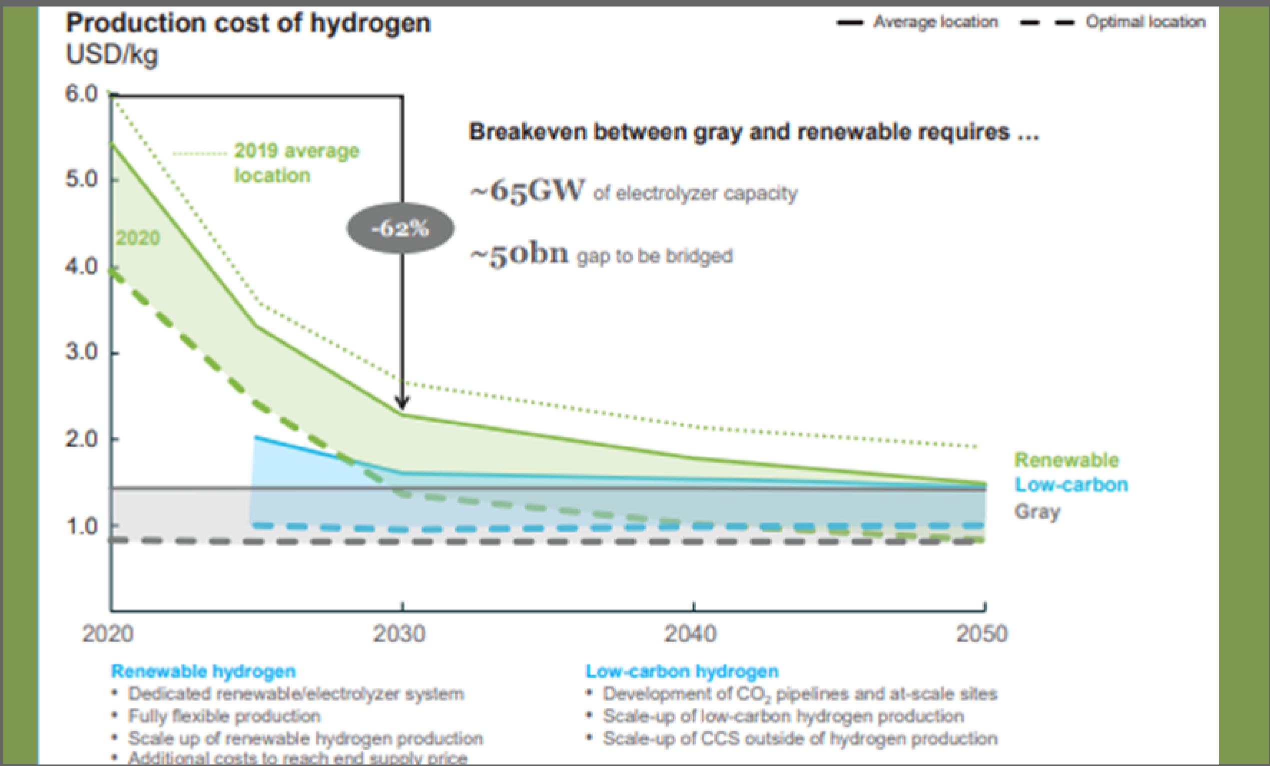


The production cost of hydrogen from natural gas is influenced by the range of technical and economic factors, with prices of gas and capital expenditures being the two most important.

The cost of fuel are the largest cost component, accounting for between 45% and 75% of production costs. Low gas prices in the Middle East, Russia and North America have given rise to some of the lowest hydrogen production costs. Gas importers like Japan, Korea, China and India have to contend with higher gas import prices, and that makes for higher costs in hydrogen production.

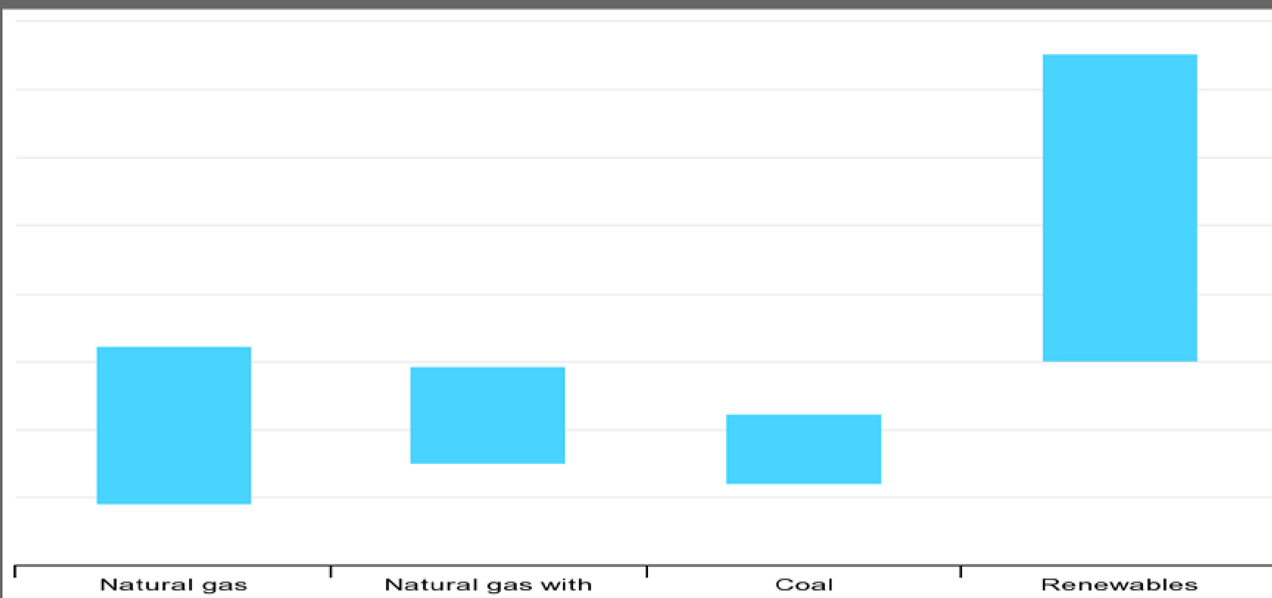
KEEPING EYE ON COSTS

Dedicated electricity generation from renewables or nuclear power offers an alternative to the use of grid electricity for hydrogen production.With reduction in costs for renewable electricity, in articular from solar PV and wind, interest is growing in electrolytic hydrogen and there have been several demonstration projects in these recent years



Producing all of today's dedicated hydrogen output from electricity could result in an electricity demand of 3 600 TWh, which is more than the total annual electricity generation of the total European Union.

With declining costs for solar PV and wind generation, building electrolysers at locations with excellent renewable resource conditions could become a low-cost supply option for hydrogen, even after taking into account the transmission and distribution costs of hydrogen transportation from (often remote) renewables locations to the end-users.



USES OF HYDROGEN

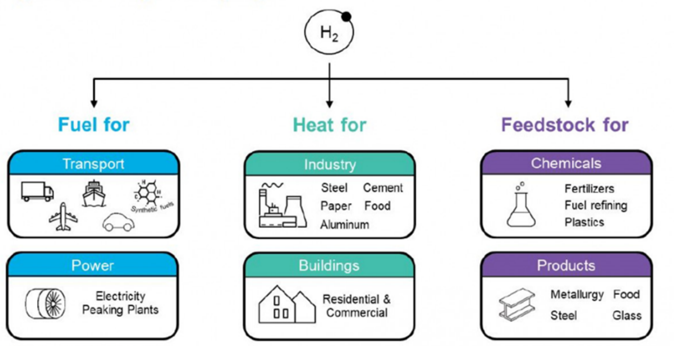
Hydrogen use today is dominated by industry which is named: oil refining, ammonia production, methanol production and steel production. Virtually all of this hydrogen is supplied using fossil fuels, so there is significant potential for emissions reductions from the clean hydrogen.

In transport, the competitiveness of hydrogen fuel cell cars depends on fuel cell costs and also refuelling stations while for trucks the priority is to reduce the delivered price of hydrogen. Shipping and aviation have limited low-carbon fuel options available and represent a good opportunity for hydrogen-based fuels

In buildings, hydrogen could be blended into existing natural gas networks, with the highest potential in multifamily and commercial buildings, specially in dense cities while longer-term prospects could include the direct use of hydrogen in hydrogen boilers or fuel cells.

In power generation, hydrogen is the leading options for storing renewable energy, and hydrogen and ammonia can be used in gas turbines to increase power system flexibility. Ammonia could also be used in coal-fired power plants to reduce emissions.

Figure 2: The many uses of hydrogen



Source: BloombergNEF

SHORT TERM, PRACTICAL OPPORTUNITIES FOR POLICY ACTION

Hydrogen is already widely used in many industries, but it has not yet realised its potential to support clean energy transitions. Ambitious, targeted and near-term action is needed to further overcome barriers and reduce costs.

The IEA has identified four value chains that offer springboard opportunities to scale up hydrogen supply and demand, building on existing industries, infrastructure and policies. Governments and other stakeholders will be able to identify which of these offer the near-term potential in their industrial, geographical and energy system contexts.

Regardless of which of these four key opportunities are pursued – or other value chains not listed here – the full policy package of five action areas listed above will be needed. Furthermore, governments – at regional, national or community levels – will benefit from international cooperation with others who are working to drive forward many similar markets for hydrogen.

SUMMARY

The time is right to tap into hydrogen's potential to play a key role in a clean, secure and affordable energy future. At the request of the government of Japan under its G20 presidency, the International Energy Agency (IEA) has produced this landmark report to analyse the current state of play for hydrogen and to offer guidance on its future development. The report finds that clean hydrogen is currently enjoying unprecedented political and business momentum, with the number of policies and projects around the world expanding rapidly. It concludes that now is the time to scale up technologies and bring down costs to allow hydrogen to become widely used. The pragmatic and actionable recommendations to governments and industry that are provided will make it possible to take full advantage of this increasing momentum.

Hydrogen can help tackle various critical energy challenges. It offers ways to decarbonise a range of sectors – including long-haul transport, chemicals, and iron and steel – where it is proving difficult to meaningfully reduce emissions. It can also help improve air quality and strengthen energy security. Despite very ambitious international climate goals, global energy-related CO2 emissions reached an all time high in 2018. Outdoor air pollution also remains a pressing problem, with around 3 million people dying prematurely each year.

Hydrogen is versatile. Technologies already available today enable hydrogen to produce, store, move and use energy in different ways. A wide variety of fuels are able to produce hydrogen, including renewables, nuclear, natural gas, coal and oil. It can be transported as a gas by pipelines or in liquid form by ships, much like liquefied natural gas (LNG). It can be transformed into electricity and methane to power homes and feed industry, and into fuels for cars, trucks, ships and planes.

Hydrogen can enable renewables to provide an even greater contribution. It has the potential to help with variable output from renewables, like solar photovoltaics (PV) and wind, whose availability is not always well matched with demand. Hydrogen is one of the leading options for storing energy from renewables and looks promising to be a lowest-cost option for storing electricity over days, weeks or even months. Hydrogen and hydrogen-based fuels can transport energy from renewables over long distances – from regions with abundant solar and wind resources, such as Australia or Latin America, to energy-hungry cities thousands of kilometres away.

There have been false starts for hydrogen in the past; this time could be different. The recent successes of solar PV, wind, batteries and electric vehicles have shown that policy and technology innovation have the power to build global clean energy industries. With a global energy sector in flux, the versatility of hydrogen is attracting stronger interest from a diverse group of governments and companies. Support is coming from governments that both import and export energy as well as renewable electricity suppliers, industrial gas producers, electricity and gas utilities, automakers, oil and gas companies, major engineering firms, and cities. Investments in hydrogen can help foster new technological and industrial development in economies around the world, creating skilled jobs.

Hydrogen can be used much more widely. Today, hydrogen is used mostly in oil refining and for the production of fertilisers. For it to make a significant contribution to clean energy transitions, it also needs to be adopted in sectors where it is almost completely absent at the moment, such as transport, buildings and power generation.

However, clean, widespread use of hydrogen in global energy transitions faces several challenges:

Producing hydrogen from low-carbon energy is costly at the moment. IEA analysis finds that the cost of producing hydrogen from renewable electricity could fall 30% by 2030 as a result of declining costs of renewables and the scaling up of hydrogen production. Fuel cells, refuelling equipment and electrolysers (which produce hydrogen from electricity and water) can all benefit from mass manufacturing.

The development of hydrogen infrastructure is slow and holding back widespread adoption. Hydrogen prices for consumers are highly dependent on how many refuelling stations there are, how often they are used and how much hydrogen is delivered per day. Tackling this is likely to require planning and coordination that brings together national and local governments, industry and investors.

Hydrogen is almost entirely supplied from natural gas and coal today. Hydrogen is already with us at industrial scale all around the world, but its production is responsible for annual CO2 emissions equivalent to those of Indonesia and the United Kingdom combined. Harnessing this existing scale on the way to a clean energy future requires both the capture of CO2 from hydrogen production from fossil fuels and greater supplies of hydrogen from clean electricity.

Regulations currently limit the development of a clean hydrogen industry. Government and industry must work together to ensure existing regulations are not an unnecessary barrier to investment. Trade will benefit from common international standards for the safety of transporting and storing large volumes of hydrogen and for tracing the environmental impacts of different hydrogen supplies.

The IEA has identified four near-term opportunities to boost hydrogen on the path towards its clean, widespread use. Focusing on these real-world springboards could help hydrogen achieve the necessary scale to bring down costs and reduce risks for governments and the private sector. While each opportunity has a distinct purpose, all four also mutually reinforce one another.

1. Make industrial ports the nerve centres for scaling up the use of clean hydrogen. Today, much of the refining and chemicals production that uses hydrogen based on fossil fuels is already concentrated in coastal industrial zones around the world, such as the North Sea in Europe, the Gulf Coast in North America and southeastern China. Encouraging these plants to shift to cleaner hydrogen production would drive down overall costs. These large sources of hydrogen supply can also fuel ships and trucks serving the ports and power other nearby industrial facilities like steel plants.

2. Build on existing infrastructure, such as millions of kilometres of natural gas pipelines. Introducing clean hydrogen to replace just 5% of the volume of countries' natural gas supplies would significantly boost demand for hydrogen and drive down costs.

3. Expand hydrogen in transport through fleets, freight and corridors. Powering high-mileage cars, trucks and buses to carry passengers and goods along popular routes can make fuel-cell vehicles more competitive.

4. Launch the hydrogen trade's first international shipping routes. Lessons from the successful growth of the global LNG market can be leveraged. International hydrogen trade needs to start soon if it is to make an impact on the global energy system.

International co-operation is vital to accelerate the growth of versatile, clean hydrogen around the world. If governments work to scale up hydrogen in a co-ordinated way, it can help to spur investments in factories and infrastructure that will bring down costs and enable the sharing of knowledge and best practices. Trade in hydrogen will benefit from common international standards. As the global energy organisation that covers all fuels and all technologies, the IEA will continue to provide rigorous analysis and policy advice to support international co-operation and to conduct effective tracking of progress in the years ahead.

As a roadmap for the future, we are offering seven key recommendations to help governments, companies and others to seize this chance to enable clean hydrogen to fulfil its long-term potential.

ELECTRIC VEHICLES

Electric vehicles (EV) are automobiles that use one or more electric motors for propulsion. These can be powered by a collector system, with electricity from extravehicular sources, or they can be powered autonomously by a battery (charged by solar panels, or by using fuel cells or a generator in a bid to convert fuel to electricity).

TYPES OF ELECTRIC VEHICLES

Battery Electric Vehicles (BEVs) are fully electric vehicles with rechargeable batteries and they do not have a gasoline engine. Battery pack provides all the energy required to run the vehicle and this battery pack is recharged from the grid. These vehicles are zero emission vehicles because they do not produce any harmful tailpipe emissions or air pollution hazards that were caused by traditional gasoline-powered vehicles.

Plug-in Hybrid Electric Vehicles(PHEVs) have both an engine and an electric motor to drive the vehicle. Like regular hybrid vehicles, their batteries get recharged through regenerative braking. These vehicles differ from regular hybrids as these have a much larger battery, and are capable of being plugged into the grid for charging. While regular hybrids can travel 1-2 miles at a low speed before the gasoline engine turns on, PHEVs can operate for around 10-40 miles before their gas engines provide assistance to them. Once the all-electric range is exhausted, PHEVs act as regular hybrids, and can thereby travel for several hundred miles on a cistern of gasoline. All PHEVs can be charged at an EVgo L2 charger, however they can't be charged at a fast pace.

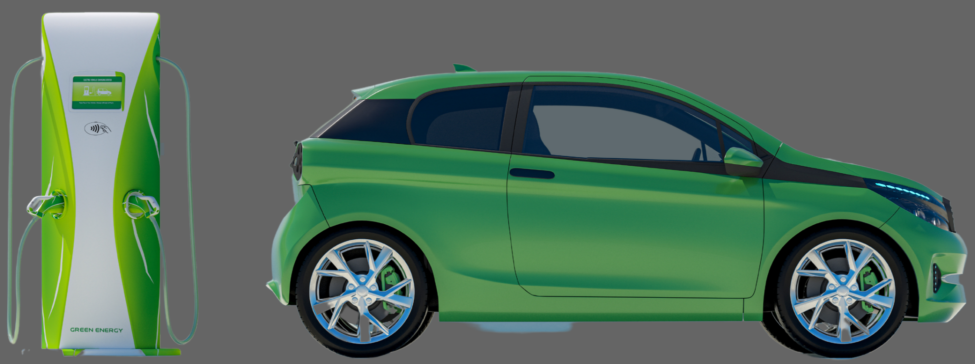
Hybrid Electric Vehicles, or HEVs, have both a gas-powered engine and an electric motor for driving the car. All the battery power is attained through regenerative braking, which retrieves the lost energy in braking to assist the gasoline engine during acceleration. In a traditional internal combustion engine automobile, this energy is usually lost as heat in the brake pads and rotors. Regular hybrids cannot be plugged into the grid to recharge and cannot be charged with an EVgo charger.

EV INDUSTRY : INDIA'S WEAPON TO ACHIEVE SDGs

To meet SDG goals, India needs a strong push towards clean mobility and here EVs provide a beacon of hope. They do away with tailpipe emissions, lessen dependence on fossil fuels, enhance community health and improve prospects for employment and upskilling.

The transport sector would be decarbonised with the assistance of electric mobility coupled with renewable energy. With the EV industry predicted to create 10 million jobs in India, EV manufacturing can provide employment opportunities, entrepreneurship, and formalization and growth of MSMEs .

It can encourage sustainable and inclusive industrialisation and also help in facilitating the integration of small scale industrial enterprises in value chains and markets.



ADOPTION OF NEMMP SCHEME BY THE INDIAN GOVERNMENT

The National Electric Mobility Mission Plan (NEMMP) 2020 is a National Mission document that provides the vision and the roadmap for the faster adoption of electric vehicles and their manufacturing in India. This scheme has been designed in a bid to enhance national fuel security, provide affordable and eco-friendly transportation and to allow the Indian automotive industry to attain global manufacturing leadership in terms of electric vehicles.

As part of the NEMMP 2020, Department of Heavy Industry devised a Scheme, Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles in India (FAME India) Scheme in 2015 to encourage manufacturing of electric and hybrid vehicle technology and to ensure its sustainable growth.

The Phase-I of this Scheme was originally launched for a period of 2 years, beginning from 1st April 2015, which was extended afterwards from time to time. The 1st Phase of this scheme was implemented through four focus areas that were -

(i) Creation of demand,
(ii) Technology Platform,
(iii) Pilot Project
(iv) Infrastructure for charging EVS.

Objectives of FAME Scheme:

- Stimulating faster adoption of electric vehicles by offering upfront incentives on the purchase of Electric vehicles.
- Establishing a vital charging Infrastructure for electric automobiles.
- Addressing the concern of environmental pollution and fuel security.

Salient Features of Phase II:

- Emphasis on electrification of public transportation which includes vehicle pooling.
- This phase aims to subsidize approximately 7000 e-Buses, 5 lakh e-3 Wheelers, 55000 e-4 Wheeler Passenger Cars and 10 lakh e-2 Wheelers.
- Incentives will be applicable mainly to vehicles used for public transport or commercially-registered purposes in case of the 3 Wheeler and 4 wheeler segment market.
- In the 2 wheeler market segment, the focus will be specifically on private vehicles.
- To boost adoption of advanced technologies, the benefits of incentives will be extended to only those vehicles which are fitted with advanced batteries like a Lithium Ion battery and other technology batteries that are new in the EV market.

- FAME scheme focuses on the establishment of charging infrastructure, wherein around 2700 charging stations will be installed across India in order to make available at least one charging station in an area of 3 square kms.

- Proposals for establishing charging stations on main highways connecting major city clusters. Charging stations would be installed on both sides of the road of such highways at intervals of approximately 25 kms each.

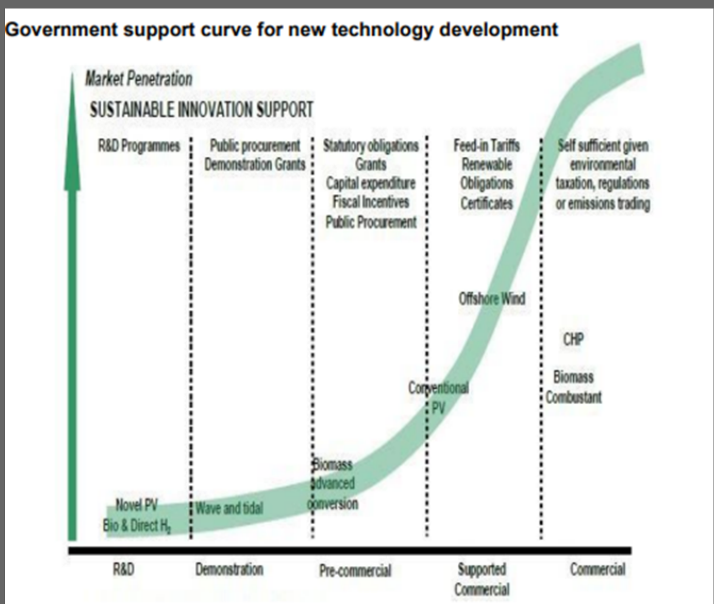
NEW HOMES IN ENGLAND TO HAVE ELECTRIC CAR CHARGERS BY LAW

New law would require all new homes built in England to have electric vehicle (EV) charging points installed from 2022. The new law will also cover new-build workplaces, supermarkets and buildings undergoing major renovations to install charging infrastructure to boost the adoption of Electric vehicles. The British government says that this will lead to an extra 145,000 charge points being installed across England every year and the government also hopes that the new laws will 'make it as easy as refueling a petrol or diesel car today'. The law has been brought into effect as the UK aims to switch to electric cars, with the decision of imposing a ban on the sale of new petrol and diesel cars.

PROBLEM IN ENERGY TRANSMISSION FROM FOSSIL FUELS TO RENEWABLE ENERGY

- **POLICY AND REGULATION**

Perhaps the most important impetus for the current energy transition compared to previous major changes in the world's energy system is that it is driven by government policies and regulations. In contrast, previous energy transitions have been based on competition between fuels, and coal, oil, or gas has emerged as an efficient source of energy to drive industrial development and economic growth. The current energy transition is driven by another motivation to avoid or mitigate global climate change as a result of emissions from the energy sector (mainly hydrocarbons), at least initially as the current alternative energy. It costs more than. In addition, the introduction of new energy sources requires and will continue to change the current regulations of the energy market and perhaps the linear paradigm that governs the current production and consumption systems of goods and services.



However, the energy transition does not proceed at the same pace in all countries and regions. They reflect the needs, priorities, and capabilities of the country and must consider all stakeholders, including governments, regulators, utilities, cities, and civil society, including youth, at all levels. Isolated energy policymakers risk developing energy policies that delay access to energy, slow economic growth, reduce the burden on one environment while reducing the burden on another. I owe it.

These traditional structures prevent the use of modern distributed solutions. They need to be modified to serve many decentralized and variable energy sources, including a large number of consumers who have taken on new roles as prosumers. This means transforming the economy and society in the short term while ensuring long-term sustainability.

Another major challenge for policymakers is to increase private sector investment and direct it to where it is most needed. In recent years, private funds have flooded renewable energy projects and several prominent investment funds have sold themselves from fossil fuels. The challenge now is to ensure that this funding covers the entire clean energy system from production to transmission to end-use. Similarly, increased investment should help address the challenge of ensuring that the technology needed for the energy transition is affordable. Costs have dropped significantly in many places, but this trend is not yet widespread in all countries. In particular, the poorest and most vulnerable countries need help building their local capacity to access and effectively use affordable state-of-the-art technology. To facilitate a just transition, labor and social protection policies need to be tailored to the specific needs of each region and country. Dialogue needs to be established between governments, employers, workers, and civil society to facilitate the transition process

- **TECHNOLOGY**

Related to the issue of technical feasibility is the issue of economic realizability. Ultimately, the government can support the development of new technologies, but it must be financially meaningful, and some stakeholders in the energy sector should say that decarbonization policies should be technology-neutral. Continues to insist. The graph below shows that for some technologies, the transition from expensive R&D programs to commercial viability may not be very long, but given the limited timescale involved. And it is important to consider all possible technologies, including those that require the removal of Embracing. We are not only developing carbon from existing energy systems but also developing new carbon-free energy sources to make a difference. Technology development requires an understanding of current costs and history, what advances are possible, and how future costs will be compared to current energy sources.

- **FINANCE**

Today, the most important and well-known barrier to the adoption of renewable energy is the cost, especially the costs associated with the construction and installation of facilities such as solar and wind power plants. Like most renewable energy sources, solar and wind are very cheap to operate because they are "fuel" free and require minimal maintenance. Therefore, most of the cost of renewable energy comes from its installation. In 2017, the average cost of installing a solar array ranged from about $ 2,000 per kilowatt for large installations to about $ 3,700 for small residential installations. For comparison, a new gas-fired power plant can cost about $ 1,000 per kW. The IEA will need to invest $ 11.3 trillion annually in the power sector (mainly renewable energy and power grids) over the next decade, and up to $ 1 trillion annually to improve energy use in the end-use sector. I estimate that you need to. The transition is great, but at the same time spending $ 0.60.8 trillion on traditional fuels such as oil and gas to ensure a restrained reduction in traditional energy sources in parallel with changes to existing systems. is needed.

- **IMPACT ON CONSUMERS**

The definition of the consumer is broad, ranging from large industrial companies and power plants to households and small businesses. However, in addition to the issue of reliability during the energy transition, consumers may also require further incentives to switch away from traditional fuels. Although the question of climate change is vital, when consumers are asked to make specific changes to industrial processes or lifestyles, the questions of economics, convenience, and cost tend to come to the fore. As a result, there are uncertainties around consumer reaction to new products, their willingness to change appliances, their desire to embrace demand-side management, and their inclination, and ability, to potentially pay more in the short-term for a product that can contribute to long-term welfare. Ultimately, of course, governments can force through change but may be reluctant to do this in countries where political power is determined by voter choice. Furthermore, many suppliers of energy will also be considering, alongside policymakers, what incentives consumers may best respond to, and whether new products and services will be needed to create differentiation to gain market share.

- **REALIGNMENT OF BUSINESS MODEL**

The two issues of climate & environmental policymaking and consumer response naturally lead on to the question of how companies that serve customers may need to realign their business models both to meet regulatory requirements and satisfy consumer preferences whilst optimizing their position during the energy transition, or perhaps more radically, simply surviving it. Already it is clear that some companies are moving faster than others, but some key themes are emerging

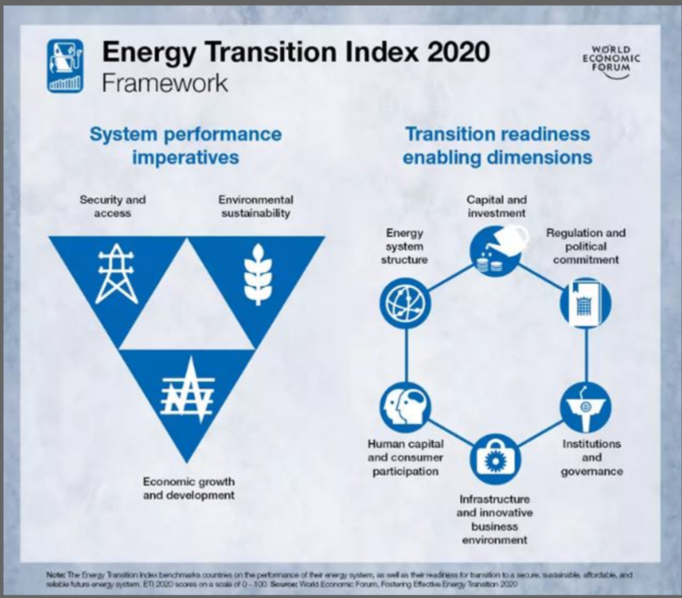
First, under pressure from investors and banks, key IOCs are making strategic decisions about whether to stick to their core business or diversify into an "integrated energy services company". The split now appears to be geographical, with European companies such as BP, Shell, Total, and Equinor leading the way to decarbonized energy, while US, Middle East, and Asian companies have been primarily core businesses to date.

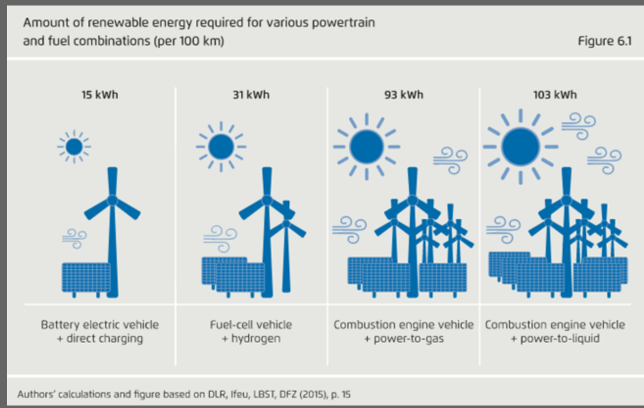
The emphasis is on. On the other hand, some state-owned oil companies are investing in clean technology, which can limit their ability to diversify, especially if hydrocarbon products and export revenues are important to the domestic economy. Being a cost producer, it is also important to reduce the carbon strength of production and store carbon.
Another issue around business models pertains to companies' own net-zero goals and the adoption of circular economy models (involving the decarbonisation of companies' supply chains) to achieve this

- **INFRASTRUCTURE**

Due to the variable nature of some renewable technologies, energy systems need to be more flexible in order for supply to always meet demand. A fully resilient transmission and distribution network is needed to meet the increased demand for electricity resulting from increased access to end-use sectors such as transportation, heating and cooling, and increased electrification. With the surge in investment in clean energy generation, parallel spending on infrastructure is required. In order to modernize the sick energy system and make it available to those who lack it today, we need to significantly increase our clean energy funding.

To ensure a sustainable, weatherproof, and more resilient future, we need to invest heavily in energy systems that prioritize renewable energy, electrification, efficiency, and related energy infrastructure. I have. Care must be taken that these investments do not cause a lock-in effect. National infrastructure development should be combined with political, regulatory, and operational cooperation between neighboring countries and subregions. Some countries with very high potential for renewable energy are expected to become net exporters, which may facilitate the transition in countries with low renewable resources.





- **TRANSPORT**

Over the years, there has been growing concern about the impact of transport on the e-health of particulate matter and other air pollutants. The World Health Organization estimates that more than 80% of urban people who monitor air pollution are exposed to air quality levels that exceed the limits recommended by the WHO. Although the problem is global, pollution levels and their associated health effects are generally exacerbated in developing countries and are the leading cause of premature death in millions of people. If current trends continue, aggregate demand for both passenger and freight transportation services is projected to nearly double between 2005 and 2050. Political concerns about global value chain transformation and high import dependence can change intercontinental transport. Similarly, as the world shifts to virtual conferences and the like, especially in developing countries, vacation habits can change while reducing energy use and associated CO2 and other air pollutant emissions.

Electrification with currently available technologies is not currently a scalable option for rugged transportation, transportation, and aviation. Innovation may change this, but in the short term, the focus is on increasing the use of sustainable biofuels and clean hydrogen in these areas. In addition to the direct energy consumption associated with the transportation services provided, we need to consider how to integrate broader life cycle considerations into our plans and policies. Several options are available to reduce both direct and indirect energy consumption.

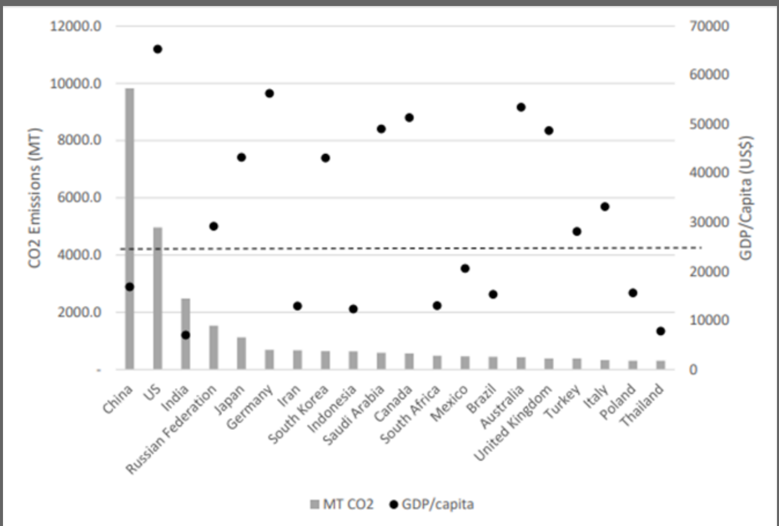
- **ENERGY SUSTAINABILITY AND EFFICIENCY**

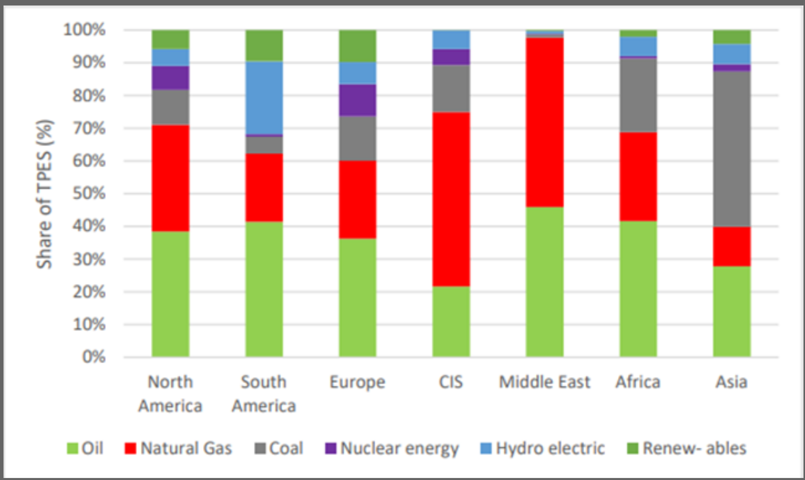
Increasing the share of renewable energy needs to be accompanied by a proactive efficiency strategy. In addition to the issues described in the Transportation and Hardware Issues chapter, the greatest potential for energy efficiency lies in equipment and lighting, buildings (including heating and cooling), industrial motors, and other equipment. The biggest challenge is that improving energy efficiency will affect all sectors, including housing, commerce, tertiary construction, industry, heating and cooling, and transportation. In most cases, technology is available and affordable, but Place needs to create a new incentive structure. Government policy to reduce time to market. Key obstacles are inadequate energy infrastructure, regulatory systems, codes of conduct, demand management, and inadequate financial incentive structures. Acceleration of energy efficiency must be achieved through action efforts between sectors. Cities are a major player in decarbonization as they account for 70% of the world's emissions. This percentage increases with no action. The building sector is the key to energy efficiency, especially in cities, and there are opportunities for efficiency measures in both new and existing buildings, including B. Highly efficient insulation, windows, and building materials. Highly efficient heating, cooling, hot water, and lighting system. Intelligent energy management service. An estimated 3.6 billion refrigeration equipment is used worldwide, which is projected to increase to 9.5 billion by 2050. Therefore, it is very important that the new air conditioning system is as efficient as possible.

- **RREGIONAL RIGIDITY**

Further levels of complexity in the energy transition problem stem from the fact that different countries and regions start from different positions in terms of both economic development the current energy mix, and CO_2 emissions. Energy mixes vary significantly within and between regions. This becomes apparent in the use of coal and nuclear power in Europe, where opinions about the future of both energy sources differ greatly.

However, the starting point for each energy transition varies significantly around the world. Regions such as North America and Europe have a relatively balanced energy supply portfolio, so the transition to more renewable energy is a relatively natural development, while regions such as CIS, the Middle East, and Asia have one or two. We expect the superiority of the two fuels. In the case of CIS, its fuel is gas, which is a relatively clean hydrocarbon, which reduces the incentive to switch without internal or external pressure. On the other hand, Asia is dominated by coal. This means that coal may need to be switched to gas in the early stages of the energy transition, and the country may leap forward as an alternative to renewable energy. After all, the Middle East is, of course, dominated by oil and gas, with high potential for renewables (especially solar), but no big taxes from cheap fuels that support both the domestic economy and export revenues. It will be difficult to get rid of it. reform. Supply security is also an important issue from a national and regional perspective, which raises two general hypotheses.





- ## SECTORAL RIGIDITY

A further layer of complexity in understanding the opportunities and risks in the energy transition can be seen through the lens of the various energy consuming sectors in the economy.

The main focus to date has been the power sector, where the introduction of renewable energy to displace hydrocarbons has been the most obvious, and early, route to decarbonisation as it provides significant emissions reductions. The largest, and most complex, sector is heat, which covers both heat for industrial processes as well as heating for buildings plus cooking. Within the industrial context, one of the key issues surrounds the levels of heat required and the ability of various fuels to reach higher temperatures. Gas, coal, and electricity all play a role, and in future hydrogen can also be added to the mix, depending on the exact process that is taking place. Furthermore, some hydrocarbons are used as inputs for petrochemicals and refining and will be hard to replace, with the production of plastics being one area where continued long-term use of oil is anticipated. Finally, the transport sector offers a diversity of challenges across its multiple sectors, stretching from rail and road to aviation and marine.Of course, the benefits of electrification of transport depend on the source of the power being used, and cost remains an issue while battery technology continues to be developed, but there is clearly hope that in the road sector the vehicle fleet can become an enabler of energy system integration and can therefore create system efficiencies as well as new sources of demand.

- ## IMPACTS ON GEOPOLITICS AND SECURITY

For more than 50 years, oil and gas have been at the heart of energy geopolitics, with trade flows, energy security, and economic power issues being the top priorities, but the energy environment is the key to achieving climate goals. Significant changes seem inevitable. While product demand is threatened, there are certainly challenges for manufacturers, but there are also opportunities for those who can become or maintain a cost-effective supplier of low carbon strength products. In addition, many oil and gas producing countries are preparing for the transition as energy companies adapt to the transition.

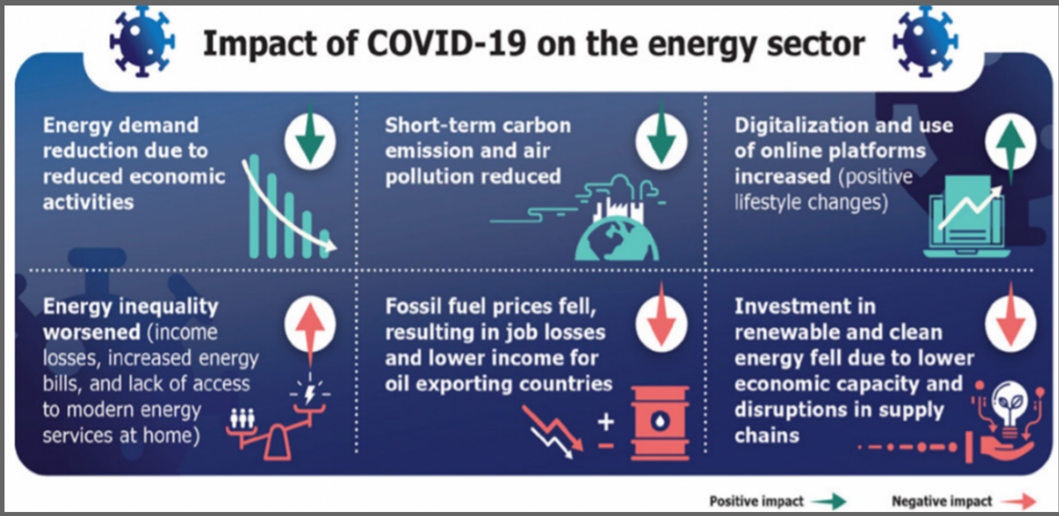
The opportunities for solar, CCUS, and hydrogen in the Middle East are clear examples. Indeed, the struggle for leadership in the development of renewable energy and low-carbon technologies and the core renewable energy sector could become a new theme in energy geopolitics in the next 20-30 years, but of the renewable energy supply chain. Decarbonization and management are important issues as countries and companies consider the potential risks of moving from one form of dependency to another. Given the technological demands of the energy transition, the new energy geopolitical foundation will focus on the ability to design and manufacture devices that will be central to the decarbonization of the global energy economy.

ADVENT OF CORONA PANDEMIC

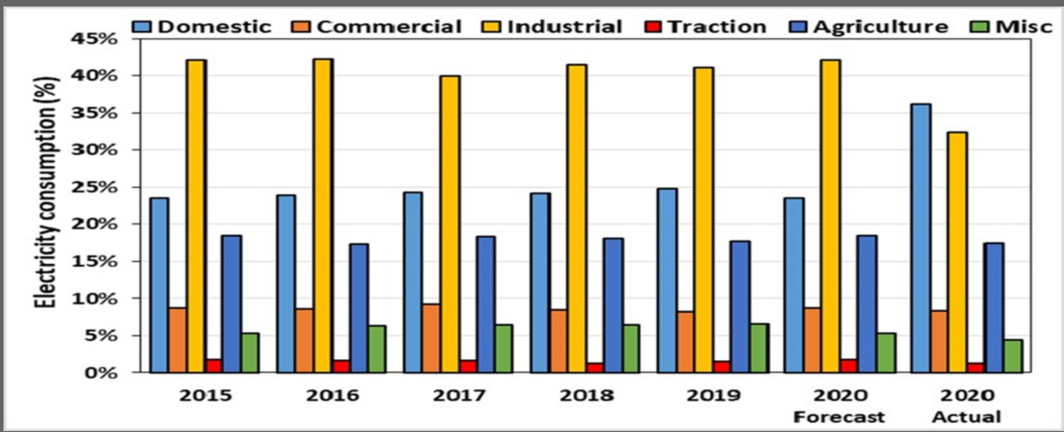
INTRODUCTION

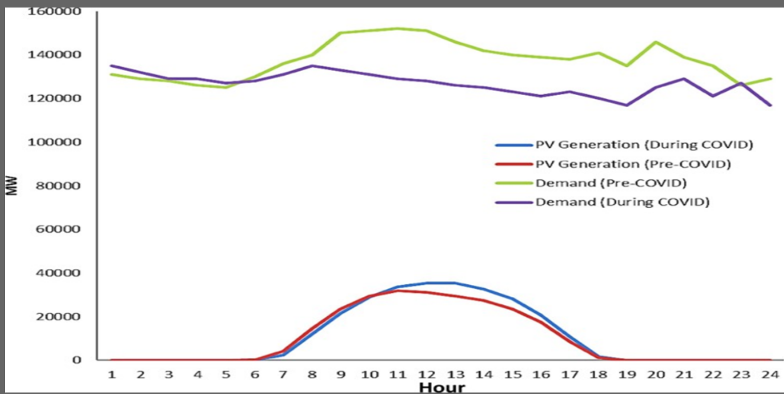
Coronavirus has been swiping the world and posing many challenges across the industry including the energy sector.

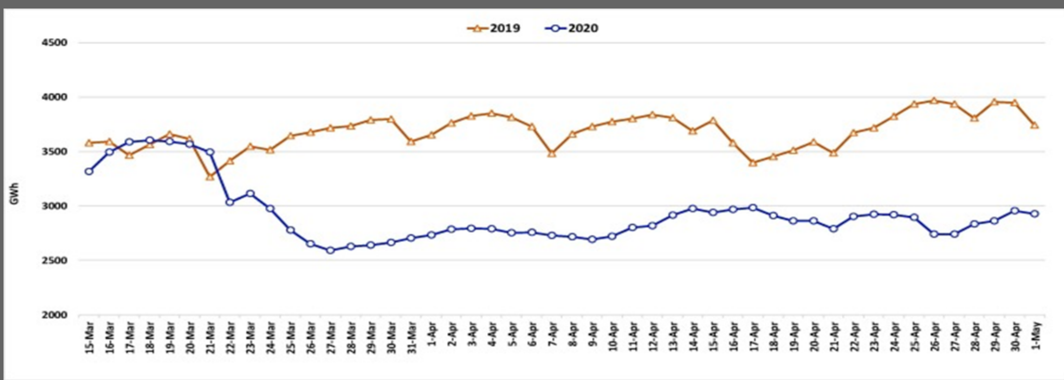
Energy is essential to drive economic growth, especially in emerging markets. Achieving the Sustainable Development Goal (SDG) 7 — Ensure that affordable, reliable, sustainable, and modern access to energy for all — is required. However, COVID-19 has had an impact on the sector, particularly leading to declining demand, financial pressure, and disruption to the electricity supply chain.
New potential trends and communication channels promoted by the epidemic have contributed to the demand for and use of energy. Emerging markets are particularly vulnerable. And despite great power achievements, over 789 million people worldwide are still in darkness.



CONSUMPTION CHANGES







India went through one of the worst demolition of electricity demands ever. Covid-19 has caused a decrease in electricity demand by about 28% by the end of March 2020, according to POSOCO (IEA Global Energy Review 2020). Even during the closure, demand for hospitals, essential services, and the housing industry was growing, while demand for industry and commercial activities declined sharply. By the end of August 2020, India's total demand for energy had not yet reached the previous levels before Covid-19.

IEA data shows that India's electricity prices in the industry are among the highest, based on energy purchases. Electricity prices for residential houses were similarly high despite being subsidized. Therefore, Covid-19 also attacked the financial stability of the energy sector.

The electricity mix is targeted at renewable sources following measures to shut off due to electricity demand, low operating costs, and significant access provided by the grid through regulations. The need for electricity and mixing returned to previous practices with lockdown freedom.

In India, the gap between coal and renewable resources is greatly reduced when the first steps are taken to close the door, renewable by a little over 30% by mid-August. The gap began to widen at the end of August, following seasonal trends. At the end of November, the share of renewable energy in the fossil fuels was less than 20%, in line with pre-COVID-19 levels. Since the end of May 2020, the demand for electricity has returned. Since the end of July 2020, power generation has been higher than in 2019 for the first time since its closure, keeping the practice for four weeks in a row.

However, the trend was reversed by lower generation rates in 2019, driven by low demand. In September and October, power generation returned to its growth path. In November, the rising trend was reversed and returned to 2018 levels due to low demand associated with seasonal combinations. The trend to rise began again in December.

The Indian grid is taken as an example for further discussion. Selected based on a few factors as given below:

• The third largest consumer of electricity at 1.54 trillion kWh per year.

• It consists of five regional centers and thirty freight centers, which is one of the most complex integrated networks.

• Different classes of people are nationally, socially, economically, religiously, culturally, etc.

• It is one of the fastest growing GDP countries (Gross Domestic Product), at about 6.68% with a global share of 3.28%. Its composition falls into three sectors such as Agriculture (15.4%), Industrial (23.0%), and Service (61.5%).

After considering all these factors, it is clear that the impact of COVID among the Indian people is affecting the Indian electricity market consistently.

GLOBAL SCENARIO: A SMALL COMPARISON BETWEEN INDIA AND THE EU

Demand for electricity has declined sharply throughout Europe and India through measures of closure. But it began to recover as these were gradually softened. In India, recovery appeared to be much faster than in EU countries. The end of the year was marked by the stabilization of the electricity demand, which is now above 2019 levels after climate change.

In India, the recovery of electricity demand was guaranteed at higher levels than in 2019, from the beginning of August. In September 2020, electricity demand was 3.4% higher than demand in September 2019 on average, driven by higher demand in the industrial and commercial sectors compared to 2019. By October 2020, the relaxation of the challenges led to a demand of more than 10% by October 2019, in line with pre-Covid-19 styles.

Government interdiction to prevent the crisis

The Unity Government jumped into action in response to the power situation. Domestic coal production and coal production increased. The government has proposed a 10 percent reduction in imported coal and domestic coal, which could reduce the price of coal. Government even called on the electronics industries that had been captured to take full advantage of them. About half of the gross mineral production of the mines may be sold on the open market.

The Coalition Government has made a number of changes later, especially in the distribution sector. The Union's budget for the 2021-22 financial year said energy buyers had a choice. Large national distribution firms are owned by the State or private companies. Competition should be encouraged to offer customers a variety of options.

Coal should be avoided by building alternatives to clean, cheap home as soon as possible. Coal is a ‘zombie fuel’. Almost any loose response that encourages additional investment in coal is useless. The costs associated with coal production are high and rising.

How Covid 19 Pandemic tested the :

- Power Market Reforms

As a result of the important changes being made by the Government, India's power system has undergone a major transformation. These changes have led to the creation of a single national power grid that expanded access to electricity and promoted the dynamic growth of renewable energy.

After years of shortages, the system has become plentiful in recent years due to investment in production, and the private sector now makes up 50% of the total capacity. But some of the biggest changes, but much needed, are yet to come.

India's energy sector must be strong, financially and physically, to protect much-needed investment to meet the country's electricity demand and to redirect to clean energy. However, by 2020, the coronavirus epidemic has added to the many challenges the sector faces in its financial and physical resilience.

- Physical resilience of India’s Power System.

India suffers from the devastating effects of Covid-19, presenting health, economic and social challenges. At the same time, the foundations of India's power system are being tested as the country faces an unprecedented crisis created by Covid-19.

The epidemic has also affected the generation mix. Thermal power plants operate at a lower rate due to a lack of industrial demand, while the share of renewable resources on the grid continues to grow, due to their "operational" nature. In some provinces, Indian system operators are already using a power system with very high renewable shares. This situation is likely to continue until 2020/21 when the old power industries will have to be shut down to be rehabilitated and rehabilitated to meet new environmental needs.

The epidemic is convincing India to strengthen its ability to maintain supply security, strengthen system flexibility, and better integrate its powerful hardware and operational readiness software in the face of potential threats to electrical safety. Sustainable, reliable electricity supply is very important to everyone in India as important progress is still needed.

CASE STUDY : THE LIGHTS-OFF EVENT IN INDIA

The Prime Minister of India has asked its citizens to turn off their lights at 9pm on April 5, 2020 for 9 minutes to count the world war against the COVID-19 epidemic. The nations gladly accepted the call and took part in the event. This sudden change in load reduction, as well as the increase after the event, could have a significant impact on the grid.

The first exercise

To ensure the reliable and secure operation of the system during the event, a fake operation was scheduled for 4 April 2020 (before the actual date of the event) to measure the actual load reduction during the upcoming event. It is an important task to calculate the total load reduction or the entire Indian lighting load in order to perform the initial test. Therefore, the weight reduction measurement was considered using two methods as follows:

All India cuts for the actual event are calculated based on the demand pattern dated 29 March 2020 especially considering the high evening rate. It has been observed that the total demand for India was almost 101207 MW at 18:07 h and later increased to 112551 MW at 21:00 h. Considering this situation, it was predicted that the total lighting capacity of India would be 11344 MW (demand difference between 18:07 h and 21:00 h).

Adopted another task to quantify India's overall decline based on the merger of home buyers from different SLDCs. It was recorded at about 15085 MW.

Therefore, it was concluded that the total load reduction in India would be approximately 12–15 GW and possibly 2–4 minutes. Later, the necessary precautionary measures / planning are performed before the start of the mock exercise. Some of them are as follows:

All small stations, productive plants and distribution centers have been adapted to the common Indian (IST) era. Hydro generations are saved in the evenings to be flexible during exercise. Advanced actions such as switching off the power cords, taking reactors to service, changing SVC set points, STATCOM, HVDC, etc. were taken before the event to maintain voltage and line load within the permissible limits. Capacitor banks are kept open at distribution level to conserve energy. Discoms are limited to changing server performance.

The operating guidelines were finalized as mentioned above and the counterfeit work was adopted on 4 April 2020. The intended actions and results are as follows: Within five minutes of 20:55 h, the Thermal ISGS (Interstate Channels) was gradually reduced by about 60%. Hydro generations have been raised from 20:57 h to meet demand. Addition of hot units is done from 21:05 h. After stabilization i.e. at 21:09 h, water units were drained from the grid. During the whole process, the grid frequency was maintained between 49.50 Hz and 50.50 Hz from 20:45 h to 21:30 h. Also, seven 764 kV and nineteen 400 kV exceeded the power limit

The real event

The actual Light off event takes place on 5 April 2020 from 21:00 onwards. The first preparations were made according to a comedy activity. The observed conditions are discussed in detail as follows:

The total reduction of all India needs recorded during the event was 31089 MW. All demand for India started to decline from 20:45 Hrs, and the minimum demand of 85,799 MW was recorded at 21:10 Hrs as shown in the graph below. Next, from 21:10 Hrs, demand started to rise and was adjusted at 22:10 Hrs with a need of 114400 MW.

Demand and declining frequency during a light switch event.

Grid Frequency during the event remained in the range of 50.26 Hz to 49.70 Hz with a recorded frequency of 21: 08 Hrs and a minimum of 20:49 Hrs. As a sudden change of maximum load can have a negative impact on the network therefore POSOCO has taken certain steps to better manage the above light event.

After a high evening peak, the hot generation is reduced while water production is raised to control demand. Hydro started to decrease to 17543 MW (from 25559 MW to 8016 MW) in 20:45 hours. This water generation was also upgraded from 8016 MW to 19012 MW from 21:10 Hrs to 21:27 Hrs to meet the increased demand after the event. The reduction in production capacity of 10950 MW was achieved through Thermal (6992 MW), Gas (1951 MW) and wind production (2007 MW) from 20:45 Hrs to 21:10 Hrs.
Advanced actions such as switching off the power cords, taking reactors to service, changing SVC set points, STATCOM, HVDC, etc. were taken before the event to maintain voltage and line load within the permissible limits. The event was run smoothly without incident, and the power system parameters were maintained within limits. POSOCO thanks the support and cooperation of all stakeholders in successfully meeting this unprecedented challenge.
From the data on the case studies of India, it was revealed that the demand pattern during COVID-19 decreased significantly. However, POSOCO was able to address this critical situation and maintained the grid profile and voltage profile within the recommended band. However, they faced a number of issues and challenges during COVID.

CONCLUSION

Thus from the above analyses, it can be summarized that the following scenarios have occurred due to the COVID-19 outbreak:

- Commercial load demand declined the maximum.
- Residential loan demand increased.
- Industrial load demand also dropped but was not very significant in many countries.
- Energy demand prices fell in most of the countries.

CASE STUDY: WASTE 2 ENERGY

What is Waste to energy technologies (WTE)?

WTE technology converts useful waste to useful energy forms. The heat in the combustion of the waste generates an overheated vapor in the boiler. And steam drives a generator for electricity production.

Advantages

WTE systems provide a highly valued source of renewable energy, but perhaps the greatest benefit of WTE today comes from its ability to convert waste into ash, reducing by up to 90 percent the volume of waste going to landfills.1 This waste reduction can also help contain the number of methane emissions from landfills with decomposing organic materials.2 These issues are especially important in Southeast Asia, where the urban population is projected to rise to nearly 400 million by 2030.

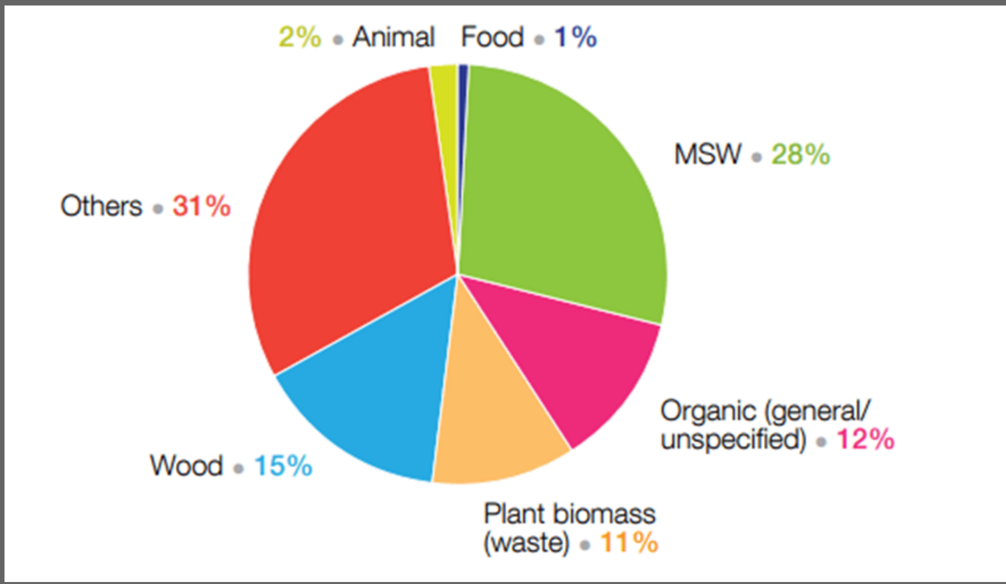
Hindrances

Many developing economies have very limited waste- segregating processes and regulatory requirements to segregate different types of waste. WTE plants produce ashes from the world posted on the landfill published on the barrier to prevent soil contamination. In addition, the cost of creating a WTE plant is very high. This means that many economies cannot go forward with environmental protection.

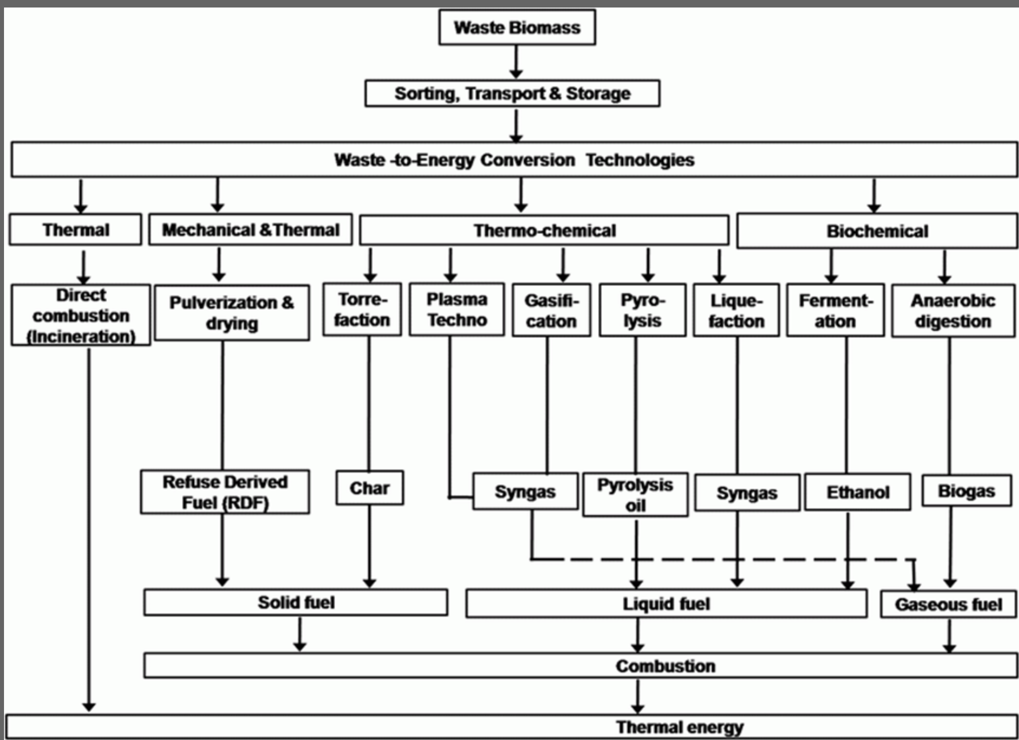
Types of waste

At present, waste is classified as one of the following:

1. Municipal solid waste (MSW)
2. Process waste
3. Medical Waste
4. Agricultural Waste



PROCESSING METHODS (BIO-MASS)



WTE TECHNOLOGY ADOPTION BY SINGAPORE:

Singapore has been a long-term regional leader in WTE development. Bhaskar shares that Singapore aims to reduce the average day to day amount of waste sent to Semakau Landfill by almost 1/3, or from 0.36 kg/capita in 2018 to 0.25 kg/capita by 2030. Currently, the county's solid waste disposal infrastructure consists of three WTE plants:

1. Tuas, Senoko:

Senoko Waste-to-Energy Plant (Senoko WTE Plant) is one of the waste incineration plants built in Singapore and is currently operating out of the four waste-to-energy plants. It was commissioned in 1992 with a land area of 7.5 ha.

Senoko WTE Plant has six incinerator-boiler units with two condensing turbine-generators offering a power generation capacity of 2 x 28 MW. Senoko WTE plant operates 24X7 throughout the year.

Tuas, South:

Tuas South Incineration Plant is the largest refuse incineration plant in Singapore. Built at a cost of S$890 million and completed in June 2000, it was designed to incinerate 3,000 tonnes of refuse daily. The plant is sited on 10.5 ha of reclaimed land and enables all incinerable waste generated in Singapore to be disposed of by incineration. The Plant was built with state-of-the-art technology. The various processes are highly automated and controlled via a digital control system. Modern equipment incorporating advanced technology is used in the plant to ensure a high level of efficiency and reliability

2. Keppel Seghers Tuas Plant (KSTP)

Modeled by Keppel Seghers in 2006 and functioning since October 2009, Keppel Seghers Tuas WTE Plant was built with Keppel Seghers' in-house technologies such as the air-cooled grate and flue gas cleaning system and is the first waste incineration plant in Singapore to showcase WTE technology from a Singapore company. Keppel Seghers Tuas WTE Plant has two incinerator-boiler units and can treat 800 tonnes of solid waste daily. It has one condensing turbine generator offering a power generation capacity of 22 MW. Waste incineration is carried out at the plant 24 hours a day throughout the year.

In the country's upcoming WTE-based Integrated Waste Management Facility (IWMF), treatment facilities for multiple waste streams will be catered for. To be developed in phases, the first phase of the IWMF will be capable of handling 2,900 tpd of incinerable waste; 250 tpd of household recyclables, 400 TPD of source segregated food waste, and 800 tpd of dewatered sludge from the future Tuas Water Reclamation Plant (TWRP), which will be integrated with the IWMF to form the Tuas Nexus.11 The Tuas Nexus allows synergies to be derived from the water-energy-waste nexus and improve energy and resource recovery efficiencies and enhance land use optimization for Singapore.

WTE TECHNOLOGY ADOPTION BY JAPAN :

Japan dominated by more than 60% of WTE industry in 2019, and it is expected to register CAGR 12% or more in 2025. The country has 380 waste-to-energy plants nationwide, and almost a third of the country's refuse—incineration facilities turn garbage into electric power. In some ways, Japan is taking a more aggressive approach than China by offering combination packages that include WTE backed by a range of services such as waste sorting, waste reduction, personnel training, and recycling. Hitachi Zosen, JFE Engineering, Mitsubishi Heavy Industries, and other Japanese exporters are expected to join consortia to bid for plant orders in Southeast Asia.

Toshima Incineration Plant

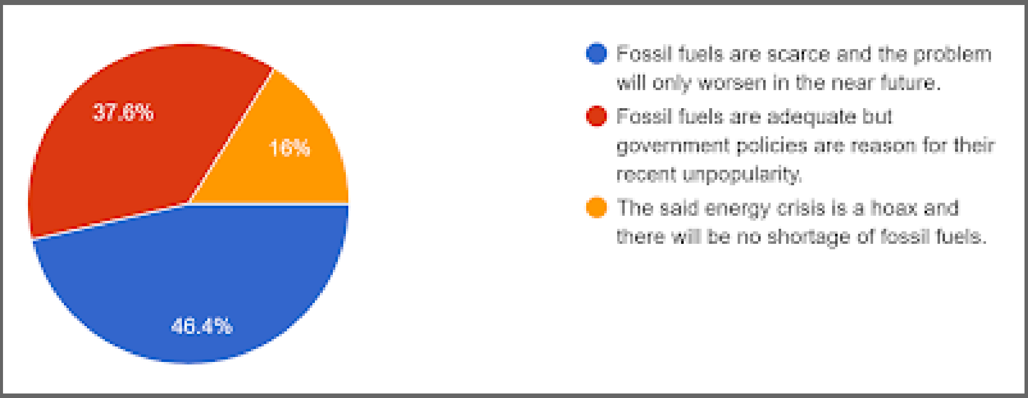
is a waste management plant located in Kami-Ikebukuro, Toshima, Tokyo, Japan It covers an area of 12,000 square meters and has two incineration units with a combined capacity of 400 tons of waste per day. The plant was constructed with a large fitness center to appease area residents who may have otherwise opposed its construction. The center's swimming pool is heated from burning garbage while electricity is supplied from a steam-driven turbine. The plant outputs 7,800 kW of electricity, enough to supply 20,000 homes.

HITACHI ZOSEN CORPORATION:
This facility burns waste and treats it hygienically, while at the same time generating electricity as an important energy resource.
Refuse brought to the refuse pit by garbage trucks is burned while moving on top of a combustion device called a stoker in an incinerator. The incinerated refuse is then discharged as ash. The energy of exhaust gas generated by combustion is recovered as steam by the boiler, and electricity is then produced by the steam turbine generator. The generated electricity is also sent outside the facility.

Mitsubishi Heavy Industries:
In 1998, MHI developed the Mitsubishi Municipal Solid Waste (MSW) Gasification & Ash Melting System, an advanced WtE system to combat the issue of waste and environment and help build a fully recycling society for the future generations. The first commercial plant was built in Kushiro city, Japan in 2006, near the Kushiro Shitsugen National Park, Japan's largest marsh designated as a Ramsar site. The plant has been operating successfully as the advanced and most environmentally friendly WtE system. The process of gasification and ash melting of the system allows high recyclability compared to conventional incineration systems. Metals (aluminum, iron, and steel) contained in the waste can be recovered and recycled with rather high sales value compared to metals from conventional incineration.

FINDINGS

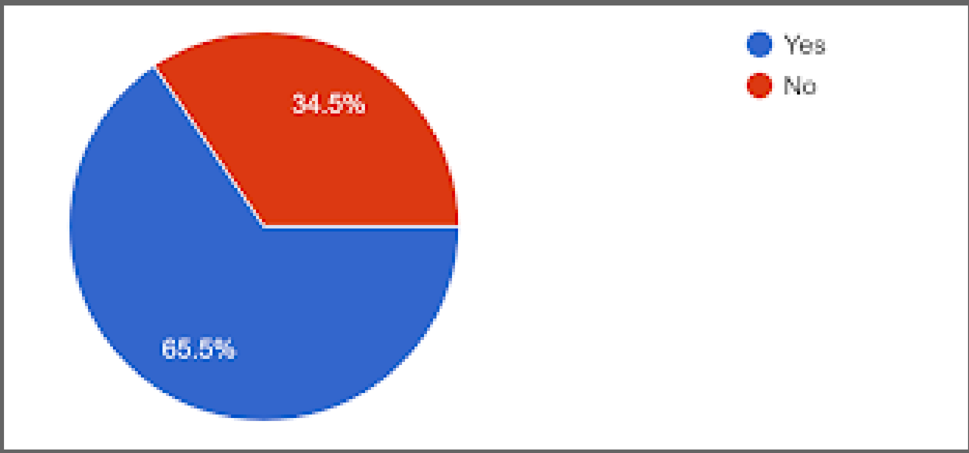
IN YOUR OPINION WHICH OF THE FOLLOWING MOST APPROPRIATELY DESCRIBES SITUATION OF FOSSIL FUELS IN THE CURRENT WORLD?



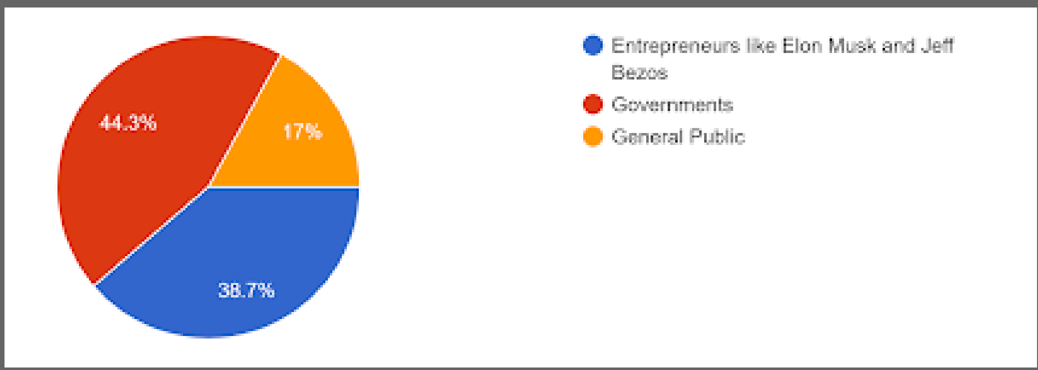
When asked what appropriately describes the current situation of fossil fuels in the world, the majority of the respondents said that fossil fuels are scarce and that the problem will only worsen soon. 46.4% of the respondents believe in this statement, followed by 37.6% of the respondents thinking that fossil fuels are adequate but government policies are the reason for their recent unpopularity. The least number of respondents went with the statement claiming that the said energy crisis is a hoax and there will be no shortage of fossil fuels. The percentage of people who believe this is 16%. To conclude, most respondents acknowledge that fossil fuels are scarce and there is a problem, but a significant number of respondents also believe that there is no shortage.

GIVEN THE CURRENT STATUS QUO, ARE YOU WILLING TO SHIFT TO RENEWABLES?

The majority of the respondents are willing to shift to renewables, the percentage of them being 65.5%. 34.5% are not willing to shift to renewables. Even though majorly respondents are willing to change given the current status quo, a huge percentage are still not willing to shift to renewables.

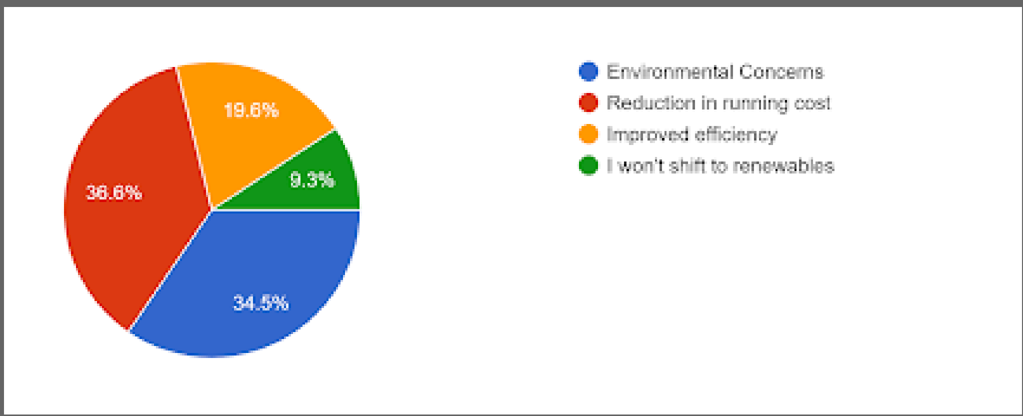


WHO ,IN YOUR OPINION, WILL HELP FAST TRACK THE TRANSITION TO RENEWABLE SOURCES OF ENERGY?



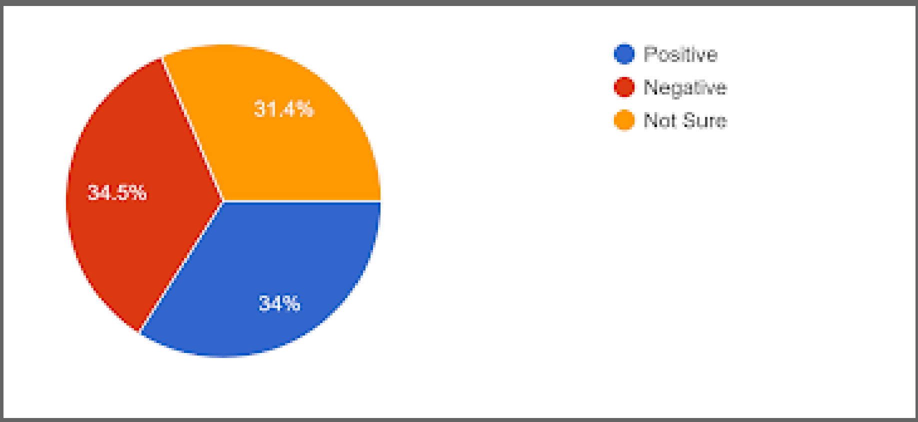
44.3% of the respondents believe that the Government will help fast track the transition to renewable sources of energy. The majority has faith in the government whereas 38.7% of respondents think that the entrepreneurs like Elon Musk and Jeff Bezos are the ones to do this. The least number of respondents that is 17% believe that the general public is the one to fast track this transition to renewable sources of energy.

IF YES, WHAT WILL BE YOUR REASON TO SHIFT TO RENEWABLE SOURCES OF ENERGY?



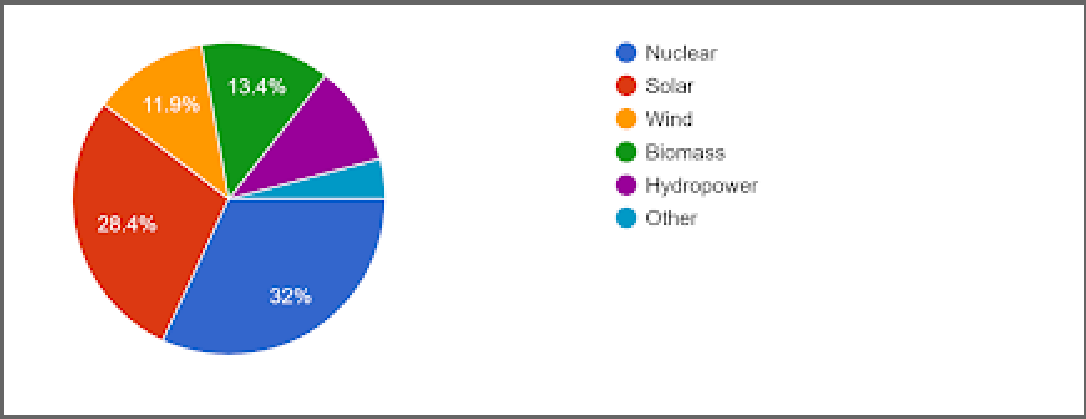
When asked what would be the reason behind shifting to renewable sources of energy, 9.3% said that they won't shift to renewables. Out of those who agreed to do so, 36.6% claimed that they would do so because of the reduction in running costs. A significant number of respondents claimed that they would do so due to environmental concerns. 34.5% claimed this to be the reason. 19.6% of respondents said that they would shift to renewable energy for improved efficiency. So majorly, respondents would shift to renewable energy due to environmental concerns and reduction in running costs.

DO YOU THINK COVID -19 HAS LEFT A POSITIVE OR NEGATIVE IMPACT ON THE ENERGY SECTOR?



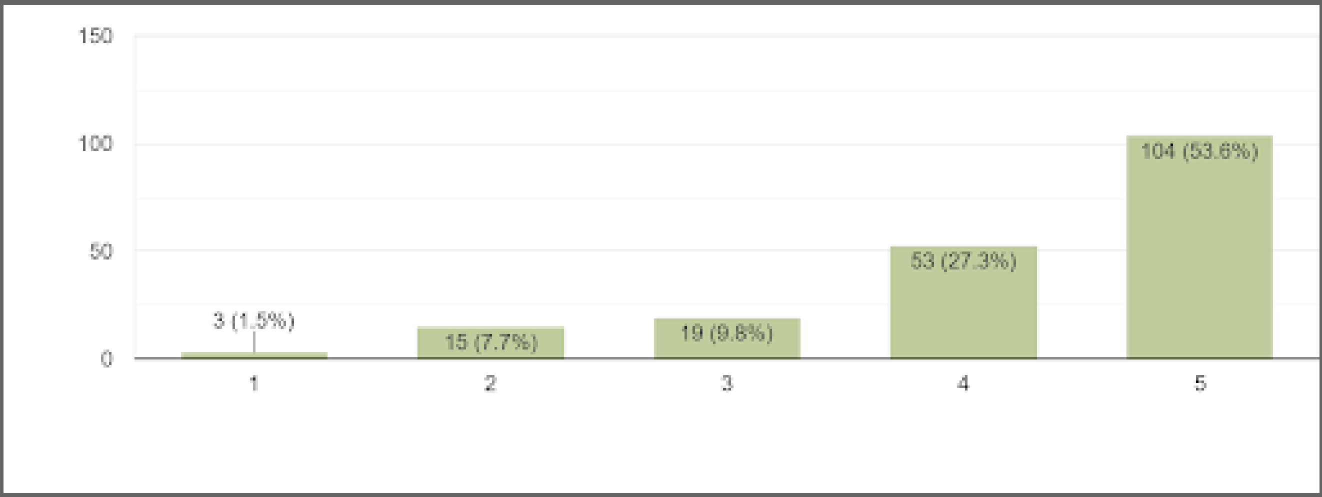
Out of all the respondents, 34.5% believe that the Covid-19 has left a negative impact on the energy sector. Surprisingly, there is only a difference of 0.5% between these people and the ones who believe the opposite. 34% of the respondents believe that the Covid-19 has left a positive impact on the energy sector. On the other hand, 31.4% of the respondents are not sure about the impact. Overall, there isn't exactly a majority opinion as all the statements have a significant number of respondents believing in them.

WHICH OF THE FOLLOWING SOURCES OF ENERGY ACCORDING TO YOU IS MOST LIKELY TO WITNESS SIGNIFICANT GROWTH IN INDIA?



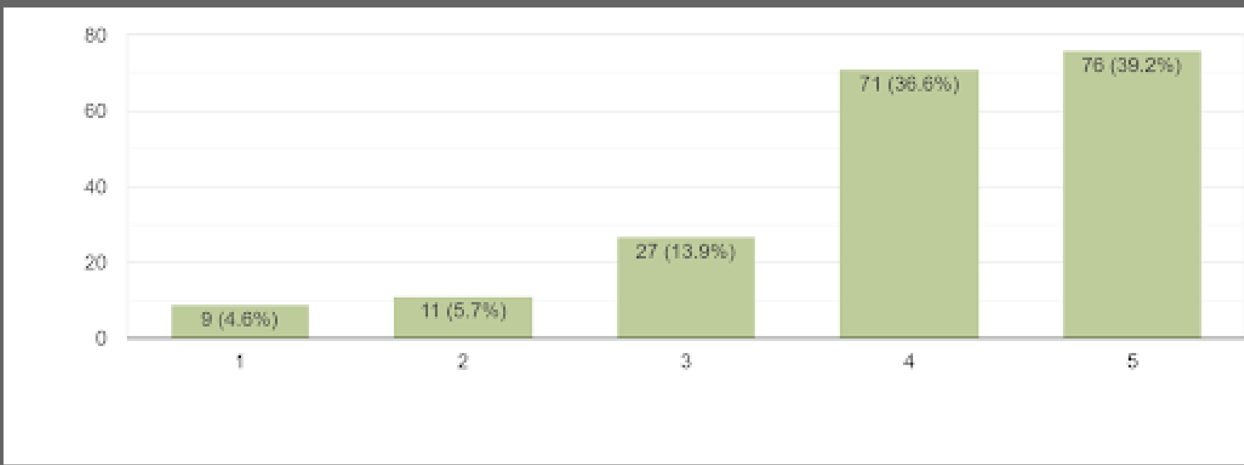
According to the respondents, nuclear energy is most likely to witness significant growth in India.32% of the respondents believe this followed by 28.4% of them believing that solar energy will witness significant growth in India. Biomass energy and wind energy are supported by 13.4% and 11.9% of the respondents respectively.Some of the respondents believe that hydropower will witness significant growth in India and a few believe in other sources of energy. To conclude, the respondents believe that nuclear and solar energy are the sources that will most likely witness significant growth in India.

ON A SCALE OF 1-5 HOW LIKELY ARE YOU TO INVEST IN SOLAR TECHNOLOGY FOR YOUR HOUSEHOLD NEEDS?



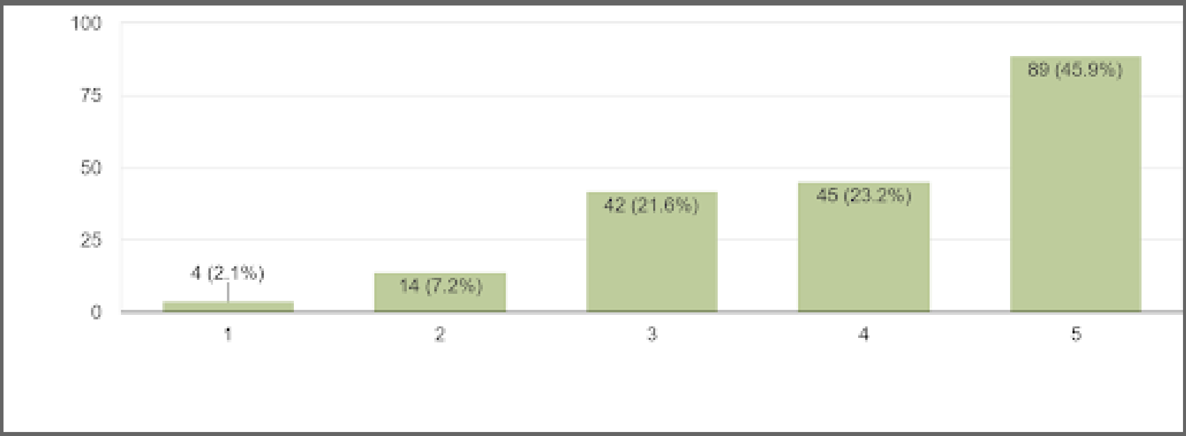
104 respondents are very willing to invest in solar technology for their household needs, that is 53.6% of them are likely to invest in solar technology, followed by 27.3% of them who are willing to invest but not strongly. 9.8% of the respondents are somewhat likely to invest followed by 7.7% who will most likely not invest and then finally there are 1.5% of the respondents, 3 to be exact who are sure that they will not invest and are unlikely to change to solar technology for their household needs.

ON A SCALE OF 1-5 , WHAT IS THE LIKELIHOOD OF YOU BUYING AN ELECTRIC VEHICLE OVER A TRADITIONAL VEHICLE FOR YOUR NEXT PURCHASE?



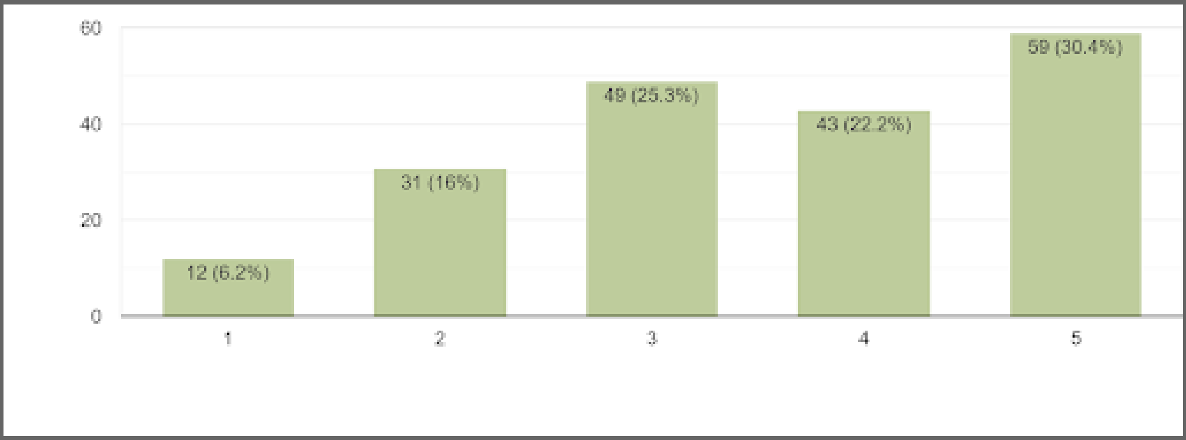
When asked how likely the respondents are to buy an electric vehicle over a traditional vehicle, 39.2% of the respondents claimed that they will do so followed by 36.6% claiming that they are most likely to do the same. 13.9% of the respondents are somewhat likely to buy an electric vehicle and not a traditional one. On the other hand, we have 5.7% of the most likely not to do this and 4.6% of the respondents who claim are unlikely to choose an electric vehicle over a traditional one.

ON A SCALE OF 1-5 , HOW MUCH DO YOU THINK REDUCING OUR FOSSIL FUEL EMISSIONS WILL CONTROL PROBLEMS SUCH AS GLOBAL WARMING AND AIR POLLUTION?



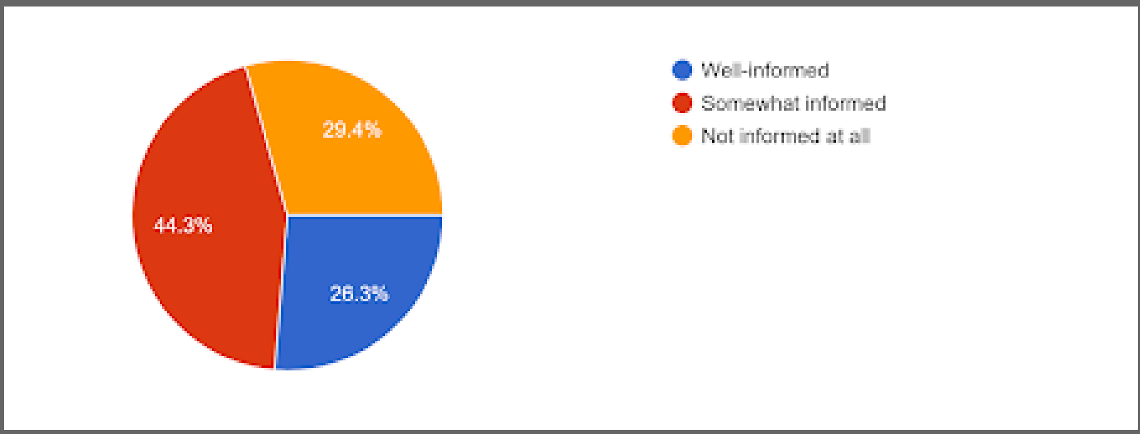
The majority of the respondents believe that reducing our fossil fuel emissions will control problems such as global warming and air pollution. 45.9% of the respondents believe in this strongly whereas 23.2% believe that reducing fossil fuel emissions will most likely control problems and 21.6% believe that this will somewhat likely help in the same. 7.2% that this is most likely not the solution to control problems like air pollution and global warming whereas only 2.1% of the respondents believe that reducing fossil fuel emissions will unlikely control problems like global warming and air pollution.

ON A SCALE OF 1-5 ,HOW SATISFIED WOULD YOU SAY ARE WITH YOUR CURRENT EXPENDITURE REGARDING ENERGY CONSUMPTION?



30.4% of the respondents claim that they are completely satisfied with their current expenditure regarding energy consumption. 25.3% of them are neither satisfied nor dissatisfied with the same followed by 22.2% of them as somewhat satisfied. 16% are somewhat dissatisfied with their current expenditure regarding energy consumption and 6.2% of the respondents are completely dissatisfied with the same. The majority of the respondents lie on the satisfying side.

HOW WELL INFORMED ARE YOU ABOUT THE VARIOUS ASPECTS RELATED TO COP26 ? (2021 UNITED NATIONS CLIMATE CHAGE CONFERENCE)



26.3% of the respondents claim that they are well informed about the various aspects related to COP26 whereas the majority of the respondents claim that they are somewhat informed, their percentage is 44.3%. 29.4% of them claim that they are not informed at all. It is evident from this that the least number of the respondents are well-informed about the various aspects related to COP26.

CONCLUSION

The purpose for this report was to achieve a deeper understanding about how our energy landscape has changed and will change in the coming few years.

Energy is the pulse of our day-to-day life and how we create and use it is changing everyday. Considering the changing landscape of the oil, gas and chemicals industry, it is imperative for companies to develop innovative strategies and leverage technologies that will lead to a sustainable future.

Oil, natural gas and coal reserves will be emptied in 44, 46 and 107 years respectively so we can state that global demand for fossil fuels has not yet reached its apex. Global energy consumption is increasing year after year, and as a result, the use of fossil fuels are increasing as well. We just do not have enough renewable energy to meet the full demand of our industry and populations.

With nuclear power being a very efficient energy source compared to other forms of renewable energy, because of its smaller land footprint and the amount of waste it produces, India's nuclear power could provide a reliable solution to the rising power demand as against wind and solar energy that is not available round the clock.

Dedicated electricity generation from renewables or nuclear power offers an alternative to the use of grid electricity for hydrogen production. With reduction in costs for renewable electricity, in particular from solar PV and wind, interest is growing in electrolytic hydrogen and there have been several demonstration projects in these recent years.

Despite renewable energy being the world's fastest growing energy source accounting for nearly 29% of worldwide power generation in 2020, the aesthetics of renewable energy should not take precedence at this time.

We need to keep in mind the time constraints imposed by climate change, individuals and energy corporations and should do all possible to transition to a renewable, low-carbon society.

What the future will look like for us is not certain, but what is clear is that we're well on our way towards a new energy revolution.

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