World® Utility Summit

New Energy: ELECRAMA 2023

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World® Utility Summit
20-21 February 2023
Delhi NCR, India

SUSTAINABLE TRANSFORMATION OF UTILITIES

THE THEME

The theme of the World Utility Summit, (WUS) is “Sustainable Transformation of Utilities”.

This summit would bring in thought leaders across the globe to deliberate the preparedness of utilities to deal with the transformational changes. Regulators, technology providers, consultants, government bodies and utility leaders are expected to share their views on the various challenging and exciting scenarios and help shape the roadmap of the future utilities.

SUMMIT TRACKS:

Accelerating Digital Journey of Energy Ecosystem

Utilities get their revenues primarily via billing the customers for their demand and energy usage. New energy ecosystem, with multiple options for consumers to meet their electricity demand, will pose stiff competition to the utilities. Earlier for paying electricity bills a long que has to be made but in today's era the process has been digitized. With the use of smart meters, every process is digitized and simple. The questions arise in what manner digitization of energy ecosystem will affect the consumers?

Best Practices in Asset Management

Proper asset management allows company to effectively provide their service to the nation. Any breakdown in this process brings the potential for catastrophic failure in the nation infrastructure. Proper asset management allows you to:

- Enhance the life of assets through proper maintenance
- Allows you to respond efficient during emergency situation
- Reduce operating cost in long term.

The four main pillar of the asset management are:

- Evaluate your system's asset
- Assess your current service level
- Identify your most critical component
- Map out your life cycle cost
- Develop maintenance plan

Enhancing the Utility System Resiliency

In this environment, the utilities, Government and others stakeholders needs to take longer and deeper look at building resilience to limit and mitigate the risk to customers. Protecting them from risk that threaten life, property and economic activities that can be costly. We would like to suggest important pillars in the effort to improve our Nations grid resilience.

- Smartening the Grid
- Hardening the Grid
- Distributed Generation
- Building resilience on demand

Distribution Utilities of Future: Advanced Technologies for Business Transformation

The Indian power sector is evolving at a fast pace and has undergone some major transformations in recent past aimed at improving grid efficiency, security, stability, and consumer experience. However, the distribution utilities remain the weakest link in power sector value chain. The deployment of advanced technologies such as smart-grids can reduce pilferage, enhance consumer participation, and realize more revenues through losses reduction, lower energy costs, and eliminate manual intervention. Further, the combination of advanced technologies, innovative market models and consumer engagement strategies can support solutions like grid interactive buildings and enable consumers to support the distribution utilities in managing the demand supply balance. Together, such technologies and solutions have the potential to transform the distribution utilities and accelerate the use of clean energy resources in power grids.

Sustainable Practices towards Net Zero Utilities

In current scenario, Energy and Utilities executives are working towards sustainable practices. Almost half of the energy and utilities respondents have committed to a net zero goal. The major driving factors for sustainable utilities are upcoming government policies favorable to consumers and industry, increasing consumer and shareholder demand, and Decreasing cost of renewable energy. The important question arises how the Utilities are building a sustainable future.

New Energies (Common track with eTECHnxt)

The Indian renewable energy sector is the fourth most attractive renewable energy market in the world. As of May 2022, India's installed renewable energy capacity stood at 159.94 GW which is 39.70 % of the overall installed power capacity. People everywhere are looking for new energy ideas to help them make energy smart decisions for the future. We believe in renewable Energy and changing the attitude and practices about the way people generate and use energy. Central to this is the discovery and development of alternative energy sources. This track will cover the latest developments in technologies, novel business ideas, grid dynamics, learnings from pilot demonstrations and working considerations associated with these technologies. The topic will emphasis on Green Hydrogen, Electrification of Transportation, Nuclear & Biomass.

MESSAGE FROM KNOWLEDGE PARTNER

Mr. Mohammad Saif
Partner (P&U)
Ernst & Young LLP, India

The World Utility Summit 2023 is back post a long pandemic hiatus but with more vigour and a larger spectrum coverage. This year, while on one side the WUS is looking at how the conventional demand-supply value chain is evolving with a clean transition centricity, on the other hand there is a specific focus on new energies too. These new energies initiatives are different from traditional renewable options and include such initiatives that are still in nascent stage of evolution.

For the purpose of this Summit, New Energies would refer to various initiatives that help in either faster replacement of conventional sources of energy generation or its usage. The initiatives on generation side may include innovative combination of the traditional clean generation sources such as solar and wind resulting in larger output. Similarly, usage would include shifting to cleaner fuels/energy sources to lower environmental impact.

The criticality of New Energies becomes all the more essential given the continues rise in Green House Gas (GHG) emissions across the globe despite the ongoing efforts towards clean energy transition. These different initiatives can complement the renewable capacity additions and facilitate a faster transition. Also, these can help improve socioeconomic situations and livelihood conditions in most of the poorer nations that are still in energy deprivation.

The New Energy Session at the WUS 2023 shall bring together a rich combination of stakeholders from the field of policy, projects, manufacturing, financing etc. who would deliberate on ways to enhance the penetration of many of these initiatives. This Knowledge Paper is an effort to consolidate information on some of the key New Energies initiatives and provide a basic information platform for the audience and participants on the subject.

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1 Introduction

Energy has always been a key element in the economic and social progress of countries. Over the past few decades, there has been an ever-growing dependence on various sources of energy that have not only helped in the socio-economic progress but have also led to adverse impacts on the natural contours of the world.

According to World Economic Forum (WEF), an estimated 36.6 billion tonnes) of carbon dioxide, (CO_2) emissions happened in 2022 which largely came from fossil fuels that have been used as fuel in various forms of industrial activities.

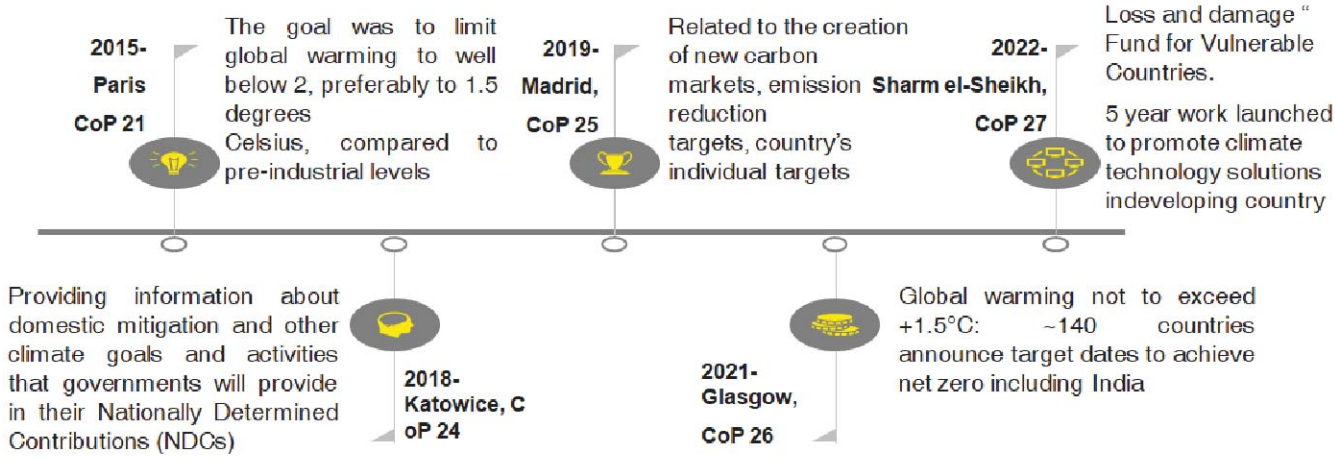
Further, the *17th edition of the Global Carbon Budget,* 2022 made an observation that if emissions continue to remain at current levels then the Paris Climate Agreement target of restricting global temperatures to at least below 1.5 0C would be breached by 2030.

In the last few decades, there has been a concentrated effort for transitioning towards cleaner sources of energy, especially through renewable sources such as solar and wind. While these efforts, across the globe, have helped in restricting the emissions but the pace of the addition of clean energy sources is not able to overcome the pace of increase in green house gas emissions.

Given this context, there has been an overarching thought to find newer ways of fast-tracking the clean energy transition agenda. The concept of 'new energies' is focused on the same.

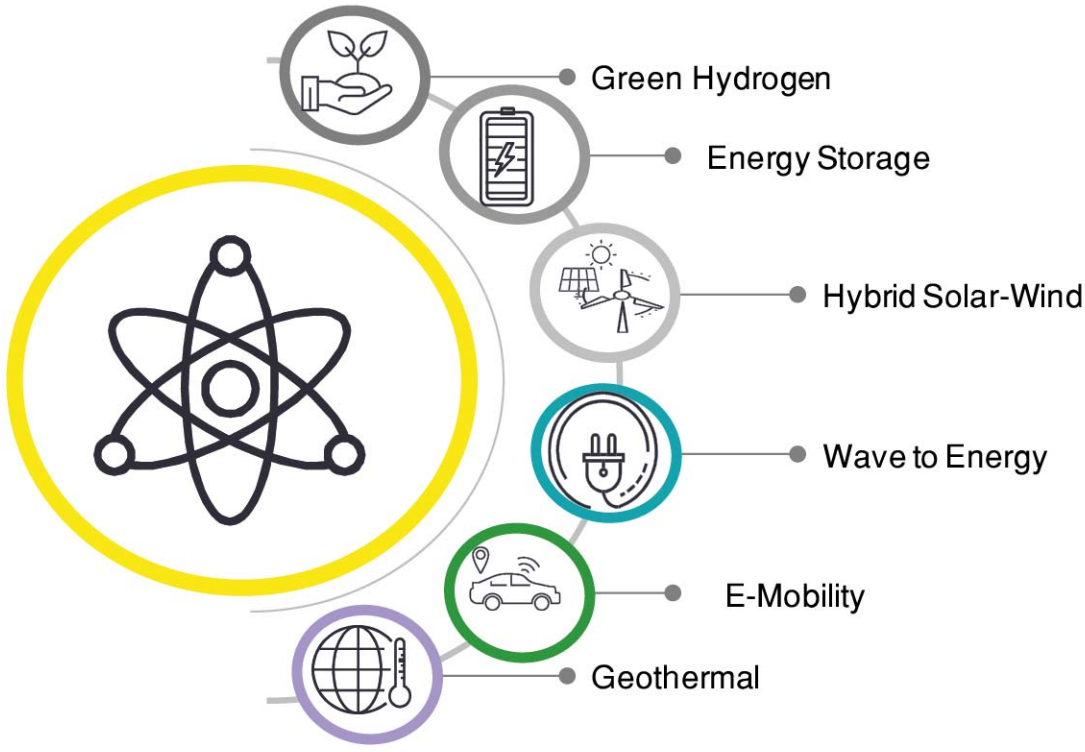
New Energies refer to various initiatives that help in either faster replacement of conventional sources of energy generation or its usage. The initiatives on the generation side may include sources other than solar and wind or an innovative combination of these conventional clean sources for a larger impact. Similarly, usage would include shifting to cleaner fuels/energy sources to lower environmental impact.

Fig 1: A timeline to global Clean energy transition commitment



As can been seen from the previous graphic, there has been a growing consideration towards clean transition and hence the role of new energies becomes extremely imperative to compliment the existing efforts towards the same.

1.1 Spectrum of new energies



The below table lists a number of new energy initiatives that are in nascent or initial stages of implementation:

Sno.	New Energies	Brief
1	**Green Hydrogen**	Green hydrogen is produced through electrolysis, a process that separates water into hydrogen and oxygen. Green Hydrogen is generated through electrolysis using electricity from renewable sources
2	**Energy Storage**	Energy storage is a medium to store energy in battery or any other form and then using it whenever there is a sudden demand of energy or to maintain system stability whenever needed.
3	**Hybrid Solar-Wind System**	The combination of renewable energy sources, wind & solar are used to provide longer duration electricity supply. These sources can be co-located or dispersed to maximize respective potential.
4	**E-Mobility**	E-mobility includes all transport systems which use stored energy to run without using the traditional fossil fuels. The stored energy comes from cleaner sources.
5	**Wave to Energy**	The tidal energy is used to produce electric energy through specially designed turbines located in water
6	**Geothermal**	Geothermal technology extracts the heat found within the earth's subsurface and using it directly for heating and cooling, or convert into electricity

It is pertinent to note that most of these sources are not commercially viable in the current scenario. Also, many of these may have limited potential or the potential has still not been explored at large scales.

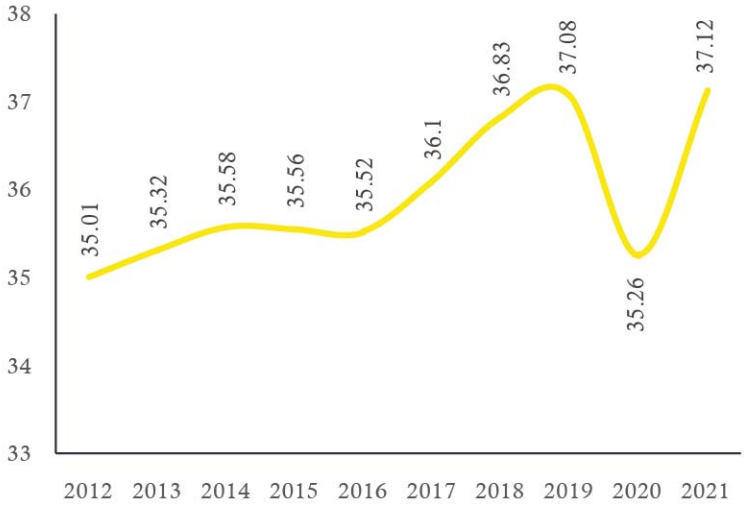
However, the vitality of such new energy options becomes essential when they are looked at from the point of view of being complementary to the core renewable energy sources. Further, the commercial business case may not be viable in the existing scenario but a decade back similar situation was for solar systems or in the previous decade for wind turbines.

This discussion paper as well as the session on 'New Energies' in the World Utilities Summit intends to share experiences and learnings with an aim to fast-track scaling up of all possible options.

Before deep diving on the experiences, the subsequent section does a situational assessment to establish the case for these various new energy initiatives.

1.2 Need for new energies-a situational assessment

Fig 2: CO_2 Emission (bn t)



Source: OurWorldindata

Figure 2 indicates the global rise in CO2 emissions in the last one decade. It indicates an average emission of 36 billion tonnes (bn t) per year.

It is also observed that there was a marginal slump in CO2 emission during the pandemic era, between 2019-20, but the very next year CO2 emissions reached pre-pandemic levels due to the revival of the global economy.

As a result of this persistent rise in global CO2 emissions, the global temperature has also been on the rise. According to National Oceanic Atmospheric Administration (US), the earth's temperature has risen by 0.14 0C per decade since 1880 and has risen more than twice i.e. 0.18 0C per decade since 1981. As a result, 2021 became the sixth warmest year of all time.

This alarming rise in temperature has catalyzed the melting of glaciers which is directly increasing the rise of sea level which has led to catastrophic events like flooding, loss of habitat, soil contamination, and other health issues for the population.

The alarming rise in environmental temperature demands that we do more than whatever is being done currently to arrest further environmental degradation. This sets the base for the need to explore newer sources of clean energy production as well as alternatives to maximize clean energy usage.

The above need is further established by undertaking a detailed assessment on the following:

a) CO2 emission -GDP correlation,

b) CO2 emission– Renewable Energy (RE) correlation

a) CO_2 emission and GDP correlation

The correlation between CO_2 and a country's GDP has been studied for two developed (USA and UK) and two developing nations (India and Bangladesh). A graphical representation of the correlation is depicted in figures 3,4,5 and 6 below:

Fig 3: CO_2 Emission- GDP per capita, PPP (United Kingdom)

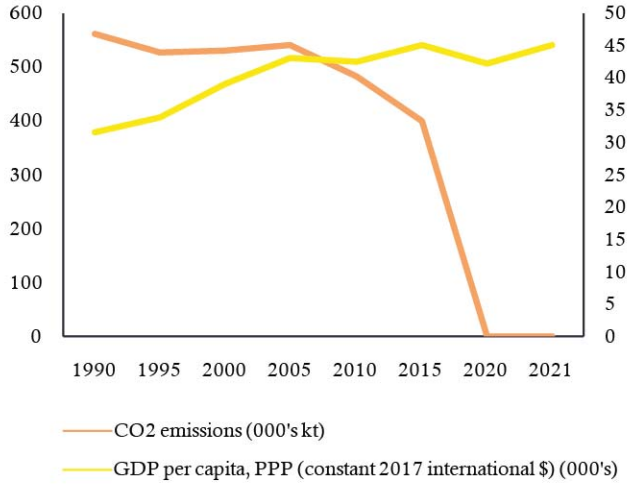


Figure 4: CO_2 Emission-GDP per capita, PPP (India)

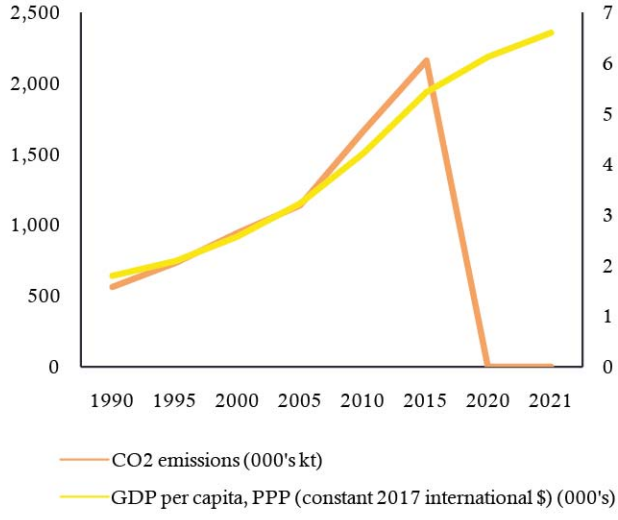


Figure 5: CO_2 Emission-GDP per capita, PPP (USA)

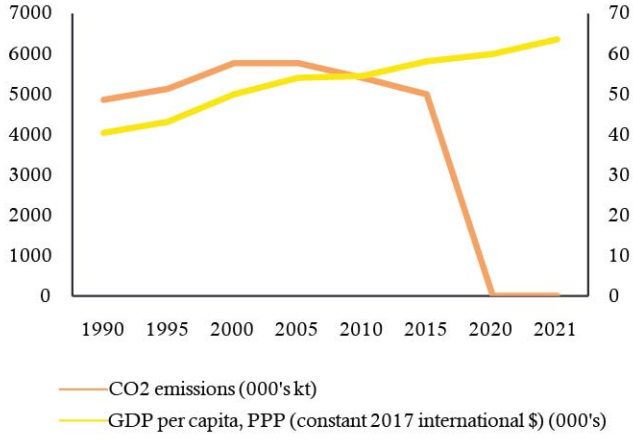
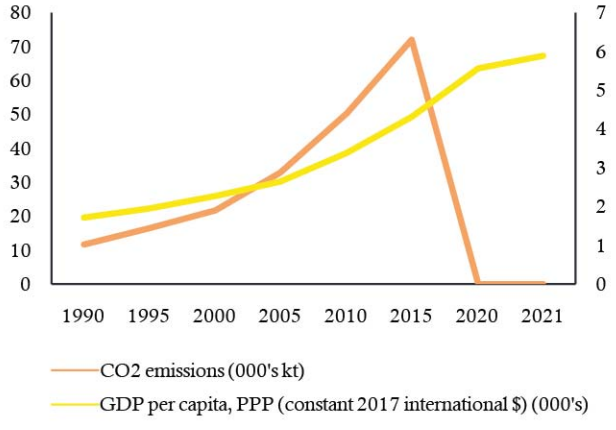


Figure 6: CO_2 Emission- GDP per Capita, PPP (Bangladesh)



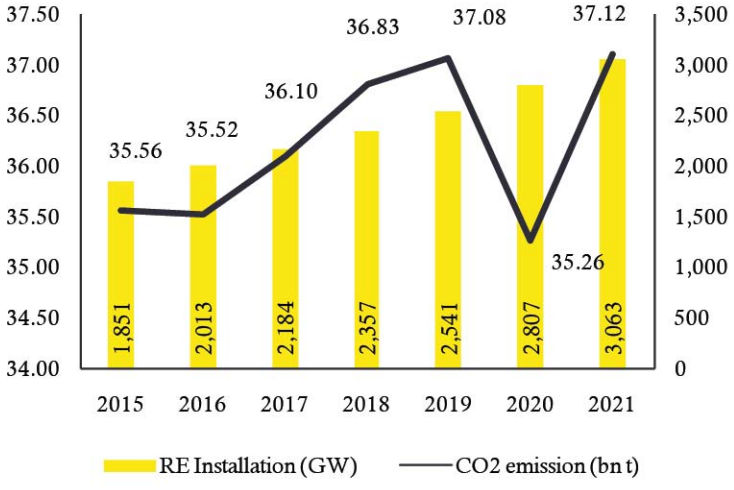
Source: World Bank

As can be seen from the various trajectories, during the period when the focus on environmental degradation was not that large, all countries have shown synchronized growth across both the GDP and the emissions. However, with interventions from various international agencies like United Nations Framework for Climate Change (UNFCCC), the focus started shifting to reducing emissions through a gradual switch from conventional to cleaner energies. Most countries, whether developed or developing, are committed to reducing their carbon footprints.

As a result, there have been green shoots in emission reductions in most countries. It is pertinent to mention that 2020 data is an outlier due to the reductions falling drastically owing to global shutdowns due to the pandemic. Still, the trend of emissions has started to decline owing to the focus on clean transition.

b) CO_2 emission and RE Correlation

Fig 7: CO_2 - RE Installation



As can be seen from Figure 7, while there has been continuous growth in global RE installation capacity (CAGR of 8.76 %), CO_2 emissions have also been increasing during the same period except for the pandemic year 2020.

It is clearly evident that the RE capacity additions are yet to outpace emissions and hence newer options to both generate and use clean energy need to be explored, scaled, and commercialized at the earliest.

Sensitization on continuous environmental degradation has been successful in garnering global traction on the need for an urgent clean energy transition. However, there is still a wide gap between commitment and one reason for the same can be limited clean energy transition alternatives. The 'clean energy options can provide sustained and credible options to complement the ongoing initiatives and help fast-track the clean transition journey.

2

Global experience: Policies / Initiatives

Some of the policies/ initiatives driving various new energy themes in some of the major economies in the world are illustrated below:

Country	Policy/ Scheme / Agency for Green Hydrogen
Australia	**National Hydrogen Strategy, 2019:** The strategy extended a support of USD 259 million towards country's technology investment roadmap.
Canada	**Canada's Hydrogen Strategy,2020:** envisions a hydrogen supply network that could include both large-scale centralized plants in its natural gas–rich provinces with high penetration of low-cost renewables, as well as smaller-scale distributed electrolytic production near demand centres.
China	**Hydrogen Industry Medium- and Long-Term Development Plan (2021–2035):** This strategy will be a key element in China's energy transition goal of carbon neutrality and building a more sustainable economy.
France*	**National Hydrogen Strategy,2020:** An investment of USD 7.8 billion was extended with a target of developing hydrogen production capacity of 6.5 GW by 2030 and additional USD 1.6 billion towards construction of electrolysis plants.
Germany*	**National Hydrogen Strategy, 2020:** Development of electrolyser capacity of 6 GW by 2024 and 40 GW by 2030.
India	**National Hydrogen Mission, 2022:** This mission aims to build capabilities to produce at least 5 Million Metric Tonne (MMT) of Green Hydrogen per annum by 2030, with potential to reach 10 MMT per annum with growth in export markets. Recently outlay of USD 2.4 billion USD was allotted by Government of India
Japan	**Basic Hydrogen Strategy,2017:** The strategy notably seeks to achieve cost parity with competing fuels, such as liquefied natural gas for power generation
United States of America	DoE National Clean Hydrogen Strategy and Roadmap , 2022 : Governing principle of Hydrogen Program **U.S. Infrastructure Investment and Jobs Act, 2022** established clean hydrogen initiatives to accelerate domestic production, deployment, and use of clean hydrogen.

Country	Policy/ Scheme/ Agency for Energy Storage
Australia	**Commonwealth Scientific and Industrial Research Organisation (CSIRO)** is an Australian government agency who takes care of scientific research in the field of energy storage.
Canada	**Power Advisory and Energy Storage** Canada together are working on number of reports related to energy storage.
China	Accelerating the Development of New Energy Storage and Participation in the Electricity Market and Power Conditioning: enabled energy storage to participate in ancillary services independently, rather than serving solely as solar-plus-storage.
France	Article 85 of the Climate and Resilience Act dated 22 August 2021 created Article L. 352-1-1 of the French Energy Code, which provides direction for the calls for tenders to develop electricity storage capacities

* Member of "The European Clean Hydrogen Alliance"

Country	Policy/ Scheme/ Agency for Energy Storage
Germany	Federal Requirements Plan (BBPIG), Energy Industry Act (EnWG) and Grid Expansion Acceleration Act (NABEG) now define energy storage as an asset.
India	Energy Storage Obligation (ESO) has been included as part of the Renewable Purchase Obligation (RPO) scheme
Japan	Storage Battery Strategy, 2012 by the Ministry of Economy, Trade and Industry (METI) mandating Commerce and Information Policy Bureau as responsible for battery industry and information policies
United States of America	USAID Energy Storage Decision Guide for policy makers in 2021.

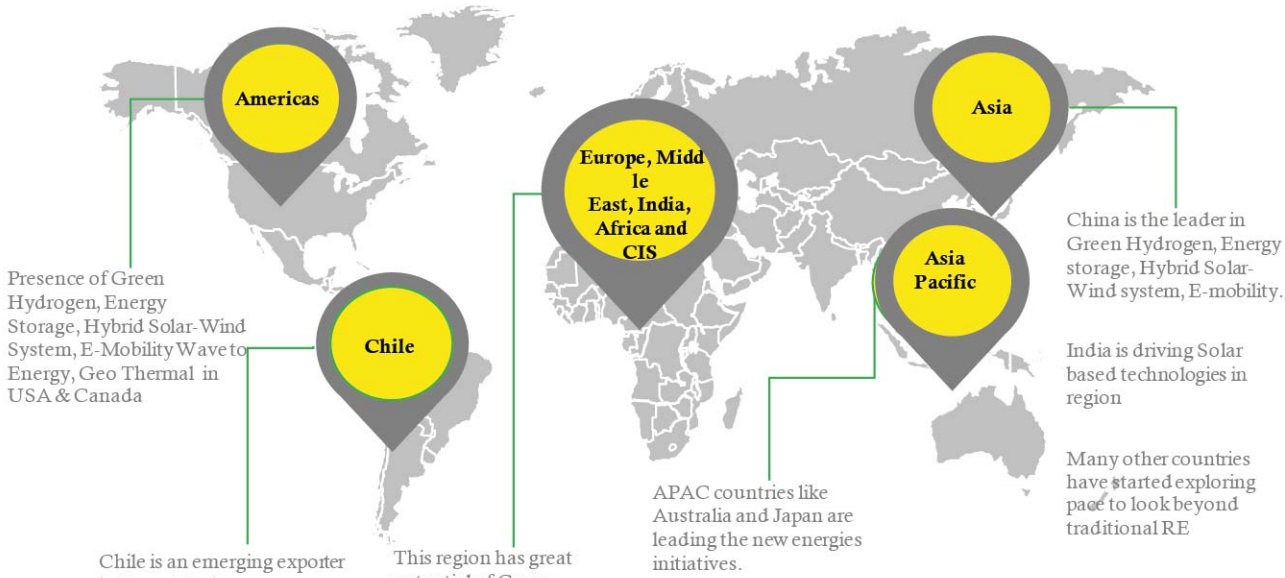
Country	Policy/ Scheme/ Agency for Hybrid Solar-Wind system
Australia	**Australian Renewable Energy Agency** have been funding different Hybrid projects. **Agnew Renewable Energy Microgrid** is a relevant example which started in 2019 with project cost of USD 111.6 million.
Canada	Canadian Renewable Energy Association (CREA) envisions to transform Canada's energy mix
India	**The Ministry of New and Renewable Energy (MNRE)** adopted the National Wind-Solar Hybrid Policy in 2018. The objective of the policy is to provide a framework for the promotion of large grid-connected wind-solar PV hybrid system for efficient utilization of transmission infrastructure and land.

Country	Policy/ Scheme/Agency for E-Mobility
Australia	The Australian government has passed Electric Car discount bill where Plug-in hybrid electric vehicles (PHEVs) would be eligible to get incentives till 2025.
Canada	**The Zero Emission Vehicle Infrastructure Program (ZEVIP)** is an initiative ending in 2027 and its objective is to address the lack of charging and refuelling stations in Canada.
China	China's dual-credit policy on EVs mandates manufacturers to produce a minimum number of EVs for claiming the credit which will also depend upon factors driving range and EV weight.
France	To promote EV, environmental bonus has been extended by the French government in the form of subsidies on electric car purchase.
Germany	**Electric Mobility Act (in German), 2015,** grants preferential treatment to electric vehicles – i.e. purely battery-driven vehicles, plug-in hybrids and fuel cell vehicles – particularly in terms of parking and the use of bus lanes.
India	**The Faster Adoption and Manufacturing of Electric Vehicles (FAME)** scheme was launched in two phases to facilitate the electrification of the public transport system including financial support.
Japan	The Ministry of Economic, Trade and Industry has envisioned to become a global leader in electric vehicles by 2050.
United States of America	Infrastructure Investment and Jobs Act provide for USD 7.5 billion funding for EV charging stations and other EV-related initiatives. This funding will benefit rural communities across the country by providing a ready source of capital for EV infrastructure projects.

Country	Policy/ Scheme/Agency for Wave to Energy
Australia	Australian Marine Energy Atlas was developed in association with **Australian Renewable Energy Agency (AREA),** to broaden their knowledge of wave energy. Wave energy could contribute up to 11 % of Australia's energy (enough to power a city the size of Melbourne) by 2050, making it a strong contender in Australia's renewable energy mix.
Canada	Around **190 tidal power sites** have been identified off-Canada's coasts with a total estimated capacity of 42,000 MW (total mean annual wave power) – more than 63 % of the country's annual total consumption.
China	13th Ocean Energy Development Five Year Plan (2016-2020) planned to install oceanic capacity of 50 MW which will become an integrated part of renewable power generation systems
France	**Environment and Energy Agency (ADEME)** is responsible for developing tidal energy converters, wave energy converters
India	Preliminary studies in association with IIT Chennai has been conducted
Japan	Under the 5th Strategic Energy Plan for Japan, **The New Energy and Industrial Technology Development Organization (NEDO)** provides funds to achieve the commercialization of ocean energy power generation technology.
United States of America	The Department of Energy (DOE) has awarded USD 25 million in funding to support eight wave energy projects that will make up the first round of open-water testing at Oregon State University.

Country	Policy/ Scheme/Agency for Geothermal Energy
Australia	Geoscience Australia is the agency which is undertaking significant work to better understand where these hot spots are in order to support the geothermal industry and encourage exploration in Australia.
Canada	The **Canadian Geothermal Energy Association (CanGEA)** promotes Canada's geothermal energy industry.
China	**China Geothermal Industry Development Group Limited** is the sole listed company in Hong Kong focusing on the field of promotion of the geothermal ground source energy as alternative energy for heating (cooling) with a large state-owned enterprise specialized in energy-conservation and environmental protection as its single largest shareholder.
France	**The French Renewable Energy Trade Association (Syndicat des énergies renouvelables, SER)** have a comprehensive dossier on geothermal energy – both deep and shallow geothermal, looking at what would be the required conditions for geothermal as part of a new model for energy in France
India	**Geological Survey of India (GSI)** has estimated a tentative theoretical power potential of 10 GW capacity could be extracted for geothermal energy in the country
United States of America	**America Rock Mechanics Association (ARMA's)** Multi-Year Program Plan is a 5-year plan of activities to support the growth and long-term contribution of geothermal energy to the U.S. electricity grid and American homes and buildings.

Regional presence of new energy



Presence of Green Hydrogen, Energy Storage, Hybrid Solar-Wind System, E-Mobility Wave to Energy, Geo Thermal in USA & Canada

Chile is an emerging exporter in Green Hydrogen

The region has high potential of, Hybrid Solar-Wind System combined with Storage.

Chile has explored the potential of Geothermal & wave to energy

This region has great potential of Green Hydrogen, Energy Storage, Hybrid Solar-wind system, wave to energy and geo thermal.

The EU has been at the forefront of driving many new technologies

APAC countries like Australia and Japan are leading the new energies initiatives.

It is expected that 43 % of APAC energy would come from RE by 2030

China is the leader in Green Hydrogen, Energy storage, Hybrid Solar-Wind system, E-mobility.

India is driving Solar based technologies in region

Many other countries have started exploring pace to look beyond traditional RE

3

Sector-specific opportunities for new energies in India

The below pie chart depicts the key sectors contributing to global CO2 emissions (Fig 8). As evident, the maximum contribution is from coal followed by transport and industry. Looking only at India, the pattern is almost identical as shown in Fig 9.

As is the case for use of traditional renewables, new energy interventions in these sectors would further complement the ongoing clean transition efforts across the individual sectors

Fig 8: CO2 emission (%)- Global

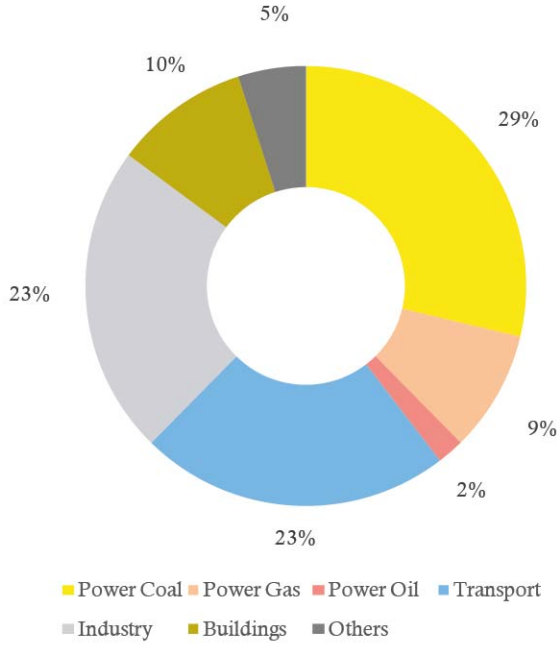
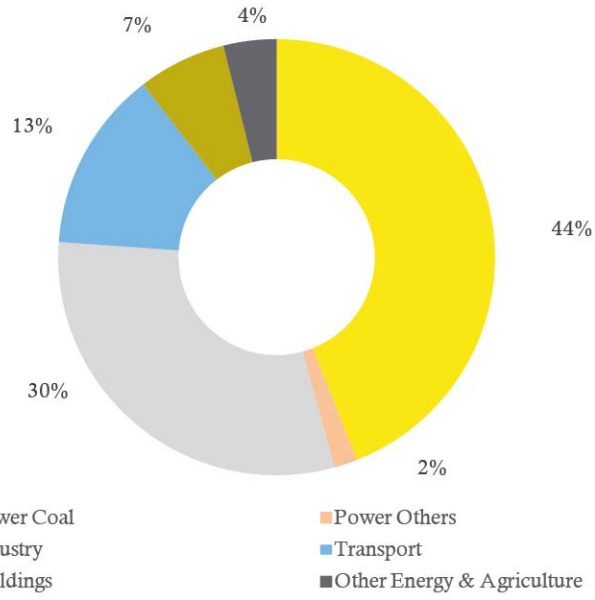


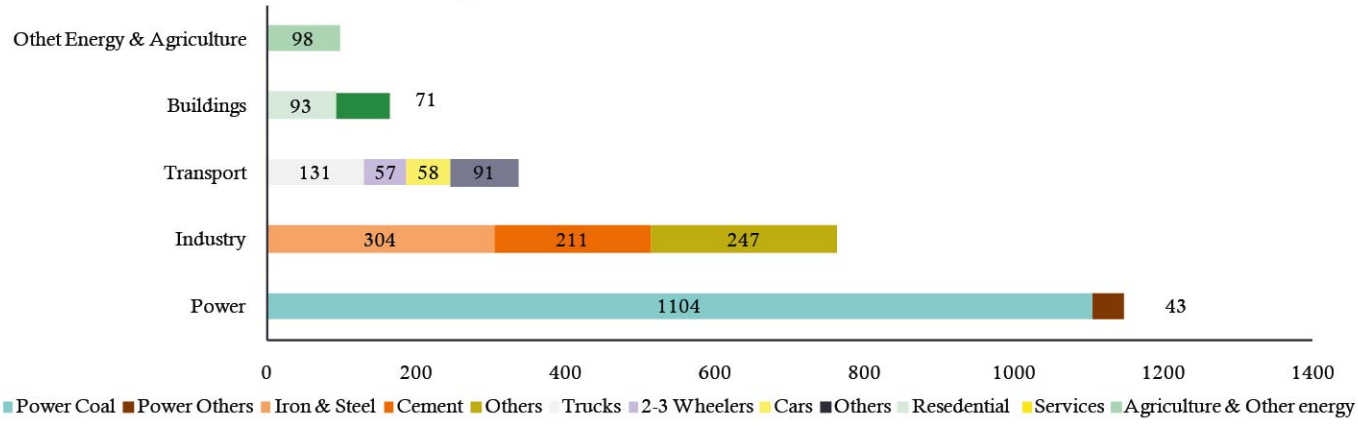
Fig 9: CO2 emissions (%)- India



Source: IEA-2022

Fig 10 further quantifies the CO2 emissions across the individual sectors. A further deep down across these sectors shows that the major contribution in Power comes from coal, in Industry from Iron & Steel, and in Transport from the Heave vehicles/Trucks. In the subsequent section, we further explore sector-specific opportunities in India's clean transition aspirations and hence possibilities for new energies.

Fig 10: Sectoral emission in Mt –CO2

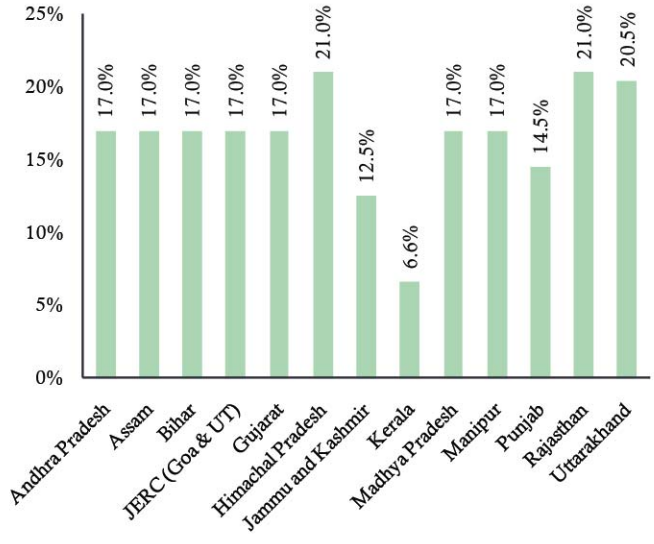


3.1 Power

The Government of India (GoI), with its commitment towards net zero emission by 2070, has been continuously working towards identifying newer possibilities to contribute to the transition. The growing renewable energy capacity is a testimony to the efforts in the last decade.

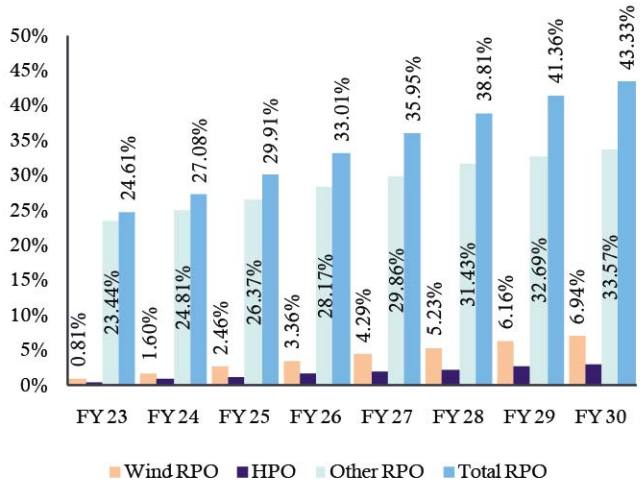
GoI's policy on Renewable Purchase Obligation (RPO) is one such initiative wherein every state power DISCOM, Open Access Consumer, and Captive Consumer has to procure power from solar and non-solar renewable sources as a percentage of the total electricity demand. The RPO obligations differ from state to state as shown in Figure 11

Fig 11: RPO – Indian State (%)



Source: MNRE

Fig 12: RPO Trajectory: Post FY 22 (%)



Source: MoP, Dated 19thSept 2022

The above figure shows the Renewable Purchase Obligation (RPO) for different states in 2022. There have been recent efforts to explore Hybrid power as well as Round The Clock (RTC) power from renewable sources with an aim to further enhance renewable share in the existing power generation mix. To timely achieve the target of 500 GW by 2030, The Ministry of Power (MoP), has pushed itself a notch towards achieving this goal by projecting RPO targets till 2030. With reference to Figure 12, it is projected that RPO would reach ~ 43 %.

New Energy options that be explored include the wave to energy as well as the well-proven Off-Shore wind power systems which are still at a nascent stage. Also, Pumped Hydro capacities need to be enhanced to help enhance Hybrid and RTC capacities in the country.

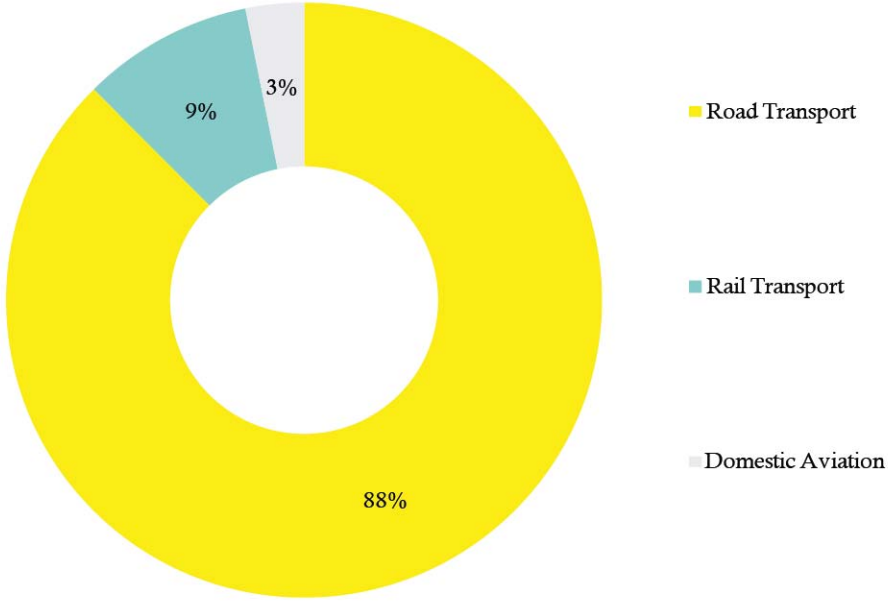
Considering the energy storage obligation, the MoP, dated 19th Sept 2022, has projected energy storage to reach 4% by 2030. Though electricity storage is still costly, efforts to commercially mainstream the same have already been initiated in the country. In the near future, renewable energy with battery storage is expected to reach grid parity.

3.2 Transport

According to India Energy Security Scenario, by 2047 transport energy demand would be around 4,414 TWh/Year after Industry. Given that the transport sector is one of the highest emission contributors to the atmosphere, it is imperative to explore possibilities to decarbonize the sector at the earliest.

As is evident from the below figure, the maximum energy consumption, in the transport sector, is from road transport which is almost 88 %. As such, electrification of the road transport is a key objective of the Government.

Fig 13: Energy Consumption: Modes of transport (%)



Source: India Energy Security Scenario

Renewable energy-powered charging infrastructure is one of the most commonly used options across the globe. India has also come out with dedicated policies and programs to facilitate both manufacturing of electric vehicles as well as the development of the charging infrastructure ecosystem.

Green Hydrogen-powered vehicles can be another option for facilitating decarbonization in the transport sector. However, hydrogen fuel cells are still a long way to reach wider commercial acceptance.

EV charging stations which are powered by rooftop solar can help in decentralizing the energy production for vehicle charging and also support better grid stability. Larger plant capacities to address charging demand would have higher fluctuations in actual generation based on the charging demand patterns.

Fig 14: EV Sales: State wise- April 2022 (%)

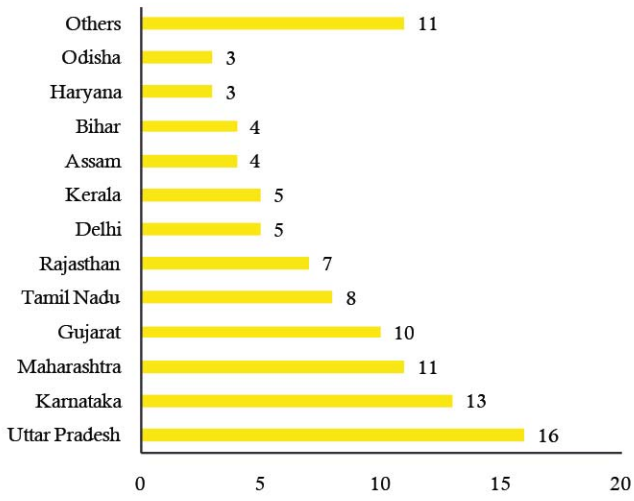
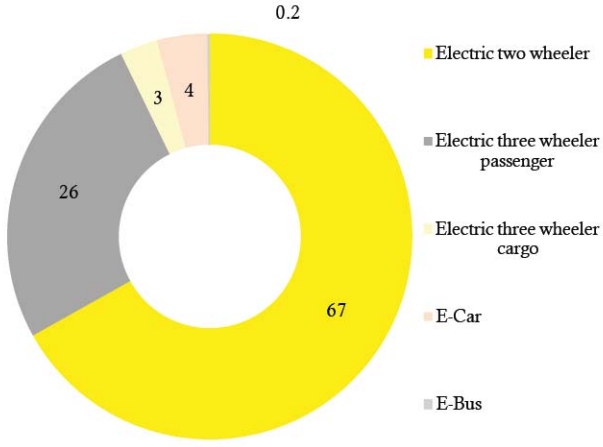


Fig 15: E-Vehicle category Sale (%)



Source: Vahan Dashboard

In India, it can be observed from Figure 14 that UP tops the chart with the highest number of E-Vehicles followed by Karnataka, Maharashtra, and others. Also, it is observed from Figure 15 that 67 % of E-vehicles are two-wheelers followed by 26 % of electric three-wheeler passenger vehicles.

From a business perspective, global electric vehicle share has increased to 8.3 % from 4.2 % in 2020 which is around 6.75 million e-vehicles. In the Indian context, the Indian automobile industry is the fifth largest in the world, and is estimated that it will be the third largest by 2030. As such, the impact of electrifying the transport sector can be manyfold.

Given this background, NITI Ayog has aimed to achieve EV penetration close to 70 % in commercial cars, 80 % in private cars, 40 % for buses, and around 80 % for two and three-wheelers respectively by 2030.

3.3 Industry

Energy-intensive industries like Iron & Steel, Aluminium, Cement, Fertilizers, Refining, Pulp, and paper contribute significantly to emissions. The biggest challenge is the decarbonization of energy-intensive industries as these require large-scale heating and cooling applications.

One major option is to enhance the energy efficiency of key Industrial equipment that consumes the most energy. This can be done by retrofitting the existing equipment or by even replacing inefficient equipment with energy-efficient equipment.

However, a major contribution to emission reduction can be through the use of a proper mix of conventional and renewable sources including some of the new-age options. The use of Green Hydrogen is one of the best clean transition options in most Industries. The Government has already notified the Green Hydrogen Mission and even announced Production Linked Incentive in this segment to promote domestic manufacturing.

In energy-intensive industries, like cement, and iron & steel industry green hydrogen can be used in the following ways:

Industry	Technology	Details	Impact
Cement Sector	Blast furnace > Electrolytic hydrogen partially replacing injected coal	Hydrogen can replace a portion of injected coal, thus reducing the need for coal.	Reduction in CO_2 emission
Iron & steel	The Hydrogen Breakthrough Ironmaking Technology (HYBRIT)	This process aims to replace the coke and other fossil fuels used in traditional, blast furnace–based steelmaking and instead relies on hydrogen created with renewable electricity..	The process reduces CO_2 emissions in all stages of steelmaking, including pelletizing iron ore, reducing iron oxides to iron, and producing crude steel

While the use of Green Hydrogen is the best-fit option for a cleaner industry, Blue Hydrogen can be used as an intermediate transition stage. Unlike Grey Hydrogen, where CO2 is directly released into the atmosphere, blue hydrogen is produced from natural gas by separating hydrogen and carbon dioxide (CO2) where CO2 is captured and stored underground, hence its impact on the atmosphere is limited which leads to a reduction in GHG emission.

4

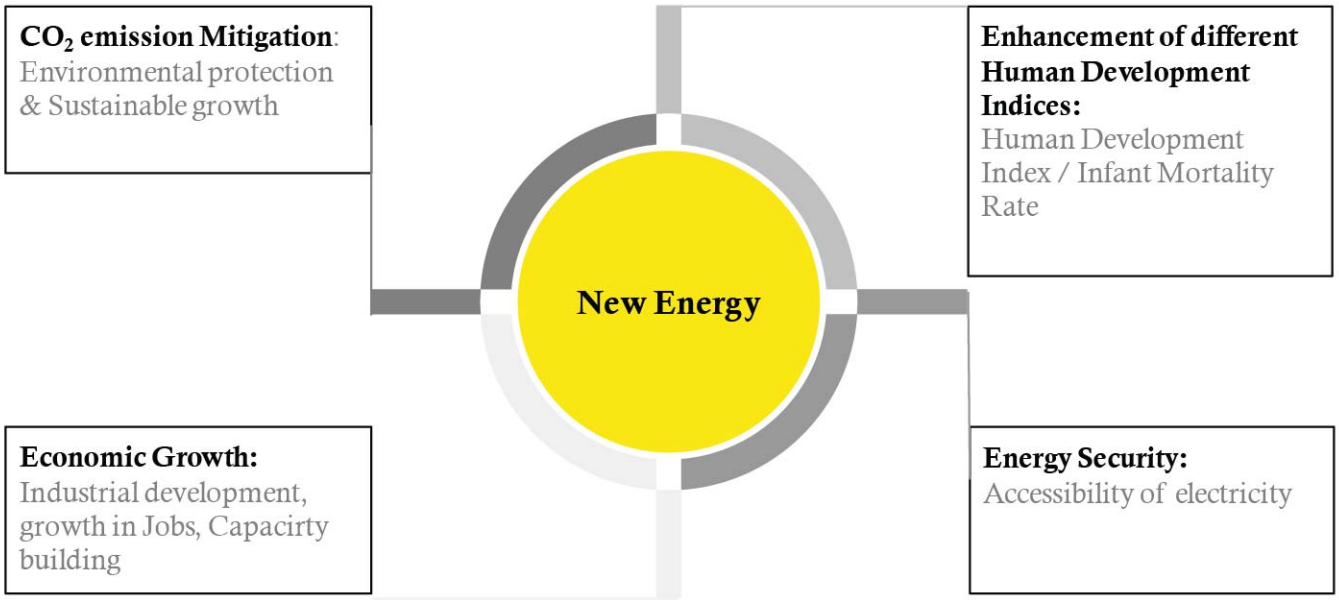
Potential Investment opportunities & key benefits

Potential Investment:

New Energy Technology	Demand	Investment prospects
Green Hydrogen	▪ According to IEA, *The Future of Hydrogen Report 2019*, hydrogen production will grow to 500-680 million MT by 2050. ▪ *Bloomberg New Energy Finance* (BNEF) has estimated that green hydrogen could be produced at USD 0.70-USD 1.60/ kg in most of the world by 2050 because of falling rate of RE, technology improvement.	At global level: Projected investment is USD 7.3 billion by 2027.[10] At India level: USD 2.3 billion under National Hydrogen Strategy
Energy Storage	▪ According to BNEF, global energy storage installation is projected to reach 411 gigawatts (or 1,194 gigawatt-hours) by the end of 2030.	At global level: Projected investment is ~ USD 136 billion by 2032.[11] At India level: ~ USD 6 billion has been projected.[12]
Hybrid Solar-Wind System	▪ According to JMK Research analysis, India's total Hybrid Solar-Wind capacity would reach 11.7 GW	At global level: Projected investment is ~USD 2.03 billion.[13]
E-Mobility	▪ According to IEA, the total global sales has crossed the mark of 6.6 million EV vehicles in 2022, doubling the growth rate as compared to 2021. ▪ Globally, IEA has reported 1.8 million charging points in 2021, of which a third were fast chargers.	At global level: Projected investment is ~ USD 515 billion by 2030.[15] At India level: ~USD 206 billion has been projected till 2030.[16]
Wave to Energy	▪ According to European Commission: Research & Innovation, the potential global market is between 150-800 TWh (terawatt hours) per year ▪ According to MNRE, India's estimated theoretical power potentials for Tidal and Wave energy are 12,455 MW and 41,300 MW respectively.	At global level: Projected market size is ~ USD 141.1 million by 2027.[17] At India level: An investment potential of ~USD 367.8 million is available.[18]
Geo-Thermal	▪ According to IEA, globally it is projected that 1,400 TWh of electricity per year could come from geothermal by 2050 from its present generation of 67 TWh in 2022.	At global level: Projected market size is ~ USD 95.82 billion by 2030.[19] At India level: At nascent stage

Key Benefits :

The below graphics represent different benefits that can be catered to through new energy integration.



The potential benefits from scaling up the various new energy initiatives are extremely similar to those from enhancing renewable penetration. These new energies would primarily facilitate and fast-track the achievement of various climate mitigation targets.

In addition, another key contribution from the new energy scale-up would be the creation of newer jobs, especially in developing countries thereby enhancing the overall socio-economic status of the country. However, as is the case with the advent of renewables, just transition is critical to ensure that the jobs from the conventional energy sectors are not lost. Hence, timely capacity building and upgrading of the skill sets of the existing workforce would remain critical for the successful adoption of most new energy technologies.

Energy Security is another critical area where new energy technologies can fill the gap, especially in some of the poorer countries. Rooftop solar combined with battery storage is a classic example of enhancing the supply hours in households/areas where grid connectivity is yet to reach or is limited. However, this can only be possible once such technologies become cheaper through wider acceptance.

5

Way Forward

Every country is on a different timeline when it comes to the clean energy transition journey. As has been discussed in this paper, the new energies can surely help fast-track these individual journeys. However, integrating these new energies with the ongoing efforts would require some focused actions as shown in the subsequent graphic:

Research and development remain the least focused aspect when it comes to exploring newer technologies for the clean energy transition. Even for the existing new energies, most countries lack basic R&D intent to make them more cheaper through constant technological innovation. However, without proper R&D the scaling up of these new energy initiatives would be slow and challenging.

As already mentioned, the existing workforce needs to be prepared for the ongoing and upcoming disruptions in the sector, especially through new energy interventions which are still to gather pace. However, planning needs to start now for focused skills in some of the initiatives which are in the advanced stage of deployment.

Financing new energy projects is a key challenge especially due to the associated risk of failure or the higher project costs as compared to conventional renewable projects. However, countries need to create dedicated funds and financing products that can help set up pilots and demonstration projects to build investor confidence.

Incentivizing domestic manufacturing of new energy equipment and components is a significant initiative to address initially high project costs. It also helps set up manufacturing capacities that can be used for future exports.

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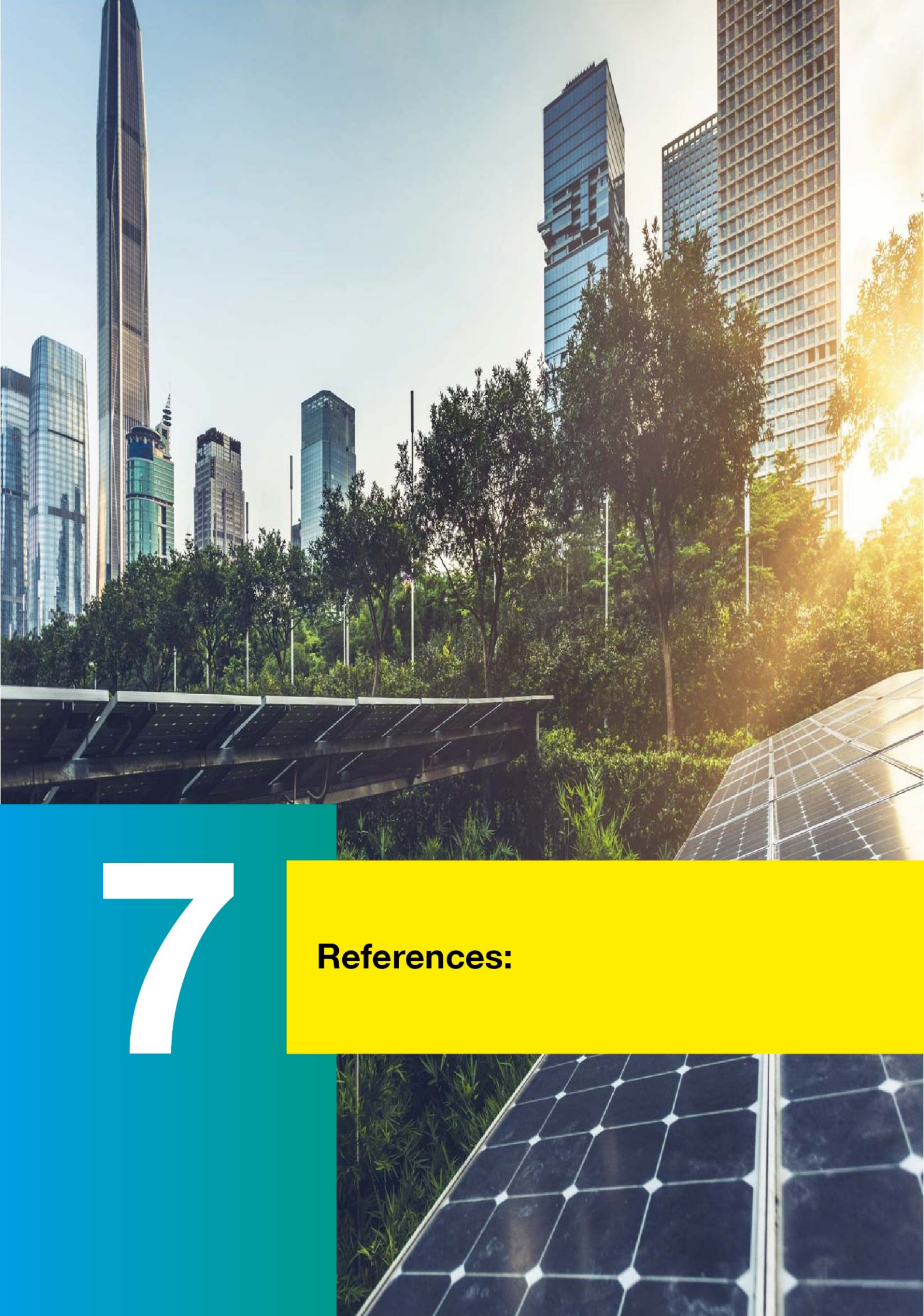

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