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Renewable energy Investment Trends towards Low Carbon Transformation and Climate Resilient Growth: A Comparative Study between India and China.

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Abstract

Energy is the major source for the economic development of any country; India's energy consumption has been increasing at a relatively fast rate due to population growth and economic development. India's energy sector is experiencing a transition with increasing penetration of renewable energy in the mix. One of the major impediments in the process of such a transition is to secure the necessary finance to achieve the transformative goal of producing 175 gigawatts of Renewables by 2022. The problem gets compounded with limited budgetary resources available, combined with difficulties associated with mobilizing private capital for the sector. Scaling up investment in renewable energy is indispensable for achieving decarbonization of the global economy, low carbon transformation, and climate-resilient growth. Taking the world to a low carbon path with reduced greenhouse gas concentration is a costly affair. It requires large scale investments. The World Economic Forum projects that by 2020; about $5.7 trillion will need to be invested annually in green infrastructure, much of which will be in today's developing world. China is the world's leading country in electricity production from renewable energy sources. In 2013 the country had a total capacity of 378 GW of renewable power, mainly from hydroelectric and wind power. China's renewable energy sector is growing faster than its fossil fuels and nuclear power capacity. This study concentrates more on total green investment and also makes a comparison in investments for Renewable energy sector between India and China from 2004-2018. This research also shows investment trends through FDI Inflows for Renewable energy in India from 2005-2018. This study could benefit policy makers and researchers by enhancing their understanding of the factors enabling the scaling up of renewable energy investment.

Keywords: Climate Change; GHGs; Fiscal policy; Feed-in tariff; Green investment; Clean energy; FDI inflows; Carbon tax; UNFCCC

Introduction

The world is facing Climate change problem by using too much conventional sources of energy in industries, transport and in housing. Few Countries in the world are as vulnerable to the effects of climate change as India and China with its vast populations, consume lots of energy and produce huge emissions of greenhouse gases which contribute to climate change. When the emissions of GHG's are rising, the earth's climate is affected, the average weather changes and the average temperature

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increases. Emissions can be reduced by improving energy efficiency, by changing demand, as well as through the introduction of clean energy. The energy sector worldwide should be at least 60% decarbonated by 2050 for atmospheric concentrations to stabilize at or below 550 ppm CO2e, and deep emissions cuts will also be required in the transport sector **Nicholas stern(2006).** There is a need for implementing adequate policies and targeted incentive mechanisms for creating conditions that facilitate low carbon energy transformation and thereby enhancing sustainable economic growth. Low-carbon energy technologies include renewable energy systems such as Wind power, Solar power, biomass, hydropower and including clean coal coupled with carbon capture and storage system and energy efficiency improvements across the sectors **Anbumozhi(2018)**. It is being acknowledged that the fiscal policy plays an important role in transforming the economy in order to become greener and more inclusive. Reflecting the cost of external factors associated with the use of natural resources in the prices of goods and services. Fiscal measures in the form of taxes, fees, subsidies, incentives, and budget allocations can help generate revenues for environmental and social purposes, shift behavior towards low-carbon activities, and stimulate green investment by setting pricing environmental effects. For example, governments around the world have introduced introductory tariffs as a support measure to encourage investment in renewable energy sources from clean sources such as solar, geothermal and wind energy, guaranteeing a tariff for a certain period of time — up to 20 years in some cases. These support measures should be periodically reviewed and gradually reduced as the share of renewable energy increases, and renewable energy becomes competitive with traditional fuels. Governments also use targeted financial programs to support the purchase of energy efficient appliances. For example, in Tunisia, $ 24 million was allocated from state funds. US to promote the use of solar water heaters and in Ethiopia more and more often use clean stoves at the expense of income saved through the abolition of fossil fuel subsidies. A pioneer in the use of environmental taxes, Mauritius has introduced a set of environmental tax measures, including an excise tax on petroleum products and a fee for products that are not efficient in terms of energy. The total contribution of these measures is equivalent to 2.6% of Mauritius's GDP in 2013 **(Carlo et.al, 2014)**. A study conducted in 2011, which examined the effects of carbon tax in China, showed that the effects would vary significantly by region. In the provinces where primary production was the main form of industry, the impact will be more significant, while in the eastern regions, where most of the high-tech industry is concentrated, the impact is likely to be lower. This study underlines the importance of developing measures that take into account regional and sectoral impacts **(Zhang & Li, 2011)**. Energy demand in Southeast Asia has expanded by two-and-a-half-times since 1990, its rate of growth among the fastest in the world. These opened market opportunities of low-carbon technologies for transport and transport-related to green urban development or low-carbon society **(Q.chotichanathawewong 2018)**. The question is how to bring private sector invest in these technologies. These markets consist of:

- Low-carbon electricity generation
    - Electricity storage
    - Smart grids in power system
    - Energy efficiency and management.

- Green transport and logistics
    - Novel hybrid vehicles
    - Electric vehicles and infrastructure
    - Novel battery development and charging systems
    - Hydrogen and fuel cell vehicles
    - Public transport and infrastructure
    - Fuel pricing and tax incentives for transport
    - Bio fuels for transport
    - Pipeline transport and regional connectivity.
- Smart cities and livable city
    - Smart grid for smart cities
    - Green urbanization: green city, green building, green industry and infrastructure
    - ICT application in smart cities
    - Digital utilities.

Objectives of the study

- To Review and evaluate the investment trends in clean energy in India and China from 2004 - 2018 and also make a comparison between the two developing nations.
- To identify the Factors that Promote Sustainable Energy Source and Technologies Related to Transport Sector that leads to low-carbon development and climate resilient growth in India and China.
- To find out the investment trends in clean energy through FDI Inflows in India from 2004- June 2018.

Scope of the Study

India, with its increasing population and limited natural resources for fulfilling its energy requirements, needs to maintain its momentum of growth and this can be made possible only by opting available energy options. Renewable energy is the best option. Shortage of fossils fuel and awareness towards global warming enhance the clean energy production. Therefore use of renewable sources increasing gradually in coming years. Renewable energy technologies require large initial capital investments, making the Levelized cost of generation higher than it is for many conventional sources. The availability of financing options shall play an important role in increasing the share of renewable energy in India. The MNRE provides financial incentives for various renewable energy programmes. These include interest and capital subsidies. In addition, soft loans are provided through IREDA and also through some of the nationalized banks and other financial institutions for identified technology. The study will be restricted to the Investments of India and China towards low carbon development and Climate resilient growth. The Reference period for the study will be 2004- 2018 for the purpose of specific comparisons between these two emerging nations and why we are taking this reference period because the maximum climate financing institutions in the world was setup during this period and many schemes / financial instruments was also launched in this period.

Literature Review

Shailly kedia (2016) in his paper *"Approaches to low carbon development in china and India"* explained that Low carbon development has gained policy prominence and is a concern of both environment and development policy globally and in China and India. This paper discusses the role of China and India as important global actors in light of development imperatives in the two countries. The article then looks at emerging approaches in the two countries related to financing, science, technology & innovation policy, and sub-national actions. The objective is to review efforts in China and India for contributing to learning experiences for other countries. The final section discussed the ways forward in terms of examining the role of China and India in terms of national policy strengthening as well as in global agenda setting. Implementation of sub-national initiatives in both countries faces challenges due to lack of adequate financing as well as knowledge such as greenhouse gas inventories and disaggregated resource and socio-economic assessments. Both India and China are making efforts in technology and innovation domains to set foot on a trajectory of low carbon development with varying degrees of success. In finance, both China and India have experimented with various instruments—the key difference is that China has taken the support of regulation more while India has leaned on to market based instruments. Both China and India are moving on an encouraging track regarding low carbon development with fairly well-designed domestic policies and consistent international engagement.

Rajendra (2017) in his paper *"The sino-india monitor on INDCs adequacy and necessity"* suggested that Climate change impacts are creating serious consequences for both countries, which need no elaboration at this stage. However, projections for the future would certainly indicate that China and India need not only to embark on a programme of adequate and widespread adaptation measures, but given the fact that both Countries would in the future account for a sizeable share of global emissions of greenhouse gases (GHGs), they also need a mutually coordinated approach for mitigation measures, including possibly the use of carbon capture and storage (CCS). It must also be remembered that mitigation of GHGs would carry substantial co-benefits for both societies, since along with reduction of GHG emissions local air quality would also improve proportionately. It is well known that the cities and other areas in both China and India have serious problems of air pollution, which has significantly harmful effects on human health, leading to higher morbidity and mortality. In order to ensure that China and India coordinate the exchange of information and knowledge in a manner that serves the interest of both the countries equally, it is proposed that a group of researchers and research institutions in both countries develop and launch an initiative to regularly monitor and analyze the progress of climate related actions in both nations.

GAO Yun (2016) in his Paper *"China's response to climate change issues after Paris climate change conference"* concluded that The Paris Climate Change Conference was successfully concluded with the Paris Agreement, which is a milestone for the world in collectively combating climate change. By participating in IPCC assessments and conducting national climate change assessments, China has been increasing its understanding of the issue. For the first time, China's top leader attended the Conference of the Parties, which indicates the acknowledgement of the rationality and necessity of climate change response by China at different levels. Moreover, this participation reflects China's commitment to including climate change in its ecology improvement program and pursuing a low-carbon society and economy. In order to ensure the success of the Paris Conference, China has contributed significantly.

China's constructive participation in global governance shows that China is a responsible power. These principles such as the creation of a future of win - win cooperation with each country contributing to the best of its ability; a future of the rule of law, fairness, and justice; and a future of inclusiveness, mutual learning, and common development will serve as China's guidelines in its efforts to facilitate the implementation of the Paris Agreement and participate in the design of international systems.

HE Jian-Kun (2016) in his Paper "*Global low carbon transition and china's response strategies"* concluded that The Paris Agreement establishes a new mechanism for post-2020 global climate governance, and sets long-term goals for global response to climate change, which will accelerate worldwide low-carbon transformation of economic development pattern, promote the revolutionary reform of energy system, boost a fundamental change in the mode of social production and consumption, and further the civilization of human society from industrial civilization to eco-civilization. The urgency of global low-carbon transition will reshape the competition situation of world's economy, trade and technology. Taking the construction of eco-civilization as a guide, China explores green and low-carbon development paths, establishes ambitious intended nationally determined contribution (INDC) targets and action plans, advances energy production and consumption revolution, and speeds up the transformation of economic development pattern. These strategies and actions not only confirm to the trend of the world low-carbon transition, but also meet the intrinsic requirements for easing the domestic resources and environment constraints and realizing sustainable development. They are multi-win-win strategies for promotion of economic development and environmental protection and mitigation of carbon emissions. China should take the global long-term emission reduction targets as a guide, and formulate medium and long-term low-carbon development strategy, build the core competitiveness of low-carbon advanced technology and development pattern, and take an in-depth part in global governance so as to reflect the responsibility of China as a great power in constructing a community of common destiny for all mankind and addressing global ecological crisis.

HU An-Gang (2017) in his paper *"The five year plan: A new tool for energy saving and emissions reduction in china"* Came up with the findings that China has achieved economic growth while great carbon emissions reduction in recent years. Amid China's effort to reduce emissions, the Five-Year Plans have guided and motivated local and foreign forces from the government, industries, and society to work together. This paper showed that a medium high economic growth gate, industry structure adjustment, and energy structure adjustment, which are guaranteed under the Five-Year Plan, all contribute to energy saving in China. The economy entered a stable growing phase during the 12th Five-Year Plan, while the economic growth rate declined to 7.8% from 11.2% in the 11th Five-Year Plan. Simultaneously, the CO2 emissions growth rate declined from 8.32% (2009e2012 mean) to 1.82% (2012e2014 mean). Industrial structure adjustment canceled out nearly one-third of the CO2 emissions caused by economic growth. Under the 13th Five-Year Plan, China will continue its energy saving efforts on the green development path, with greener quotas, a stricter implementation process, and more key projects.

Jingli Fan et al (2018) in his paper *"The Development of China's Renewable Energy Policy and Implications to Africa"* explained that in 2005 "Renewable Energy Law of the People's Republic of China" was adopted, in which the article 4 clearly stipulated: "The state will arrange the development and utilization of renewable energy as the priority area of energy development, and promote the

establishment and development of renewable energy markets by formulating various total amount target of the renewable energy and the corresponding measures. The State encourages various ownership entities to participate in the market of renewable energy, and will protect the legitimate rights and interests of renewable energy users."

David Fridley (2010) in his paper "*Nine Challenges of Alternative Energy"* came up with the suggestion that the Alternative energy forms are crucial for a global transition away from fossil fuels, despite the myriad challenges of their development, scaling, and integration. In face of the peaking of global oil production—to be followed by peaks in natural gas and coal extraction— and of the need to reverse trajectory in carbon emissions, alternative energy sources will need to form the backbone of a future energy system.

Sarangi (2018) in his paper *"Green energy finance in India: challenges and solutions"* explained the genesis of renewable energy development in India could be traced back to the global oil crisis in late eighties. The Government of India has been, since then, striving consistently to develop renewable energy sector with a set of strategic policy and regulatory measures. Given the constitutional status of energy as a concurrent item—entry 38 in the concurrent list—strategic policy initiatives are framed from time to time both by the federal government as well as provincial governments to expand the renewable energy sector. (**Eyraud et.al, 2013)** test the implications of four policy support variables for green investment. The study finds a positive and significant effect of feed-in tariffs on green investment, which supports the view that feed-in tariffs promote the expansion of renewable. (**Steven et.al, 2014)** to address the environmental impacts due to the operation and development of coal mines in India, in 2010 the Government of India introduced a nationwide cess on coal in 2010 of INR 50 (US$ 1 approx.) per metric ton of coal both produced and imported into India. The cess has now been revised to INR 100. The proceeds of the cess go to the National Clean Energy Fund for funding research and innovative projects in clean energy technology. While these measures can generate revenues, induce clean technology innovation and increase demand for clean energy, they can also hike up the prices of fuels, electricity and energy appliances thereby compromising the competitiveness of businesses and the purchasing power of households. Mitigation measures are therefore needed to protect vulnerable groups. In addition, there is still a lot to be done to remove subsidies for fossil fuel production and consumption, which are estimated to account for 3% of GDP on average in developing countries. These subsidies encourage excessive consumption of energy, tend to benefit high-income households and create a significant fiscal burden in many countries. The transport sector relies heavily on petrol and diesel to fuel vehicles, resulting in serious externalities such as air pollution from exhaust fumes, traffic congestion and accidents. **According to the Intergovernmental Panel on Climate Change,** the transport sector accounted for 14% of total anthropogenic greenhouse gas emissions in 2010, compared to 25% from electricity and heat production and 24% from agriculture, forestry and other land uses. Addressing GHG emissions in the transport sector is therefore indispensable for mitigating climate change. There are also important health implications from the current fossil fuel-intensive transport system. For instance, the **World Health Organization** recently reported that outdoor air pollution in both cities and rural areas was estimated to have caused 3.7 million premature deaths worldwide in 2012.Fiscal reforms in the form of phasing out support to diesel and petroleum products can help reduce

air pollution from the transport sector while reducing health burdens from respiratory diseases and preventing premature mortality. Moreover, fiscal incentives can induce investment in low-carbon transport infrastructure such as light rail and encourage the uptake of electric vehicles. Taxes on motor vehicles fuels, public investment in public transport and non-motorized transport, and tax breaks for efficient vehicles can also have a positive effect. **According to UNEP's Green Economy Report (2011)** Investing US$ 419 billion per year (constant 2010 US dollars) between 2010 and 2050 in promoting modal share to bus and rail transport and increasing the efficiency of motor vehicles would reduce the travel volume of road vehicles by 35% compared to Business as Usual and would decrease the share of passengers travelling by car from 62% to 33%. **In Copenhagen**, a world leader in cycling mobility, 20% of all trips are undertaken through cycling, thanks in part to investments in cycling infrastructure.

Richard Bridle and Lucy Kitson (2014) in their paper "*Public Finance for Renewable Energy in China: Building on international experience"* concluded with a finding that with a rapidly growing economy and a corresponding increase in demand for energy, China has turned to subsidies to drive an increase in deployment of renewable energy and establish China as a leader in the manufacture and export of renewable energy technology. Subsidies to renewable generation play a major role in the sector. Bloomberg reported that subsides for wind, solar and biomass totaled US$1.4 billion in 2012 **(Bloomberg News, 2012).**

Data Analysis and Discussions

The aim of this study is to understand the linkages between green investment and the production of Clean energy and the emission reduction in India and China .Based on the availability of data this study selected two countries for analysis purposes. In this chapter an attempt has been made to develop the operationally feasible research methodology that can help in achieving the objectives of the study effectively and efficiently. On the onset various sources of data have been identified and their characteristics noted.

Table 1: Power generation mix of India
Installed capacity by source in India as on 31 October 2019

Sources	**Capacity(in MW)**	**%share(Capacity wise)**
Coal	203,954.5	56.1%
Large Hydro	45,399.22	12.5%
Small Hydro	4,610.81	1.3%
Wind Power	36,930.32	10.2%
Solar Power	31,101.71	8.6%
Biomass	9,271.3	2.6%
Nuclear	6,780	1.9%
Gas	24,937.22	6.9%
Diesel	509.71	0.1%

Source: Central Electricity Authority (CEA), New Delhi

Power demand in India is set to increase robustly through to 2030, rising by 140% by 2040, propelled by GDP growing five- fold, population growth that makes India the world's most populous country by the mid-2020s and a rapid alleviation of energy poverty (IEA 2016b). While the country experiences this exponential growth, it also aims to reduce the emissions intensity of its GDP by 33-35% below the 2005 levels by 2030-all which calls for aggressive investment in the energy sector and energy efficiency. The Indian power sector is one of the most diversified in the world. The sector has been continuously progressing in generation capacity addition through conventional like Coal, lignite, gas, hydro and nuclear power as well as non-conventional sources like Wind, solar, hydro and biomass.

Table 2: Technology wise breakup of Energy in India

Region	Technology wise break up				
	Thermal	**Nuclear**	**Hydro(Renewable)**	**RES(MNRE)**	**Grand Total**
Northern region	**44825.25**	**1620**	**16598.11**	**5935.77**	**68979.13**
Southern region	**33284.60**	**1320**	**11398.03**	**13784.67**	**59787.30**
Western region	**69792.40**	**1840**	**7447.50**	**11271.07**	**90350.97**
Eastern region	**26735.08**	**0**	**4113.12**	**432.86**	**31281.06**
North-eastern region	**1774.54**	**0**	**1242**	**256.67**	**3273.21**
Island	**70.02**	**0**	**0**	**11.10**	**81.12**
All India	**177741.89**	**4780**	**40798.76**	**31692.14**	**253389.48**

Source: Central Electricity Authority (CEA), New Delhi

Renewable energy is derived from natural processes that are replenished constantly. India is blessed with a variety of renewable energy sources, the main ones being biomass, biogas, and sun, and wind, geothermal, tidal and small hydro power. (Large hydro power is also renewable energy in nature, but has been utilized all over the world for many decades, and is generally not included in term new and renewable source of energy). India's electricity sector is amongst the world's most active players in renewable energy utilization, especially wind energy. As of 31 March 2014, India had an installed capacity of about 31.69 GW of non-conventional renewable technologies-based electricity.

Table 3: Levelized Cost of Installation of energy sources in India

Energy source	**Levelized cost of electricity production(Rs/KWh)**
Coal/natural gas	**2.2-2.6**
Wind	**2.75-3.5**
Biomass	**3.5-5.0**
Solar PV	**10-12**
Solar CSP	**8-10**

Small hydro	**2.2-3.0**
Large hydro	**2.3-3.2**
Diesel generator sets	**13-15**

Source: Central Electricity Authority (CEA), New Delhi

The initial capital cost of installation is higher in most of the renewable sources except hydro. But the cost of operation and maintenance is comparatively cheaper than thermal or nuclear power plants. Also since the cost of fuel is none for renewable energy sources. With increase in prices of coal, gas and other fossil fuels renewable sources will become comparable or cheaper than conventional power sources and will thus become economically viable. Levelized cost of electricity production (LCOE) of renewable energy technologies varies by technology, country and project, based on the renewable energy resource, capital and operating costs and the efficiency/performance of the technology.

Table 4: Electricity productions (GWh) in China by source, 2008-2016

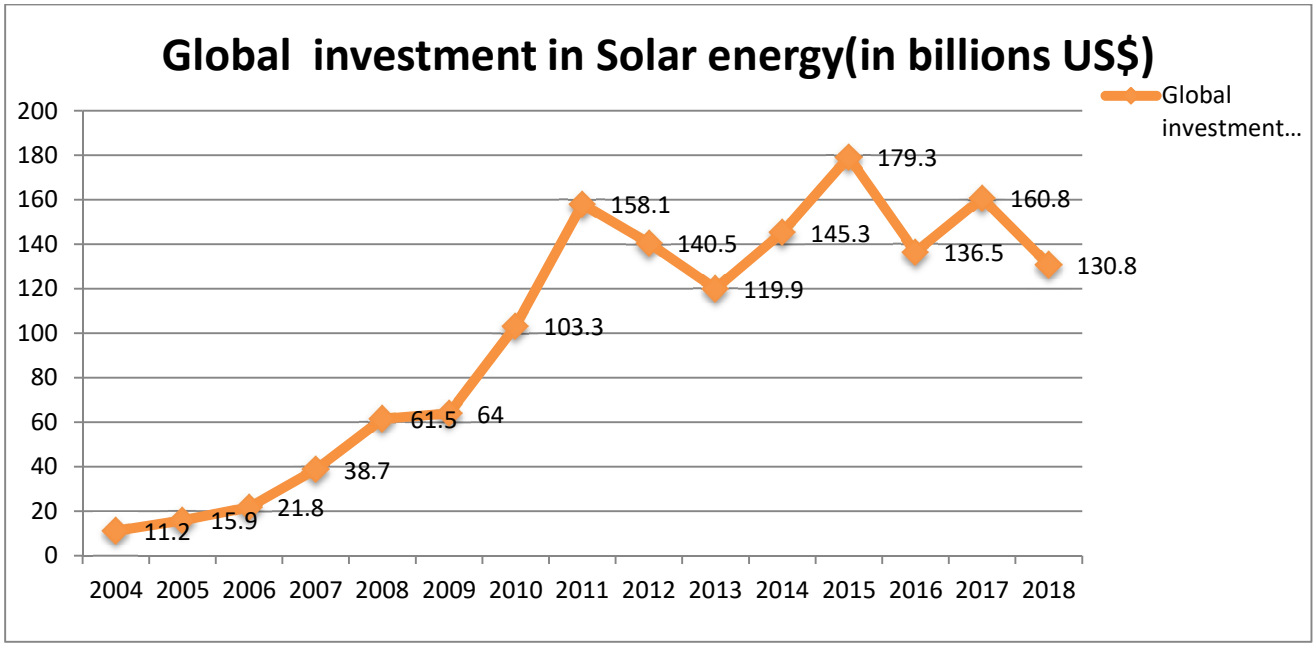
Year	Total generation	Fossil			Nuclear	Total Renewables	% Renewables
		Coal	Oil	Gas			
2008	3,481,985	2,743,767	23,791	31,028	68,394	615,005	17.66%
2009	3,741,961	2,940,751	16,612	50,813	70,134	663,651	17.74%
2010	4,207,993	3,250,409	13,236	69,027	73,880	801,441	19.05%
2011	4,715,761	3,723,315	7,786	84,022	86,350	814,288	17.27%
2012	4,994,038	3,785,022	6,698	85,686	97,394	1,019,238	20.41%
2013	5,447,231	4,110,826	6,504	90,602	111,613	1,127,686	20.70%
2014	5,678,945	4,115,215	9,517	114,505	132,538	1,307,170	23.02%
2015	5,859,958	4,108,994	9,679	145,346	170,789	1,425,180	24.32%
2016	6,217,907	4,241,786	10,367	170,488	213,287	1,581,979	25.44%
2017	6,417,109	4,149,763		202,760	248,125	1,692,100	26.37%

Source: International Energy Agency Report

China has ambitious targets for low-carbon energy systems across its 13th Five year plan, National Plan on Climate Change (NPCC) and Nationally Determined Contributions (NDC) plan. At a high level, China has a target of Increasing Non- Fossil Fuels in Primary energy Consumption to 15% by 2020, up from 12% in 2012. It is also committed to reducing the CO2 and energy intensity of its economy, having pledged that its CO2 emissions would peak by 2030, which would trigger a decrease in the economy's CO2 intensity by as much as 60-65% below 2005 levels (Central committee of the communist party of china 2016). China's future investment is focused in four main areas: Wind, energy efficiency, solar, and hydro. Wind emerges as the dominating technology sector (US$465 billion), representing 35% of all investments during 2017-2030, Energy efficiency as a whole is a close second (US$368 billion), and representing 28% of investments in the same period. Industrial energy efficiency (US$244 billion) and residential energy efficiency (US$105 billion) make up the majority of overall energy efficiency spend, with commercial energy efficiency representing a very small portion (US$19billion). Solar (US$250 billion) and hydro (US$216 billion), represent 19 and 16% of china's total investment, respectively **(K.Treco et al. 2018)**. As of year-end 2014 hydroelectric power remains by far the largest component of renewable electricity production at 1,064 TWh. Wind power provided the next largest share with 156

TWh followed by biofuels at 44 TWh. Solar PV power started from a low base of just 152 GWh in 2008 and has grown rapidly since then to reach over 29 TWh by 2014. The overall share of electricity generated from renewable sources based on the figures in the above table has grown from a little over 17% in 2008 to over 26.37% by 2017. Solar and wind power continue to grow at a rapid pace.

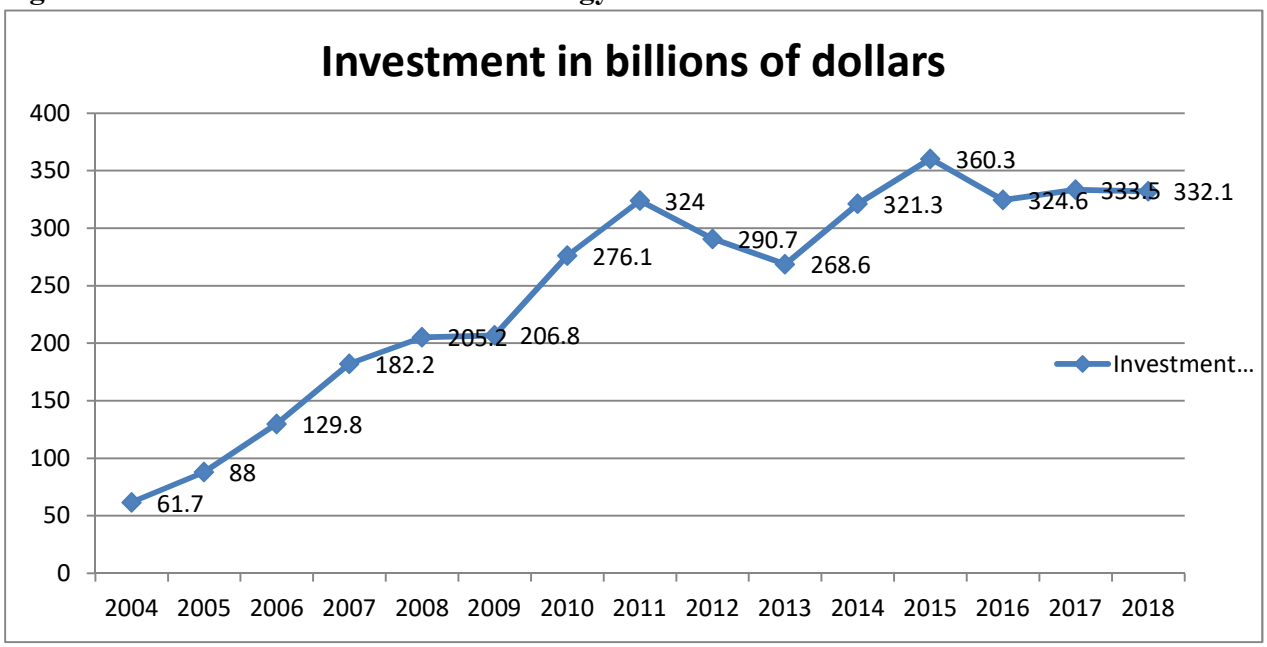
Figure 1: Global investment in solar energy technologies from 2004 to 2018 (in billion U.S. dollars)



Source: Statista.com---Business Data Platform

This figure shows that global investments in solar energy was at peak in 2015 i.e.179.3 billion US Dollars as compared to its lowest /initial limit in 2004 that was 11.2 billion US Dollars invested in solar energy globally during this reference period from 2004- 2018. Initially the investment in solar energy which was invested globally was low from 2004 -2007 than after it increases sufficiently.

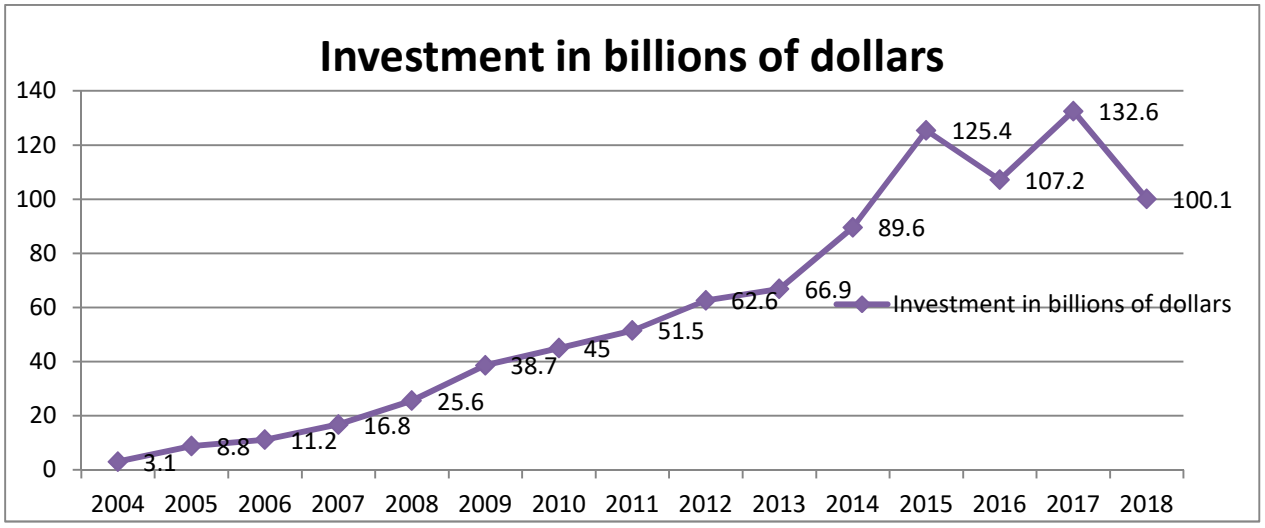
Figure 2: Global investments in clean energy



Source: **BNEF Report**

This figure shows that global investments in clean energy was at peak in 2015 i.e.360.3 billion US Dollars as compared to its lowest /initial limit in 2004 that was 61.7 billion US Dollars invested in clean energy globally during this reference period from 2004- 2018. Initially the investment in clean energy which was invested globally was slowly increases from 2004 -2009 than after it increases sufficiently from 2010 -2018.

Figure 3: New Investments in Clean Energy in China (2004 – 2018)

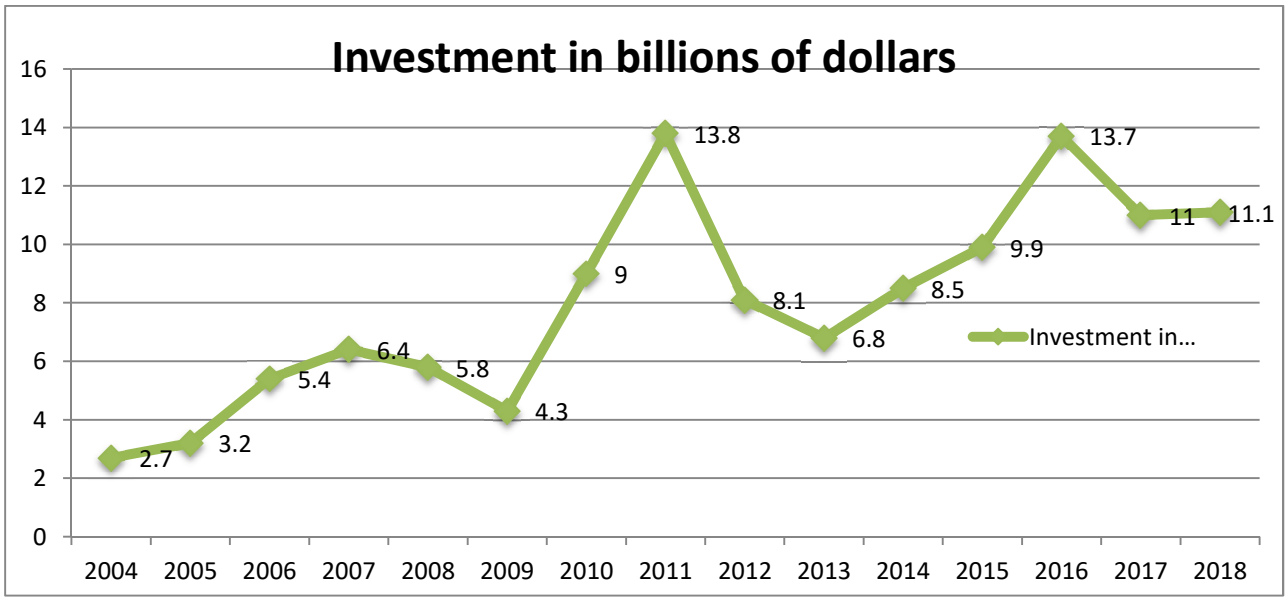


Source: **BNEF Report**

This figure shows that investments in clean energy in China was at peak in 2017 i.e. 132.6 billion US Dollars as compared to its lowest /initial limit in 2004 that was 3.1 billion US Dollars invested in clean

energy during this reference period from 2004- 2018. An investment in clean energy in china was increasing gradually from 2004 -2018.

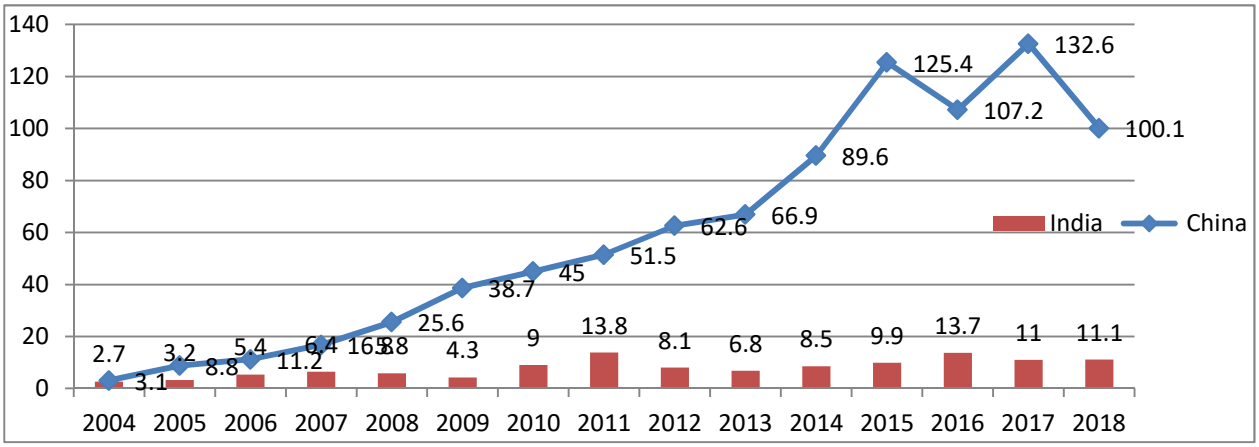
Figure 4: New Investments in Clean Energy in India (2004 – 2018)



Source: **Bloomberg New Energy Finance Report**

This figure shows that investments in clean energy in India was at peak in 2011 i.e. 13.8 billion US Dollars as compared to its lowest /initial limit in 2004 that was 2.7 billion US Dollars invested in clean energy during this reference period from 2004- 2018. An investment in clean energy in India was increasing slowly from 2004 -2018.

Figure 5: New Investments in Clean Energy in India and China from 2004 – 2018(in billions of US$): A comparison between the two nations

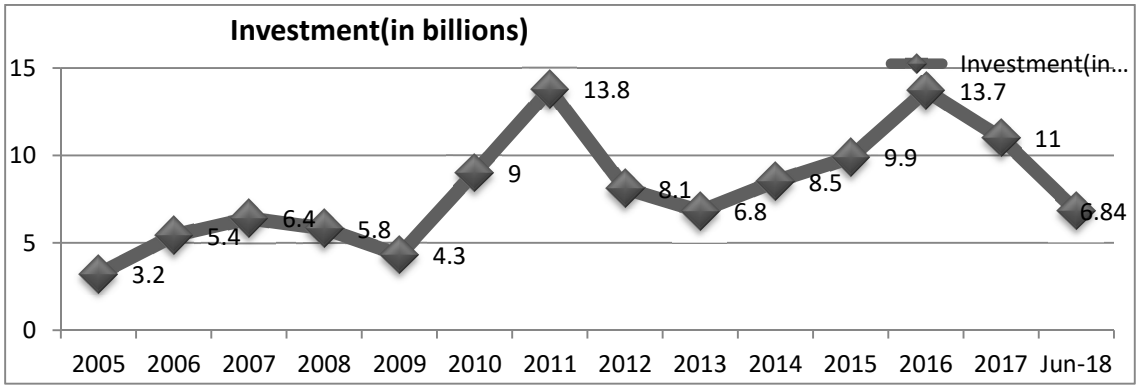


This figure make a comparison between China and India and shows that investments in clean energy in China was at peak in 2017 i.e. 132.6 billion US Dollars as compared to investments in clean energy in India was at peak in 2011 i.e. 13.8 billion US Dollars which was the maximum contribution of India in investing in clean energy in India as compared to china and then make a comparison of lowest /initial

limits of both these countries in 2004 that was 3.1 and 2.7 billion US Dollars invested in clean energy in China and India respectively during this reference period from 2004-2018. An investment in clean energy in china has been increasing at a relatively fast rate due to population growth and economic development from 2004 -2018 as compared to an investment in clean energy in India was increasing slowly from 2004 -2018. India is lagging behind in investments in clean energy as compared to China. China is the world's leading country in electricity production from renewable energy sources.

Increasing investments: FDI inflows in Renewable Energy Sector in India from 2004- June 2018.

Figure 6 New Investments in clean energy in India (in billions)



Source: DIPP, EY, Bloomberg NEF

This figure shows that investments in clean energy in India through FDI was at maximum in 2011 i.e. 13.8 billion US Dollars as compared to 2005 that was 3.2 billion US Dollars which is the lowest investment in clean energy through FDI during this reference period. An investment in clean energy in India through FDI was increasing slowly from 2005 -2011 than after 2011 it decreases till 2016 and reaches 13.7 billion US Dollars in 2016 invested in India through FDI in clean energy and then it again decreases and reaches 6.84 billion US Dollars in June 2018. 100 per cent FDI is allowed under automatic route for projects of renewable power generation and distribution subject to provisions of The Electricity Act, 2003. New investments in clean energy in the country reached US$11 billion in 2017.

Conclusion

With increasing importance of sustainable energy and green environment issues in both the countries, and worldwide, particularly the threat to human and ecological sustainability, the portfolio of sustainable energy technologies-related to transportation is becoming high on the agenda for the sustainable energy transport Which cleaner energy and more energy efficient transport can help to reduce energy use, oil imports and carbon emissions in transport networks, in rapidly growing urban areas, in the movement of goods and people both within and between ASEAN economies, and in air travel across the region. In present movement of innovative energy technology and ICT is so fast, it is good time and good opportunity to use both of them in changing of life style of people to sustainable transport.

We have evaluated clean energy investment trends with a main focus on renewable energy and the combination of power generation from India and China. This research paper seeks to provide

stakeholders a practical guide for understanding the current clean energy investment environment in India and China. This study concentrates more on total green investment and also makes a comparison in investments for renewable energy sector between India and China from 2004-2018. This research also shows investment trend through FDI inflows for renewable energy in India from 2005-2018. This study could benefit policy makers and researchers by enhancing their understanding of the factors enabling the scaling up of renewable energy investment. By overtaking the developed countries, emerging economies like China and India have become important players in the solar energy market. China is the largest consumer of coal and the second largest consumer of oil after the United States; it has also emerged as the leader in the renewable energy segment, doubling its production between 2008 and 2016. China's previous target was to make Renewables account for up to 20% of electricity consumption by 2030, which it has revised to at least 35% in the new plan called the renewable portfolio standard. Revised targets became possible because China could attain the 2020 targets three years earlier. Despite China's thirst for energy to feed its growing industries, China is trying to adopt clean energy, especially solar energy, into its energy mix and has been leading in both solar photovoltaic(PV) installed capacity and solar power generation since 2015.

As per our findings in 2017 China has total Renewables of 1,692,100(GWh) and Figure 5 makes a comparison between China and India and shows that investments in clean energy in China was at peak in 2017 i.e. 132.6 billion US Dollars as compared to investments in clean energy in India was at peak in 2011 i.e. 13.8 billion US Dollars which was the maximum contribution of India in investing in clean energy in India as compared to China and then make a comparison of lowest /initial limits of both these countries in 2004 that was 3.1 and 2.7 billion US Dollars invested in clean energy in China and India respectively during this reference period from 2004-2018. An investment in clean energy in china has been increasing at a relatively fast rate due to population growth and economic development from 2004 - 2018 as compared to an investment in clean energy in India was increasing slowly from 2004 -2018. India is lagging behind in investments in clean energy as compared to China. China is the world's leading country in electricity production from renewable energy sources. The Indian power sector is one of the most diversified in the world. The sector has been continuously progressing in generation of clean energy in addition to conventional sources of energy like coal, lignite, gas, hydro and nuclear power. Total installed capacity of power plant in the country stands at 253.39 GW in which, thermal power accounts for 69.5%, renewable energy accounts for 12.5%, nuclear 2% and hydro holds a 16% share. India's electricity sector is amongst the world's most active players in renewable energy utilization, especially wind energy. As of 31st march, 2014 India had an installed capacity of about 31.69 GW of non- conventional renewable technologies- based electricity.

Suggestions

- India should have to take new Initiatives like Detailed planning, feed-in tariff, Protect the legitimate rights and interests of renewable energy users, tax relief policies for various types of renewable energy sources which is already done in China to access, mobilize, disburse and track climate change finance in terms of Mitigation and Adaptation climate finance at nationally as well as globally to create Renewable energy and for ensuring the sustainability of natural ecosystems. Unless we can have financial resources it will be difficult for us to mitigate and

adapt. This is why climate financing is so important. Climate finance- helps in finding ways in dealing with climate change- mitigation and adaptation e.g. Crop insurance. If we generally want to scale up finance the reality is that the private sector is the prime mover and prime agent. We need to look at the private sector for large scale solutions.

- Technology and business models of China should be adopted in India.
- We have to develop the entrepreneurial environment in India for example solar home systems in Bangladesh by the private sector in clever partnership with the government. We need to think in the same way towards innovative solutions. We have an entire ecosystem to make electric motorcycles. We can charge motorcycles through panels on rooftops- Fantastic 'Make in India' initiative as well; a win-win situation. This kind of solution would enable us to face the challenges of both mitigation and adaptation.
- This study will give ways and means which India should adopt for creating new Development Financial Institutions to promote low carbon development actions in carbon-intensive sectors, such as transport, energy-intensive industries, forestry, and waste and water management. This Study makes a comparison between China and India and shows that investments in clean energy in China was at peak in 2017 i.e. 132.6 billion US Dollars as compared to investments in clean energy in India was at peak in 2011 i.e. 13.8 billion US Dollars which was the maximum contribution of India in investing in clean energy in India as compared to china and then make a comparison of lowest /initial limits of both these countries in 2004 that was 3.1 and 2.7 billion US Dollars invested in clean energy in China and India respectively during this reference period from 2004-2018. An investment in clean energy in china has been increasing at a relatively fast rate due to population growth and economic development from 2004 -2018 as compared to an investment in clean energy in India was increasing slowly from 2004 -2018. India is lagging behind in investments in clean energy as compared to China. China is the world's leading country in electricity production from renewable energy sources.
- Indian Researchers have to take research in new financing instruments which should lead to increase project implementation capacity across a wider range of themes, sectors and geographies and pilot new approaches based on innovative financing models to develop capacity in Development Financial Institutions(Andhra Pradesh launched Green tax recently).

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