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Analysis of the pivotal role of Entrepreneurship in the Solar Energy sector of India

-A focus on the Indian Renewable Market

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Abstract - Renewable Energy, is considered to be the need of the hour, as the world is grappling with issues of climatic change, energy poverty and un-employability. In a developing country like India, Solar Energy holds the key to aforementioned challenges as it is abundantly available and free of cost. The Solar energy market of India, in the last decade has been growing at an unprecedented pace, with rapid developments being made in both on-grid and off-grid sector. This study highlights the pivotal role of entrepreneurship in the solar energy sector of India. The topic of research being inter-disciplinary takes into consideration the aspects of entrepreneurial theory and the current trends in renewable energy. The quintessential role of entrepreneurship in promoting the cause of solar energy, has been analyzed using three different parameters i.e. Number of starts-up or entrepreneurial ventures conceived, the investments made in the solar energy sector and the policy incentives by the Govt. of India. This study also characterizes the current status of the solar start-ups into ideation, validation, traction and scale-up stages. It is expected that growth of the solar energy sector, catalyzed by the innovative actions of entrepreneurs will help in achieving the sustainable development along with the future energy needs.

Keywords - Renewable Energy; Solar Energy; Entrepreneurship; Start-Ups; Policy Incentives.

I. INTRODUCTION

The CoVID-19 pandemic has shown how fragile the world is. A microscopic virus has brought the entire humanity on the knees. Millions of lives and livelihood have been threatened and lost. In-fact today, also happens to be the time, when we need to introspect the future we want to build and the planet we want to leave for the upcoming generations. The last 18 months of the pandemic has shown that the humans can adapt to evolving circumstances and indeed have enormous capacity to change the way they live, work and organize themselves. On 25 September, 2015, the members the United Nations, signed up for the 17 sustainable development goals, a set of solution to the biggest problems the world faces. Many of these problems are interlinked and interconnected. Climate change happens to be one of them and quintessentially a critical one [1]. According to the latest reports by NASA on climate change 2010-2019 was the warmest decade, indicating the fact that climate change is real and happening [2]. Today as the globe confronts the verity of climate change, these warmer temperatures further aid in the fueling of a host of natural calamities resulting in further degradation of the natural habitat and environment. Carbon dioxide (CO_2) and other greenhouse gas emissions are considered to be the major sources of continued global warming. As a matter of fact, the CO_2 concentration in the atmosphere has increased by up to 48% since 1850, when compared to the pre-industrialized era and the continuous usage of fossil fuels has played the major part in it. [3]

Affordable and Clean Energy is one of the seventeen goals adopted by the UN. One of the many objectives that is meant to be achieved through this goal is to considerably enhance the percentage share of renewable energy in the overall global energy scenario. According to IRENA (International Renewable Energy Agency) by the beginning of the year 2021, the

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international energy generation by renewable means reached 2799 GW, superseding the previous year by 10.3%. The maximum increase occurred in Solar Energy, which increased by 22% (+127GW) closely followed by wind energy at 18% (+111GW) [4]. Figure 1 depicts the distribution of the global renewable energy generation by energy source in the beginning of 2021. In terms of the continental distribution, Asia (in particularly China) played a pivotal role in enhancing the renewable energy generation by a staggering 64%, followed by the North American & European markets, where an increase of 8.2% and 6% was witnessed respectively. India too has made its make on the international scene, with the rapid generation and deployment of the renewables, specifically the solar power. It's in fact among the top 5 nations of the world in photovoltaic power programs. Today, the aggregate capacity of installed solar PV in the country is nearly 40 GW as compared to 161 MW in 2010. This includes both the roof-top solar and ground-mounted solar along with the off-grid solar power.

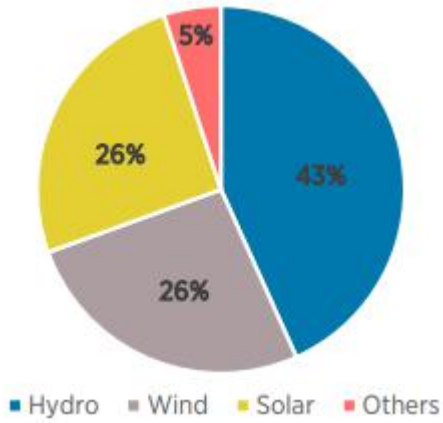

Figure 1 : Distribution of Energy sources in Renewable Energy generation

The surge of the usage of renewables serves dual purpose: 1) It is considered to be an imperative action for reducing the impact of the climatic change in agreement to the Paris Accord, besides 2) the goal of providing universal clean, affordable and reliable energy to everyone becomes more enabled. According to 2019 Energy Progress Report by IEA (International Energy Agency), IRENA, UN Statistics Division, World Bank & WHO (World Health Organization) even today, 12-14 percent of the world's population haven't got any access to modern electricity and more than 2.9 billion inhabitants have no ingress to clean cooking and heating [5]. Renewable energy is not only close to local communities but also possess the potential to create a difference in the lives of millions.

Today, there's no denying the fact that innovation and entrepreneurship are critical for the further development and deeper penetration of the renewable energy. Multiple opportunities exist for entrepreneurs to identify the gap in the existing renewable energy market, deploy creative and innovative solutions with scalable business models, procure liberal benefits and create an impact. Many entrepreneurs are focusing their ventures along the different aspects of renewable energy entrepreneurship like consultation, installation, financing and maintenance. Globally green energy investments are expected to be at least half of the total investments in the entire energy sector in 2020. Start-Ups across the globe, are being conceived in the energy industry with solar energy, wind energy, hydro energy and biomass being the prominent fronts in the area of renewable energy. Furthermore, besides the conventional mainstream energy market, ample possibilities do exist in the off-grid energy sector as well with social enterprises like SELCO Solar, Urja Unlimited, Pollinate Energy etc having made a mark for themselves by working at the BOP (Base of Pyramid) in developing countries like India. [6]-[7]

In this paper, the importance of entrepreneurship in promoting the growth of solar energy in a developing country like India is highlighted. The paper is structured as follows: After the introduction in section I, a review of renewable energy entrepreneurship, both on and off grid is presented in section II. Section III explores and studies the role of entrepreneurship in the solar energy sector of India in terms of number of start-ups conceived and investments made by government, private and public-private networks. The start-ups conceived has also been characterized on the basis of their stages in this work. The paper also highlights the new governmental policies and regulatory frameworks of the recent past introduced to promote/support the same. Section IV concludes the paper.

II. ENTREPRENEURSHIP IN THE RENEWABLE ENERGY SECTOR

With the ever increasing demand for energy in our daily lives, from the household needs to

commercial obligations, the role of renewable energy is gaining more prominence. According to IRENA Global Energy Transformation: A Roadmap to 2050 report, the intended target for the next three decades is to create a renewable energy dominated market for creating a sustainable energy future. In order to achieve the same and to ensure that the targets are met, both the market incumbents and new ventures, created by Renewable energy entrepreneurs have a significant role to play [8]. Traditionally, the incumbents had an upper hand when it came to government energy policies, regulations, market share and dynamics; however, with the changing times, the role of start-ups in the renewable energy sector is gaining prominence. The new entrepreneurial ventures or start-ups in the renewable energy sector are usually associated with disruptive innovation, (when compared to the incremental innovation followed by the incumbents); as well as being more sustainable [9]. As a matter of fact, the literature suggests that pressures of sustainable development have resulted in ample opportunities being created for new entrants, who tend to follow a value based approach in creating products, processes or services with the aim to create a more social and environmental impact. [10]

Another aspect that's important from the economics point of view and is fundamental to entrepreneurship, in general, is the creation of jobs. The Renewable sector has generated about 11.5 million jobs in year 2019, with the solar photovoltaic (PV) leading among the renewable energy technologies (RETs). It accounted for every 1 out of 3 jobs created in this sector. However, the lack of skilled labor that could deal with the specific necessities of the job-at-hand like installation, maintenance, consultation, repair work etc does at times impede, the brisk pace of the renewables especially in developing countries of South Asia and South East Asia. Questions have also been raised in the past, regarding the need to introduce new specialized programs in Higher Educational Institutes (HEIs) that deals with imparting technical skills required in the 21st century renewable energy sector. The authors on researching found out that in India, out of 54 central universities, about 26 universities offer a specialized course in renewables at the Master's level, whereas the number is comparatively very less at the Bachelor's level. Furthermore, out of 31 National Institute of Technology (NITs) ,23 institutes offer renewable related courses at postgraduate level, but similar to central universities here also, the figure for the under-graduate courses remains comparatively low. Does this hinder, up to an extent the prospects of interested future taskforce of renewables? Could the launch of vocational training course specific to the needs and requirements be introduced? These questions do intrigue a thinking process that could help by creating a future task force in the renewable sector.

Renewable Energy Entrepreneurship is an inclusive domain, with the research being carried out, broadly segmented into two different areas i.e. entrepreneurship and renewable energy. Renewable Energy Entrepreneurship (REE) can be defined as the *"starting-up, running and potentially growth of a new business venture that focuses on the development, design, production and distribution of renewable energy as well as renewable energy systems and technologies including all aspects of the renewable energy value chain, comprising of planning, consulting, financing, installation, maintenance and end of life management or disposal*" [11]-[12]. The development and execution of technological feasibility along with sustainable business model are critically important from the renewable energy entrepreneur's perspective for the success of any venture. Furthermore, their significance from the investors perspective is no less and it also aids the governments in formulating policies and regulations that helps in supporting new innovations. As a matter of fact, new ventures and start-ups with creative business models are on the rise, with numerous new entrants trying to create an impact. The major funding of the renewable energy sector comes from the private investments, which according to an estimate accounts for more than 80% in the last decade.

Off-grid renewable energy also represents an equally important domain, that presents magnitude of opportunities in terms of new entrepreneurial ventures, that could create interventions which could benefit millions of people who have no access to the grid connected modern energy. Tailored approaches in terms of technology innovative solutions, creative financial and business models, cross sector linkages and capacity building programs have proved to be game

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changers in numerous circumstances, across the continents of Asia, Africa & South America. Besides, the conventional venture and start-ups, social entrepreneurs have also played an important role in reaching out to the underprivileged masses and improving their daily lives by helping to increase the work hours, providing light for children's study and other household chores (especially during evening, after the natural light is no longer present). [13]-[14] The concept of iterative learning and empathizing with the end user are central to many of these initiatives. Moreover, they tend to engage the local rural population by providing them with training and easier payment mechanisms. .Selco Solar in India, Grameen Shakti in Bangladesh, Solar Sister in Tanzania, Sistemas de Technologia Adequada Agroeletro (STA) in Brazil are few examples of social enterprises that has helped millions of rural people who suffer from energy crisis, across the globe.

III. ANALYSIS OF ENTREPRENEURSHIP IN THE GROWTH OF SOLAR SECTOR IN INDIA

The Indian economy has grown in the last many years and is considered one of the key drivers for the pursuit of renewable energy along with the needs of energy security and reduced carbon footprints. As of 2021, India stands tall among the top five countries of the world having the largest installed capacity of 95.66 G-Watts renewable energy, with Solar and Wind constituting the major stake, as shown in Figure 2. The country further intends to reach a target of 40% generation through renewables by the year 2030 to meet it's growing domestic, commercial and industrial demands and has taken a lot of policy measures and regulatory frameworks, both at the Central and State levels to achieve the same. Among the renewable technologies, the solar power has witnessed tremendous growth in the last decade. The Govt. of India launched National Solar Mission, a three phased project in 2010 with the intention to streamline the diffusion of solar energy across India. Various subsidies and incentives were given as a part of the scheme to enhance the adoption of solar based products like solar lanterns solar pumps etc. Among the various objectives outlined to be achieved, focus was also given on promotion and conceptualization of start-ups and entrepreneurship in the solar energy sector by leveraging financial assistance, mentoring and networking to the upcoming entrepreneurs interested in the domain. The state of Telangana, for example established an Incubation center in association with Texas University, United States of America to nurture and support new ventures in the area of solar energy for promoting the cause

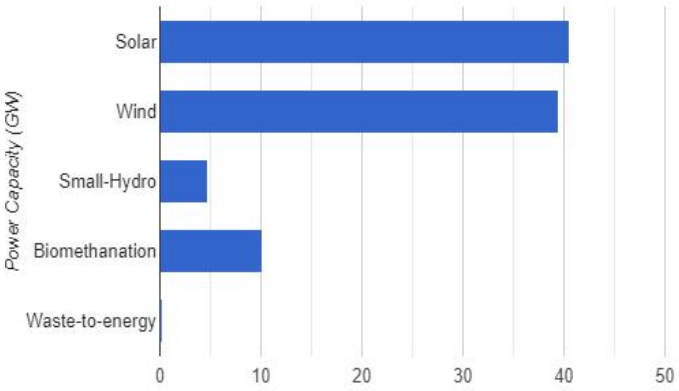

Figure 2 : The Installed All India power capacity of renewables

This section of the paper, investigates the pivotal role of entrepreneurship in the growth of the solar energy sector of India. The number of start-ups conceived in the last 10 years, the investments made by private players along with governmental offerings & policy incentives and regulatory frameworks have been chosen as the parameters of assessment. Content based analysis has been used for carrying out this research by studying data in a methodological and organized manner. Important keywords related to the solar energy sector and entrepreneurship were targeted for carrying out this search

A. Start-Ups & Entrepreneurial Ventures in the Solar Sector of Indian Market

Under the Jawaharlal Nehru National Solar Mission, numerous incentives were taken to promote the spirit of entrepreneurship in the solar energy sector by providing subsidies, rebates and tax benefits to the energy entrepreneurs venturing in the solar sector. Furthermore, the Start-Up India initiative introduced by Govt. of India in 2015 aimed at promoting innovation and entrepreneurship by handholding, providing funding and simplifying the overall mechanisms, facilitated to the growth of start-ups across industries in multiple sectors including solar renewable energy. The research indicates that in the last five years the number of startups have grown

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in an exponential manner, with 3678 registered start-ups in the Renewable Energy sector of India till Jan 2021. The distribution of registered start-ups and entrepreneurial ventures, according to the technologies is shown in Figure 3. The results indicate that the entrepreneurial ventures in the solar energy sector, far exceed its counterparts. Many of these ventures are in the areas of design, consultancy, distribution, installation and maintenance. Figure 4, further illustrates the stages of the solar start-ups /entrepreneurial ventures. The results are encouraging as majority of the start-ups are in validation, early traction and scaling mode, thereby signifying a positive trend in the growth of the renewable solar sector of India. Moreover, Incubators and Accelerators, both governmental and private too play an important role in creating an ecosystem for nurturing of

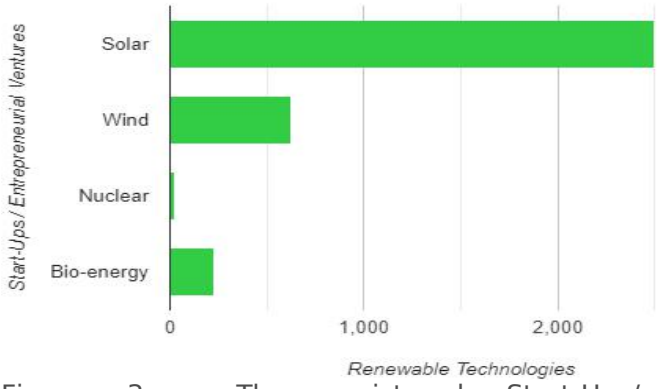

Figure 3 : The registered Start-Ups/ Entrepreneurial ventures in the last 10 years in Renewable Energy sector of India

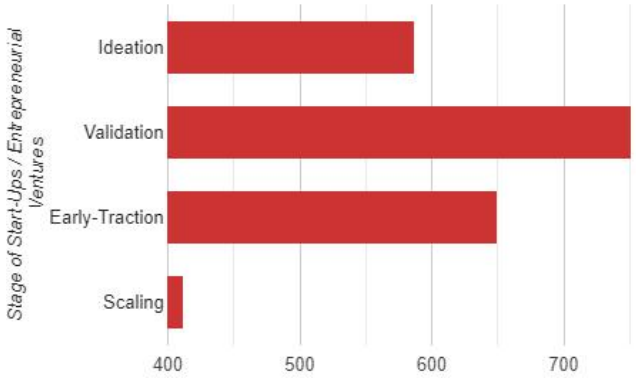

Figure 4 : Stages of the start-ups/ Entrepreneurial ventures in the Solar energy sector of India

The new companies. As of Jan 2021, there are more 179 incubators and 43 accelerators at Pan-India level that supports the new entrants in Solar energy and creates an ecosystem for nurturing the start-ups in the solar sector.

B. Investments in the Indian Solar Sector

The investments made by private players (angel investors, venture capitalists, equity firms across Series A, B and C round of funding), government agencies or public-private networks has also been chosen as another parameter of assessment, signifying the important role, investors play in nurturing and growth of any sector of the market. Funding is an essential aspect of the growing business, and is required atdifferent stages for product or process development, R&D, procuring the essentials, obtaining governmental licenses and certifications besides marketing & sales operations. It also helps in improving the operational capacity of the existing systems.

Furthermore, India has a 100 per cent FDI policy for the renewable energy sector under automatic route, thereby making the Indian market an attractive proposition for both national and international investors. The key findings illustrate that in the last seven years since 2014, 69 Billion $ have been invested in the Indian renewable market, with more than 55 percent of these investments being made in the solar energy sector. In-fact the net investment in the last one-year financial time frame i.e. 2020-21 exceeds 10 Billion $. The key research however suggest that the country further requires an investment of 500 Billion $ by year 2030, to reach its capacity target. Recently in June 2021, Reliance Industries, an incumbent and a major player of the fossil fuel industry, pledged 10 Billion $ over the next three years for manufacturing and generation of green energy, with solar energy being one of the prime areas of focus as it intends to achieve a production of 100 G-Watt in the next 10 years.

C. Policy Incentives & Regulatory Frameworks

Inadequate policy support by the government or policymakers has been cited as one of the major constraints that hinders the diffusion of renewable energy at a decent pace in developing countries. It’s of immense importance to create a positive outlook among incumbents and new entrants by creating, designing and implementing policy incentives and regulatory frameworks that brings an optimistic attitude as a general sentiment. The policymakers and the Govt. of India have taken

a lot of initiatives under various schemes of different ministries and departments to promote the cause of clean and green energy, to limit the bureaucratic disruptions and to promote the spirit of entrepreneurship and start-ups in the solar energy sector. Some of the latest initiatives, by the government and highlighted as a part of this study are as follows:

1. Though the "*Make in India*" initiative, the Central Govt. intends to promote the manufacturing and production process in the renewable solar sector like for example Solar PV's, solar charging infrastructures, batteries etc. The scheme, besides reducing the dependability on other countries for procuring the raw materials and equipment's is also expected to provide a boost to the solar industry of the country by promoting innovation and entrepreneurship at both the local and national level. It could further help the economy of the country, with the increased exports as there's always a possibility of becoming a major production hub.
2. Production linked incentives (PLI) scheme "*National program on High Efficiency on Solar PV Modules*" endorsed by Ministry of New and Renewable Energy (MNRE) has recently been approved in November 2020. An estimated 4500 Crores has been allocated for the next 5 years, specifically to upgrade the production capability of High efficiency solar PV modules. The scheme also promotes entrepreneurship at both manufacturing and integration capacity, as both new entrants and incumbents are eligible for the bidding process.
3. Approved List of Models and Manufacturers i.e. ALMM of Solar photovoltaic modules is yet another initiative by the Ministry of New and Renewable Energy (MNRE) to safeguard long term energy interests of the country, by assuring that the quality and reliability of the solar PV modules and cells used is in accordance to the BIS compliances. The scheme was launched in January 2019 and gives boost to local and national entrepreneurial efforts in regards to the manufacturing of the components at the domestic level.
4. Indian Renewable Dashboard, launched in April 2021 is a joint initiative by Central Electricity Authority (CEA) and CEEW's Centre for Energy Finance, to provide a single platform for providing information regarding the upcoming and ongoing renewable energy projects in the country.

However, in-spite of the aforementioned there are still issues to be tackled and challenges to be faced, in order to achieve the goals of energy security and sustainability. Infrastructure related issues in the remote parts of the country, the shortage of the skilled technical manpower and hindrances in obtaining the finance in a systematic and synchronized manner are those matters which needs to be looked into for further strengthening the roots of entrepreneurship in the solar sector.

IV. CONCLUSION

In this working paper, the pivotal role of entrepreneurship in the growing solar energy sector of India is presented. The number of start-ups or entrepreneurial ventures conceived, investments made by private-public institutions and favorable policy incentives by the government have been chosen as the parameters of assessment. The renewable energy sector, in general offers ample opportunities of employment as well. The sector in the last five years has created 0.8 million full time jobs at different designation, based on the possessed skillset. The basic aim of providing clean and green energy to everyone, along with the motivations to reduce the carbon footprints does gain momentum with the enhanced coverage of renewable technology, for which the new entrants, start-ups and entrepreneurial ventures do play a critical and quintessential role.

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