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Critical Drivers in Global Clean Energy Transition: Case of Job Creation in the Solar PV Sector

ASHUTOSH KUMAR
Assistant Professor, Department of History, Deshbandhu College, Kalkaji, New Delhi (India)
and
Ph.D. Scholar at Energy Studies Programme, School of International Studies
Jawaharlal Nehru University, New Delhi (India)

ABSTRACT

Energy has traditionally been dealt by the policy makers in terms of price, supply and environmental impact. Economic growth and employment generation become part concerns only in times of recession and resulting unemployment. However, in recent times this has also emerged as one of the key considerations especially in relation to the narratives of the transition from fossil to renewable energy. This research paper is based on the data analysis of the number of jobs created in various countries in the renewable energy sectors, especially solar Photovoltaic (PV). A survey of such literature finds that the apprehension of the scholars and energy planners that large-scale shift to renewable would not be beneficial from the employment perspective is unfounded. In fact, studies throughout the world have given ample data to assert that renewables create more jobs than fossil fuel-based energy systems. The paper argues that the solar PV sector has surpassed other renewable and fossil energy in cost competitiveness and in terms of job creation. This is the reason that market forces have increased their investments in this sector. The paper concludes that a shift to solar PV is very advantageous, especially for the developing economies of the Global South, which are incidentally energy-starved and high in unemployment. Thus, it will enhance their energy security and could become a game changer in the reduction of rural unemployment. However, technology transfer, fund and intellectual property rights are some of the important issues that need to be addressed. The International Solar Alliance (ISA) is poised to play a crucial role in this.

Keywords: Energy transition, Solar PV, Energy security, Global South, Employability, Intellectual property rights

INTRODUCTION

The New Education Policy 2020 has laid great emphasis on the development of skills to enhance the employment potential of the people. The solar PV sector has emerged to play a big role in this regard by opening new opportunities for employment. Beating all apprehensions and hiccups the renewable energy transition is a global reality now. All the countries of the world now have some kind of policy in increase the uptake of renewable in their energy mix. Its environmental as well as economic and social benefits are loud and clear. The technological advancements in the solar PV have led to sharp decline in the installation cost (up to 85% in the last decade) and increase in its efficiency (up to 22 %) which has made solar power generation cost competitiveness compared to that from fossil fuels as well as other renewable sources such as wind and others. This has triggered massive inflow of funds and private investments in this sector. The renewable is into the take off stage to sustain its growth even without the state's fiscal patronage. The market forces and the society at large are developing models to increase its penetration.

While discussing energy issue, the policymakers have traditionally focused on the price, supply, and environmental impact. Economic and employment growth

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are taken into consideration only at the time periods of recession and consequent unemployment (Yergin *et al.*, 2012). The renewable energy transition has brought the issue of employment into the narrative of energy in a prominent way. This is because the transition is not only a techno-infra issue, but also a socio-economic problem. Thus, shifting to the low carbon energy should ensure social justice as well (Jenkins *et al*., 2018; Geels *et al.*, 2017).

The number of jobs created by a sector is a really difficult task and the two studies may differ substantially. This happens not only because of different approaches/ methodologies adopted to calculate but also due to the involvement of many types of uncertainties inherent in the project and complexities of the labour market (Bacon and Kojima, 2011). This logic applies to the energy project or proposed programme too. One cannot calculate the job created in the energy sector just by surveying the number of people hired for the construction and operation of the power plant. It should be noted that while construction, installation, and manufacturing (CIM) jobs are short term, the operation and maintenance jobs are long term. Thus, while calculating total employment impact, one needs to consider both short term and long term as well as direct, indirect, and induced jobs (Breitschopf *et al*., 2011; Fulton *et al.*, 2011). The input-output approach is used extensively in studies dealing with renewable energy transition (IRENA, 2020b; Lambert and Silva, 2012; Miller and Blair, 2009). However, it should also be noted that the renewable energy transition is a wider and more complex process and the solar PV sector creates multiple kinds of new and sustainable employment opportunities for all kinds of people. Thus, the employment potential of renewable is far more diverse, distributed and sustained compared to that of conventional energy.

During 1980s and 1990s the fossil fuel lobbies argued that shifting from fossil to renewable will cause loss of employment and hence it should not be taken as an economically, politically, and socially viable option. Some literature continues to support that argument (Almutairi *et al.*, 2018; Ortega *et al.*, 2015). But serious studies on long-term impacts undertaken in several countries across the world have made it clear that the situation is rather the other way round. Shifting to renewable not only creates more jobs compared to fossil fuels in terms of both capital investment and per unit power generation but it has many significant collateral advantages too (Terrapon-Pfaff *et al*., 2014; Juchau and Solan, 2013). Many reports and studies have found that the loss in the fossil sector will be more than compensated by the renewable sectors, especially solar PV, and wind (Pestel *et al.*, 2019; Cai *et al*., 2011). Pai *et al.* (2021) found that achieving 2 degrees Celsius by 2050 will create 26 million direct jobs and that 84 per cent of entire energy related jobs will be in solar and wind. It also helps in the reduction of poverty as well as meeting various targets of the Sustainable Development Goals (SDGs) in developing countries.

Apart from ensuring energy security and energy access at an affordable cost, the solar PV has the potential to generate multiple kinds of employment opportunities in the rural areas especially and hence it could become a game changer in helping to reduce rural poverty in the developing countries. It should be noted that the expansion of the solar PV not only creates short-term CIM (construction, installation, and manufacture) but also long-term O&M (operation and maintenance) jobs. Various governments have launched many programmes of rural electrification. Bangladesh's Home Solar System programme and India's PM-KUSUM can be cited as examples in this regard. Many Asian countries such as Malaysia, Viet Nam and the Philippines are emerging as the global hub for solar PV manufacturing thereby opening new vistas of job opportunities. Thus, job creation has emerged as one of the critical drivers for the adoption of solar PV in many countries in recent times.

METHODOLOGY

The research paper is based on the analysis of published documents and reports on energy transition, economy, and employment generation/scenarios in different countries as well as by various agencies. Thus, it is a qualitative analysis of the data on jobs created by the renewable energy systems, especially the solar PV.

CRITICAL DRIVERS

Price Decline: The Real Trigger

Any technology must be economically viable for its sustained and wider acceptability. This applies to renewable energy technology as well. Although the environmental benefits of shifting to renewable sources of energy were known to all, it was only when its prices came down drastically in the last decade and the energy that it produced became cost-competitive compared to

that of fossil fuels that it has found wider acceptability. The cost of production of electricity from renewable has come down sharply in the last decade. Here again, solar has established its advantage over other renewable. The global data shows that while the cost of electricity production for onshore and onshore wind declined by 54% and 48%, respectively, that of solar PV and concentrated solar came down to 85% and 68%, respectively over the last decade, 2010-2020 (Table 1). In many regions of the world, such as China, United States, the European Union (EU) and India, the building of wind and solar PV power plants has become cheaper than the operational cost of the coal-based power plants. In many countries of the world renewable energy is giving tough completion to even gas-fired power plants (GWEC, 2021; Hodges, 2020; SolarPower Europe, 2020). Thus, renewable led by solar has become cost competitive across continents and emerging as the cheapest source of electricity generation (IRENA, 2021). Technological advances in solar cell technology are expected to enhance efficiency and cost further. TOPCon and heterojunction are such promising technologies. Heterojunction technology is claimed to have increased the efficiency level of the PV to 25.2% (SolarPower Europe, 2020). With this rate of increase in solar power conversion efficiency, the price is expected to fall further in near future.

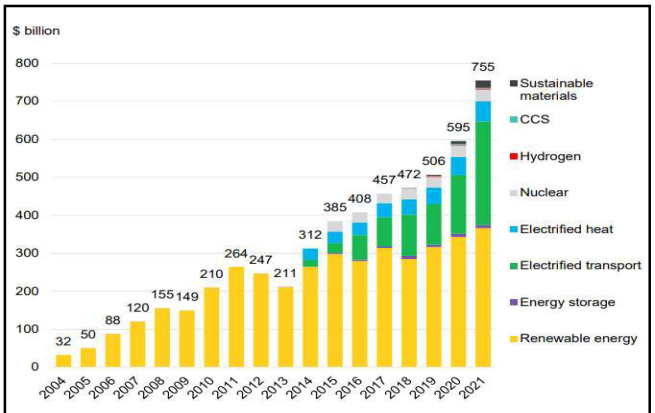
Table 1 : Global Levelised Costs of Electricity from Newly Commissioned Utility-scale Renewable Power Generation Technologies, 2010 and 2020

Source of Renewable Energy	2010 (USD/kWh)	2020 (USD/kWh)	Decline (%)
Solar PV	0.381	0.057	85
Concentrated solar power	0.340	0.108	68
Offshore wind power	0.162	0.084	54
Onshore wind power	0.089	0.039	48

Source: IRENA Renewables 2021, Global Status Report.

Global Investment Trend in Clean Energy: shedding state's fiscal patronage:

The renewable energy sector is gradually but consistently coming out of the state's fiscal patronage support (subsidies, tax credits, incentives etc.) and market forces have started showing a positive response. According to the Bloomberg NEF report (January, 2022) global investment in the low-carbon energy transition totaled $755 billion in 2021, up from $595 billion in 2020 and just $264 billion in 2011. Of this nearly half ($366) was invested in the renewable sector (Fig. 1) (Bloomberg NEF, 2020). If the global trend of private investments in renewable particularly solar and wind in the last few years is taken as a cue, then one can safely say that this sector is all set to see a massive flow of investments in years and decades to come. Already several governments and multilateral funding agencies have started withdrawing from further investments in fossil fuels and shifting funds to renewable developments. While Denmark has announced to stop exploration of all kinds of fossil fuels both domestic and overseas by 2050 (BBC, 2020), the United Kingdom declared its intentions to end support for oil, gas, and coal projects overseas "as soon as possible" (Nugent, 2020). Japan has also expressed its intention to end all support to the overseas exploration of fossil fuels (Shigeta and Miki, 2021). Multilateral development banks dedicated more than USD 13 billion to "clean" energy (Energy Policy Tracker, 2024). By early 2021, many private banks, pension funds and insurers also had committed to ending or restricting support for fossil fuels (Espiner, 2021, Ellfeldt and EandE News, 2021; Theakstone, 2020; Reuters, 2020; Sims and Jessop, 2020). Further, the humanity has learnt a big lesson during COVID-19 pandemic that economic growth should be in tandem with nature and human well-being. the post-Covid trend in renewable led by solar, clearly shows that it is will grow faster than anticipated.



Source : BNEF. Energy Transition Investment Trends, Executive Summary, 2022

Fig. 1 : Global Trend in low-Carbon Energy Transition Investment (Billion USD)

The upbeat global investment trend in the clean technology and supply chains of needed materials

continues to open new landscapes of international cooperation and competition (IEA, 2021). Renewable sector and especially solar PV continue to attract huge investments. Here again, solar has taken a lead over other renewable. Investments in solar capacity building increased to USD 148.6 billion, a rise of 12% compared to the previous year and nearly half of the global total investment in renewable energy. Despite an overall decline in the global investment in fossil fuels in 2020 due to the economic crisis triggered by COVD-19 pandemic and the expectation that there will be at least 10% depreciation in the renewable investment in 2020 (IEA, 2020a), the global data showed the opposite. Global investment in new renewable power and fuel capacity was estimated to be more than twice the investment in coal, gas and nuclear power generating plants combined in 2020. Investments in renewable increased by 2% to reach USD 303.5 billion in the same year. Solar PV has beaten the trend by attracting nearly half (USD 148.6 billion) of the total investments in renewable energy capacity building. This amounts to be 12% rise compared to 2019 (USD 132.4 billion) (BloombergNEF, 2021). The dominant reasons behind this massive sustainable surge in solar PV were a sharp decline (85%) in the cost of utility based solar PV in the last decade, fluctuating oil and gas prices, longer-term investment perspectives and supportive policies initiated by governments throughout the world as a part of their commitments on climate change issues (IRENA, 2021). The corporate sector has also come forward to increase its uptake of renewable energy through various power purchase agreements (PPAs) or other means (Filbert, 2021; Martin and Crowley, 2018; SunPower, 2019). Beating all adversities related to the COVID-19 pandemic, the industries' purchase of renewable power increased from 20.1 GW in 2019 to 23.7 GW in 2020, an increase of 18% (BloombergNEF, 2021).

GLOBAL TREND IN EMPLOYMENT GENERATION IN RENEWABLE AND SOLAR PV ADVANTAGE

Employment opportunities are one of the key considerations in planning for low-carbon economic development. Many governments have prioritized renewable energy development to meet international obligations on climate goals, but they also target to derive broader socio-economic benefits from this. An apprehension was expressed not long ago that this renewable transition may cause a substantial loss of jobs in the fossil-based energy sector and that not many jobs will be created in the new renewable energy sector. But most of the studies conducted in several countries in this regard have belied this notion and found that although some retrenchment in fossil energy, especially the coal mining and power sectors, is likely, the overall employment scenario in energy is encouraging. This transition boosts the economy and creates more net employment too (IEA, 2021; Bulavskaya and Reynes Free, 2017). World Energy Outlook (2021) asserts in no ambiguous terms that employment generated by the clean energy will be far more than the loss of job opportunities in the fossil fuel caused by this renewable transition.Most of the retrenched employees from fossil fuels can be employed in renewable sector after re-skilling through a short period of vocational/technical training. Further, the RE sector, especially solar PV, is more labour intensive and hence creates more employment compared to that by conventional ones. The renewable energy sector has four major elements to its value chain: equipment manufacturing and distribution, project development, construction and installation, operations, and maintenance. Of these fourth one generates maximum jobs both directly and indirectly. Lots of indirect and induced jobs are also created with the expansion of renewable energy (RE). Additional jobs are created for educationists, professionals, and trainers to impart academic and technical skills through different courses. Thus, the renewable energy sector is expected to create new vistas of direct/indirect/induced job opportunities for all kinds of people- experts, technicians, skilled, semi-skilled or even non-skilled and help in reducing rural poverty (Jairaj and others, 2017) poverty. According to Garrett-Peltier (2017) energy efficiency and renewable energy industries create almost three times as many jobs as fossil fuels industries at the same level of spending.

Data show that renewable has provided new employment opportunities to millions worldwide. The trend continues to be upward despite the economic stress generated by the COVID-19 pandemic. According to the latest IRENA Renewable Energy and Jobs (2021) report, the renewable energy sector has provided 12 million jobs worldwide in 2020 (up from 11.5 million in 2019) and the trend is most likely to continue in both the short and long terms. An additional 5.5 million jobs to be created in the next three years with a total job to reach 30 million by 2030, the report highlighted. In terms of

employment generation, solar PV sector stands out much ahead of other renewable sources of energy globally since 2012. The employment in this sector grew from 1.36 million in 2012 to 3.98 million in 2019, almost three times in seven years. Solar PV alone provided more than 1/3rd (36%) of the total renewable workforce in 2020 (Table 2).

Table 2 : Comparing Global Employment in the Renewable and Solar PV

Year	Employed People Renewable (in millions)	Employed People in Solar PV (in millions)
2012	7.3	1.36
2013	8.5	2.27
2014	9.5	2.49
2015	10	2.77
2016	10.1	3.09
2017	10.5	3.37
2018	11	3.68
2019	11.5	3.75
2020	12	3.98

Source: IRENA job database. *Renewable Energy and Jobs, Annual Review 2021*

PV Solar also stands out as the most beneficial of all in the renewable basket also in terms of job creation per unit of energy produced as well as capital invested. According to a joint study in 2019 by the Council on Energy, Environment and Water (CEEW), the Natural Resources Defense Council (NRDC), and the Skill Council for Green Jobs (SCGJ), solar in general leads other renewable, rooftop solar provides 24.72 job-years per MW in comparison to 3.45 job-years per MW for utility scale ground-mounted solar and 1.27 job-years per MW for wind power in India (IASS *et al.*, 2019). The RE data on the ratio of job creation to capital investment is also very encouraging when compared to that of fossil fuels. A modelling study shows that on average while USD1million investment in fossil fuels creates 2.65 full-time-equivalent (FTE), the same amount of spending provides 7.72 FTE jobs in renewable or energy efficiency in the short-to-medium term. Thus each USD 1 million shift from fossil to green energy is expected to create 5 more jobs (Garrett-Peltier, 2017). According to a report of the IEA, the global data shows that investment in the solar PV sector in 2020 created an estimated 13 jobs per USD 1 million invested or twice as many jobs as in the coal or gas industry (IEA, 2020b).

SOLAR PV EMPLOYMENT SCENARIO AND TRENDS IN ASIA

The developing countries of South Asia continue to be hotspots of energy demand. The cost competitive renewable energy has offered a new vision to meet growing demand and meet the climate obligations too. This is the reason that this part of the world has seen maximum investments in the renewable sector, especially solar PV. According to IRENA (2021) out of the 127 GW solar power additions in 2020 globally, 98 GW (60%) was added in Asia (IRENA, 2021).

Of the leading ten countries in terms of job creation, seven are in Asia. Other than China and Japan, India, Viet Nam, Bangladesh, and Malaysia are in the top ten countries of the world in terms of job creation in solar PV. Asian countries (including China) held 79.4% of the world's PV jobs and this shows continuous dominance of the region in both manufacturing and installations. This figure is far ahead of the Americas and Europe where the data stand at 8.8% and 6% respectively (IRENA, 2021). Bangladesh has been able to generate 1.37 lakh jobs through various schemes (World Bank, 2021) of rural electrification through solar PV. According to an estimate by the Sustainable Energy Development Authority (SEDA, 2020) there are 54,900 people are employed directly or indirectly in solar PV in Malaysia (SEDA, 2022). Philippines employed 41,035 persons in solar PV in 2020. According to IRENA (2021) estimate Viet Nam, which has emerged as one of the leading global hubs in the manufacture of solar panels, continued to give the job to 126,300 persons in 2020. The ASEAN has already committed to meet 23% of their total primary energy supply and 35% of the total installed power capacity through renewable (ASEAN, 2020) and thus it is all set to create massive job opportunities for the people at large.

Thus, renewable is setting new trends in Asia. Given the fact that energy demand is expected to jump manifold in this region of the world and the commitment shown by nations to incorporate renewable in their energy mix, it is very much clear that more and more job opportunities shall be created in the solar PV.

SOLAR POWER DEVELOPMENT AND EMPLOYMENT TREND IN INDIA

India is the third largest installer of solar panels after China and the US and fourth in terms of job creation. The robust policy of the government towards renewable is giving a boost to the developments in PV solar. It is

important to underline that India has recently emerged as a producer of the cheapest solar PV power in the world. In a very comprehensive report on the capital investment cost estimates (CAPEX) of the cost of utility-based PV installation cost in the leading countries of the world, the IRENA (2021) calculated that in India it was 596 dollars per kilowatt against the global average of 883 dollars per kilowatt. It is also to be noted that India's cost is 8 percent lower than even China (IRENA Power Generation Costs, 2020). India is moving fast on solarisation. The pace has geared up in past few years.From 3GW in 2014 to 89.43 GW by August 2024, a rise of almost 30 times in ten years (MNRE, 2024). What is more important is that it is spearheading the growth of renewables in the country.

Many schemes (such as Solar Parks, PM Surya Ghar Yojana, and PM-KUSUM) have been launched to scale up the solar power. India is committed to go further for more ambitious targetsfor 2030 and achieve net zero emission by 2070. According to a study, while there has been fivefold (19,800 to 99,900) increase in the job in renewable energy during FY 2014 to FY 2019 and the trend is expected to be faster with increased solarisation (Kuldeep *et al.*, 2019). The total number of jobs in this sector, both on- and off- grid, has further increased to 163,500 in 2020 (IRENA Renewable Energy and Jobs, 2021). Under the RE map scenario, more than 3.2 million people would be employed in the renewable energy sector by 2050. The report further highlights that India would face a skilling challenge in future because 143,000 skilled experts and approximately 410,000 semi- and low-skilled technicians would be required in the solar sector by 2030 and this number would increase to 250,000 and more than 850,000, respectively by 2050 (IASS *et al*., 2019). Further, India is also set to emerge as an effective player in the manufacture of solar panels in near future and this will open new avenues of job opportunities.

TANGIBLE ADVANTGES: ACHIEVING SUSTAINABLE DEVELOPMENT GOALS

Renewable has other direct and collateral advantages also including reduction in poverty. It helps in achieving various socio-economic and climatic targets of the Sustainable Development Goals (SDGs), especially Goals 1, 5, 7, 10 and 13. Because of the universal availability of the Sun as well as off-grid production and consumption advantages, solar power can play a crucial role in achieving goal 7 ('energy, dominantly clean, accessibility to all by 2030') of the SDGs. Its role in providing social security and gender parity (Goal 7) has also been remarkable. Compared to 21% in the fossil fuel-based energy sector, the women workforce in renewable energy sector is 32% (IRENA Renewable Energy and Jobs, 2021). Because of its decentralized nature, solar creates jobs in every region thereby removing regional disparity (Goal 10) in terms of employment generation which is often associated with centralized fossil fuel-based power generation plants. Further renewable, and especially solar power, generates employment opportunities for all classes of educated/ uneducated or skilled/unskilled people. According to an estimate (IRENA, 2021), about 87% of 122 million jobs created by the renewable by 2050 would require only primary to secondary level education, and only 13% would need graduate, master, and doctoral level education. The development of off-grid solar PV in rural areas holds immense potential for employment generation because its operation and maintenance does not require much expertise and rural youths including women can be employed after short technical training. Thus, renewable holds the immense potential for job opportunities for the masses.

CHALLENGES AHEAD AND ROLE OF INTERNATIONAL SOLAR ALLIANCE

Though all the indicators and trends are positive for renewable and especially solar PV, there is a need of caution as well. The global energy governing institutions and policy makers need to ensure that all enabling factors are taken care of and its benefits are distributed properly. It is important to ensure that the potentials of the renewable sector are realized and that it does not get trapped into 'zero-sum game, else the entire gain on renewable front may backfire' (Levi *et al*., 2010). It is important to underline that harnessing of the solar potential is not only dependent on geography (*i.e.* availability of the Sun) but also on the accessibility of host of green technologies involved in its harnessing and utilization.

There is a need for both more investment and wide-ranging collaboration in the research and development of more efficient solar PV cells as well as technologies associated with a storage battery and more efficient transmission as well as many other enabling factors. The intellectual property (IP) rights (patents, trade secrets etc.) associated with green technology innovation and

diffusion is an important issue that needs to be tackled to ensure speedy accessibility to developing countries (IRENA, 2020a). The availability of finance and capacity building are the biggest concerns in the developing countries and the developed countries need to come forward generously on these fronts (Lybecker, 2015).

The International Solar Alliance (ISA) can play a complementary role to what is being done by IRENA and REN21in tackling the above challenges for a greater infusion of renewable in the energy mix. With its action-oriented programmes, customized services, bottom-up approach and legal flexibility, the ISA is poised to play a big role in scaling up solar power in developing countries and ensuring just transition. Its capacity building programmes are creating also new opportunities of employment.

CONCLUDING REMARKS

- Analysis of the data and study of trends in many countries, including leading countries of the developing world, clearly indicate that renewable in general and solar PV, in particular, has opened new vistas of employment opportunities.
- Employment prospects are emerging as one of the critical drivers of renewable (especially solar PV) transition in the world.
- Shifting to the clean sources of energy is vital to achieving the Goal 7 (affordable and clean energy to all by 2030) of the Sustainable Development Goals (SDGs). With low installation cost and diversified utility systems solar PV has huge potential to ensure access to clean energy to even the most marginalized sections of people as well as people living in the remote areas where no grid connectivity exists.
- Compared to all sources of energy, conventional and renewable, solar PV is advantageous from many perspectives. The study finds that apart from providing clean energy with multiple health benefits, a greater infusion of solar PV could be a game-changer for employment generation, poverty reduction and educational uplift in rural areas, especially in the developing countries.
- Because of every distributive nature of solar PV, as opposed to the centralized production units of power in fossil and other energy systems (thermal, nuclear), it will create jobs in every region and thus help in reducing regional disparities in a country.
- The challenges associated with intellectual property rights related to green technology innovation and diffusion, finance and capacity building need to be taken care of to fully harness the renewable potential.

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