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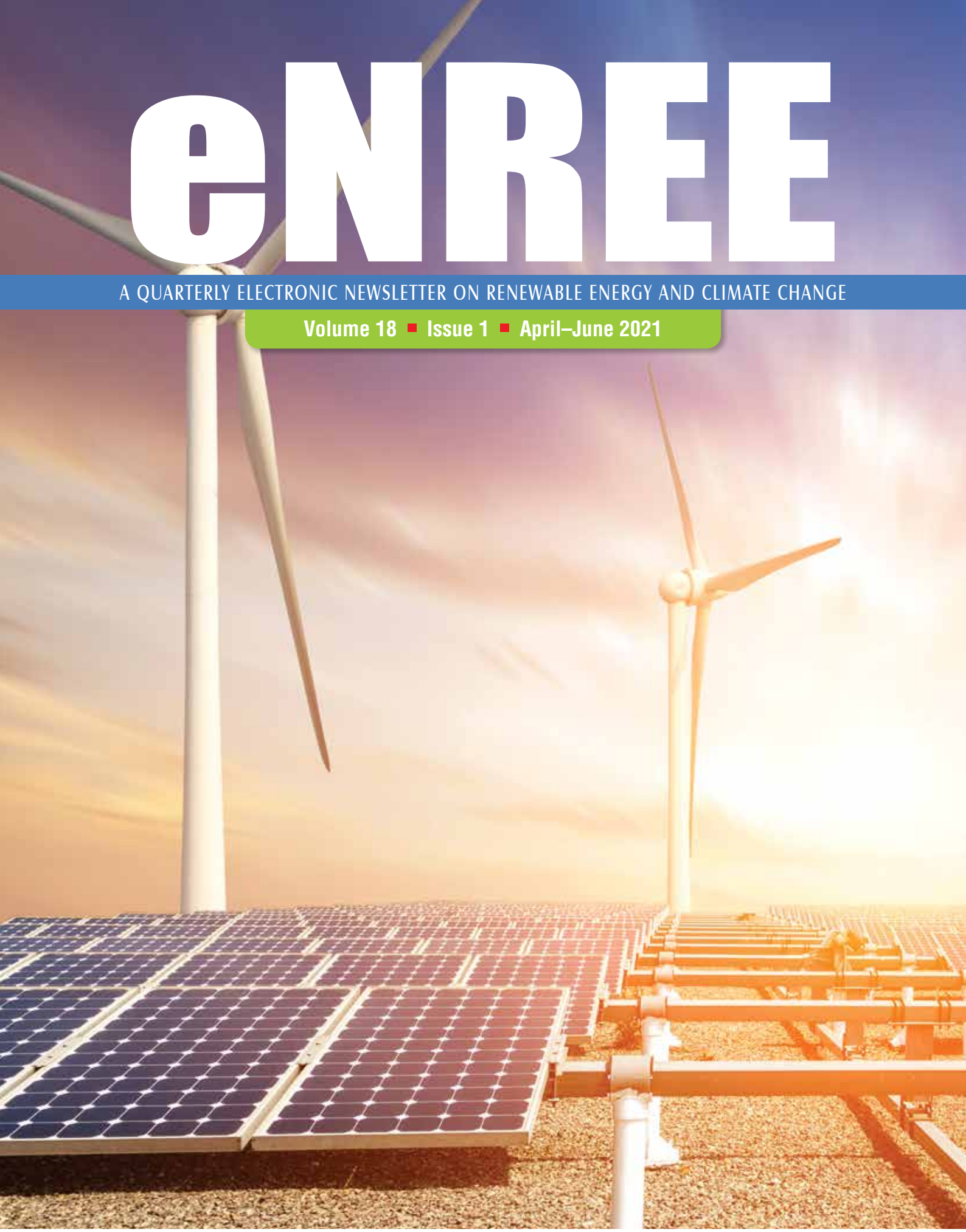

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TOURISM IN THE NEW NORMAL POST-COVID-19: IS ECO-TOURISM THE SOLUTION?

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The sudden onset of the coronavirus pandemic, also known as COVID-19, has caught the world off-guard. The unexpected spike in the spread of the virus has led to several containment measures being imposed globally including in India, most notably in the form of lockdowns and strict travel restrictions. The impact of the pandemic was felt across the global and national economy, and continues to do so, with local businesses being severely affected including travel agencies, tour operators, hospitality sector, all kinds of transportation services such as aviation, railways, shipping, and roads, and many more. The Indian tourism industry, which is dependent on travel, trade, and hospitality has been one of the significant contributors to India's GDP (6.8% in 2019) and as a labour- intensive sector, it generated around 39 million jobs, equivalent to 8% of the total employment of India in FY 2019/20.[1] Naturally, the sector was not averse to job losses and salary cuts inflicted due to COVID-19 lockdowns and restrictions. According to the Federation of Associations in Indian Tourism & Hospitality, about 3.8 crore people in the country faced unemployment due to the pandemic (see Footnote 1). A study by CII-Hotelivate suggests that the entire value chain of India's tourism industry could face losses up to ₹5 lakh crore (USD 65 billion).[2] Globally, the tourism industry suffered losses to the tune of USD 460 billion in the first half of 2020, with the Asia-Pacific region seeing the highest decline in tourists (around 72%).[3]

As countries move towards easing restrictions imposed due to the pandemic and resuscitating economies back on track with recovery measures and stimulus packages, the tourism sector is bound to pick up gradually. With Indian travellers unable to freely take a trip overseas for tourism, the only option is domestic travel in line with the Ministry of Tourism's initiative – *Dekho Apna Desh* – to promote domestic tourism across plentiful tourist destinations ranging from mountain tourism, cultural and religious tourism, wildlife tourism, adventure tourism, and heritage tourism. Sustainable tourism is not just an option anymore, but a pre-requisite with a large proportion of travellers favouring holidaying with organizations that inculcate a commitment to greener, environmental-, and socially friendly practices. Although the pandemic has adversely affected economic activities, the nature and the environment has thrived sans human interference amid lockdowns. Numerous reports have highlighted how nature has been healing – from

1 Details available at https://www.ibef.org/industry/tourism-hospitality-india.aspx, last accessed on May 12, 2021
2 Details available at https://economictimes.indiatimes.com/jobs/coronavirus-impact-may-render-3-8-crore-people-jobless-in-tourism-hospitality-sector/articleshow/74709878.cms?from=mdr, last accessed on May 12, 2021
3 Details available at https://economictimes.indiatimes.com/industry/services/travel/travel-and-tourism-sector-likely-to-lose-rs-5-lakh-crore-due-to-covid-19-crisis-report/articleshow/78015214.cms?from=mdr, last accessed on May 12, 2021

drastic decline in air pollution, increasing visibility of the Himalayan Ranges from cities such as Jalandhar and Saharanpur, which are located in the plains, the reappearance of birds and animals in urban spaces, to minimal to zero waste and litter across popular tourist spots.[4] The main challenge, however, lies in sustaining these unprecedented positive impacts on nature and environment, especially since the economy is slowly opening up and most of the Indian states have done away with major restrictions. Moreover, after enduring months of isolation, tourists would capitalize on the opportunity available to them to travel to popular destinations as well as less unexplored or commercialized places. The hospitality sector, which lost out on considerable peak season business, would also welcome the influx of tourists. While this may be beneficial for business and recreation for tourists, the recovering natural landscapes and local resident communities may not just be ready yet to receive unregulated tourist entrees. For instance, Rishikesh, which is popular for river rafting, received more than 8000 tourists within a short span of reopening.[5] Similarly, recently inaugurated Atal Tunnel connecting Manali to Lahaul has generated much curiosity among tourists, leading to traffic jams and accidents in the tunnel,[6] and created issues of overcrowding, littering, and even instances of crime in the remote quaint valleys.[7]

Is Sustainable Tourism the Answer?

Sustainable tourism or eco-tourism which builds on basic principles of local procurement while assimilating local culture and bringing livelihood opportunities to local communities without causing harm to the natural environment has gradually found space in the Indian tourism sector. The acknowledgement of the negative effects of mass tourism by policymakers, host communities, and some travellers has led to formulation of policies on sustainable tourism as well as several initiatives that promote conservation principles among tourists. Ecotourism, defined by The International Ecotourism Society, as 'responsible travel to natural areas that conserves the environment, sustains the well-being of the local people, and involves interpretation and education',[8] may be the way forward in a post-pandemic era. Involving the host community and creating opportunities for additional livelihoods while preserving nature and culture could create a niche for low-impact high-value tourism, in areas that are ecologically fragile.

How to Facilitate Eco-tourism?

Promoting ecotourism needs concerted efforts from all stakeholders. The government could come out with guidelines and directives to address a host of issues such as developing alternative tourist destinations, regulating and penalizing illegal construction activities, promoting theme-based tourism (adventure, nature, cultural, heritage, religious, wellness, etc.), imposing restrictions on tourists' entry to ecologically sensitive areas, capacity building of tourism service providers, among others. Locally owned guest houses and homestays could be promoted over large hotels that contribute to additional carbon emissions. Waste management measures also need urgent attention from relevant authorities as it not only stands to harm the environment and wildlife, but also reduces the aesthetic value of places. Building a stance towards circularity of plastic waste and pollution in tourism can lend a positive impact towards health. Keeping in mind the importance of prioritizing health, considering COVID-19, hygiene and safety standards must be specified and enforced in tourism businesses, including sanitized living spaces and kitchen, cooking with organic produce, making provisions for open kitchen, first aid and basic medical training, developing touch-less washrooms, etc. Furthermore, successful eco-tourism initiatives from states like Odisha[9] and Sikkim could be studied to understand what works and what does not work, with respect

[4] Details available at https://www.unwto.org/news/international-tourist-numbers-down-65-in-first-half-of-2020-unwto-reports, last accessed on May 12, 2021
[5] Details available at https://www.news18.com/news/buzz/how-coronavirus-lockdown-helped-nature-to-heal-even-if-temporarily-from-human-damages-2652815.html, last accessed on May 12, 2021
[6] Details available at https://www.hindustantimes.com/india-news/rishikesh-draws-over-8-000-tourists-for-river-rafting-within-10-days-of-re-opening/story-hp1abhrjzeMIhU6GL4TjOO.html, last accessed on May 12, 2021
[7] Details available at https://timesofindia.indiatimes.com/city/shimla/trash-jams-lahaul-witnesses-flip-side-of-tourism-post-tunnel-opening/articleshow/78726150.cms, last accessed on May 12, 2021
[8] Details available at https://www.timesnownews.com/india/article/opening-of-rohtang-tunnel-for-tourists-exposes-lahaul-valleys-to-pollution-and-crime/668651, last accessed on May 12, 2021
[9] Details available at https://ecotourism.org/what-is-ecotourism/, last accessed on May 12, 2021

to the specific conditions and needs of a particular landscape.[10] In the long-run, the health infrastructure in tourist spots may be appended and adequate capacity built for any COVID-like eventuality.

At the same time, it is also incumbent on tourists to make smart choices that commensurate with conserving the natural environment and respecting local sensitivities, while enhancing their travel experience. While choosing accommodation, travellers can opt for homestays and local tourist camps/lodges instead of business hotels. While these may not offer too many luxuries, it would help generate livelihood for the community in a sustainable manner. Similarly, tourists can be encouraged to reinforce local value chains through the procurement of local produce and handicrafts which help augment social and economic benefits for the local communities.

There is still an opportunity to develop upcoming and unexplored tourist destinations such as Miyar Valley and Pangi in Himachal Pradesh or Darma and Vyas valleys in Uttarakhand, Western Ghats, and several pristine places in India's North East among other locations across the country in a sustainable manner as these places are yet to be subjected to mass tourism. With improved road connectivity to the most remote places, and the opportunity to improve livelihood as observed by locals, it would not be long before such untouched places start following the same path as popular tourist spots. The hospitality sector, in addition to relying on government interventions, should focus on improving its business model given the impending changes in people's social behaviour. Investing in safety and hygiene protocol is of utmost importance since this would reassure customers in availing the tourism services. Making use of technology to make tourist areas digital and paperless, contactless food deliveries, information on places, and mechanisms for waste management, among others can be the way forward. Furthermore, engaging communities, including women's self-help groups and local youth groups to promote local experiences among tourists, conserving the landscape and keeping vigil, could be effective in preserving fragile ecosystems while providing livelihood opportunities to the people. In this regard, lessons may be drawn from women-managed community tourism in Meghalaya, to effectively adopt local socio-cultural gender norms into a sustainable livelihood intervention.[11]

Overall, the idea of tourism, emerging from innocent curiosities about alien lands and people leading to exhilarating experiences with nature and cultural exchange, resonates with the traveller's personal growth. Communities that open their homes and landscapes to visitors stand to gain from additional livelihood opportunities, upgrading skills, exchange of knowledge, and bringing in development to the region. However, when development turns reckless and travellers do not respect local environment and culture, the novel idea behind tourism spirals into a disaster. Eco-tourism in todays' condition, thus becomes the only way to adopt and promote travel, for long-term sustainable outcomes.

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[10] Details available at https://www.ecotourodisha.com/, last accessed on May 12, 2021
[11] Details available at https://www.greeneconomycoalition.org/news-and-resources/sikkims-eco-tourism-evolution, last accessed on May 12, 2021
[12] Details available at https://www.researchgate.net/publication/271725387_Sustainable_Nature-based_Tourism_Involvement_of_Indigenous_Women_and_Development_A_Case_of_North-East_India, last accessed on May 12, 2021

Renewable Energy

Adani Green Energy's arm commissions 50 MW solar plant in Chitrakoot

Adani Green Energy Ltd recently announced that its subsidiary, Adani Solar Energy Chitrakoot One Ltd (ASECOL), has commissioned a 50 MW solar power plant in Chitrakoot, Uttar Pradesh. In a regulatory filing, Adani Green Energy Ltd (AGEL) said the plant has a 25-year power purchase agreement with the Uttar Pradesh Power Corporation Ltd (UPPCL) at ₹ 3.07/kWh. This commissioning takes AGEL's total operational renewable capacity to 3520 MW, a step closer to its vision of 25-GW capacities by 2025, the filing added. With the successful commissioning of this plant, AGEL has an operational solar generation capacity of over 3 GW. AGEL has a total renewable capacity of 15,240 MW including 11,720 MW that have been awarded and are at different stages of implementation. With this 50 MW, AGEL marks the beginning of this year's commissioning plan with full commitment from its team, amidst continuing challenges of the COVID-19 outbreak, the filing said. Like all its other assets, the newly commissioned plant will be managed by the Adani Group's intelligent Energy Network Operation Centre (ENOC) platform.

Source: Details available at https://energy.economictimes.indiatimes.com/news/renewable/adani-green-energys-arm-commissions-50-mw-solar-plant-in-chitrakoot/82049870, last accessed on May 3, 2021

Solar PV systems: Soon, 151 rural houses to be powered by the Sun in Goa

The state government has issued a work order to Convergence Energy Services Limited for commissioning of solar PV systems at 151 households in Sanguem, Quepem, Sattari, and Canacona to provide electricity with comprehensive maintenance contract for 5 years under the Remote Village Electrification Programme (RVE). As per the cabinet decision, the work order is issued for the tender to design, manufacture, supply, install, test, and commission a 500 Wp Solar condition system at 151 households, at the rate of ₹ 43,000 each and 6 home lighting systems at the rate of ₹ 20,000 each in Goa with comprehensive maintenance contract for 5 years under RVE. The special purpose vehicle (SPV) module shall be guaranteed life of 25 years from the date of commissioning. A cabinet note said the programme aims to bring electricity, through renewable energy sources, to un-electrified remote villages, hamlets, and wards where grid connectivity is either not feasible or not cost-effective. Keeping in view the role of electricity in human and socio-economic development, this scheme is formulated to ensure last-mile connectivity and electricity connections to all remaining unelectrified households in the state. This scheme is, therefore, formulated in order to fulfil the government's target of 100% electrification in the state. Under the scheme, 100% financial assistance will be provided to households, with an upper limit of ₹ 90,000 per household, for a 500 Wp solar system. Each household will be levied monthly electricity charges, as determined by the government, depending on the number of units consumed. This amount will be used to create a village-wise or hamlet-wise corpus fund which will then be used to undertake maintenance of the systems after the expiry of the AMC period.

Source: Details available at https://energy.economictimes.indiatimes.com/news/renewable/solar-pv-systems-soon-151-rural-houses-to-be-powered-by-the-sun-in-goa/82019250, last accessed on May 3, 2021

IFC proposes $50 million debt finance for Thar Surya solar power project

International Finance Corporation (IFC) plans to debt finance the construction of Thar Surya 1 Pvt Ltd's 300-MW solar power project in Bikaner, Rajasthan with $50 million. Apart from lending $50 million, IFC will also mobilize $100 million debt through parallel lenders. According to IFC, the total solar power project cost is estimated at $200 million. The solar power project is sponsored by Enel Green Power India, one of the step-down subsidiaries of Enel Green Power S.p.A., an existing IFC client. Enel Green Power is one of the largest renewable energy developers in the world with 49-GW installed capacity across wind, solar, geothermal, and hydropower projects, and with presence in 28 countries. Enel Green Power is a subsidiary of Enel S.p.A., Italy. The solar power generation project was awarded by Solar Energy Corporation of India (SECI). The power generated by Thar Surya will be sold to SECI under a 25-year Power Purchase Agreement (PPA).

Source: Details available at https://energy.economictimes.indiatimes.com/news/renewable/ifc-proposes-50mn-debt-finance-for-thar-surya-solar-power-project/82001936, last accessed on May 3, 2021

Climate Change

Climate change: Wealthiest 1% are driving global carbon emissions, says new report

The world's wealthiest 1% produces twice as much carbon emissions as the poorest 50%, according to a report by Cambridge Sustainability Commission on Scaling Behaviour Change. Despite sharp falls in carbon emissions in 2020 linked to the COVID-19 pandemic, the climate crisis – which is driven by the accumulation of emissions in the atmosphere over time – continued to grow. Ahead of the COP26 climate change summit, it says that 'government must use this historic juncture to build fairer economies within the limits our planet can bear.' 'Dramatic lifestyle changes are needed among the so-called "polluter elite" to limit global warming to the 1.5°C target set out in the Paris Agreement,' the report said. To avoid passing this limit, the richest 1% will need to reduce their emissions by a factor of at least 30 by 2030 – while the world's poorest 50% should be able to increase their emissions by three-times their current level – meaning that the ladder of cheap energy is not pulled away from developing nations. According to the report – an expert panel of 31 leaders – individual and systemic changes go hand in hand. Some of the report's recommendations are dramatic, including addressing over-consumption by 'addressing advertising and the media's role in the normalization and reification of high consumption behaviours,' potentially by banning advertising. It recommends 'choice editing' in which 'governments, businesses, and those with direct control over production restrict the availability of high carbon products and services', by arguing that 'undoing unsustainable behaviours is a whole lot harder than preventing unsustainable products from coming to market in the first place.'

Among the commission's proposals are establishing what it describes as 'a sustainable economy and society' by establishing a way to live 'within planetary boundaries'. 'This means initiating difficult conversations about limits, proposals to "shrink and share" carbon budgets within and between countries and to regulate the production of polluting goods in the first place,' it adds.

The authors call on governments to consider introducing wealth taxes and luxury carbon taxes, such as carbon sales taxes on SUVs, private jets or super yachts, and levies on business class or frequent fliers. 'Ending the tax-free status of aircraft fuel, unconditional aviation industry bailouts, and tax breaks for company cars', are among their other recommendations.

Source: Details available at https://news.sky.com/story/wealthiest-1-polluter-elite-are-driving-global-carbon-emissions-says-new-report-12274350, last accessed on May 3, 2021

India addressing climate change issue efficiently

With climate change becoming an eyesore for the world, India has been making several attempts to fight it with path-breaking moves. Aiming towards making the industrial sector energy efficient, India's Bureau of Energy Efficiency launched the Perform, Achieve, and Trade scheme on July 4, 2012.

Industries achieving the set targets are given incentives in the form of energy-saving certificates and the ones that fail to achieve the targets are penalized – calculated on what remains to be achieved. Addressing audiences at TERI's annual flagship event – World Sustainable Development Summit in February 2020, India's Prime Minister spoke about safeguarding the health of earth by thinking out of the box and investing in the youth of the country. He emphasized on attaining Climate Justice as a measure towards the sustainable climate. He also spoke about India's progress towards attaining the goals set for 2030 at the Paris Agreement in 2015. India's annual renewable energy capacity has been exceeding that of coal-based thermal power since 2017, he mentioned. In addition to this, he said that India to have 220 GW of renewable energy capacity by 2020 and currently, India's renewable energy capacity is 136 GW. In March 2019, the Ministry of Environment, Forests and Climate Change launched the India Cooling Action Plan (ICAP) making India the first country to launch a national plan on sustainable cooling.

The responsibility of successfully tackling climate change does not entirely rely upon the government alone. Laxman Singh, a climate crusader from Rajasthan, has been building water conservation and natural resource management systems in the rural, drought-prone districts of the state since 1977.

Source: Details available at https://www.wionews.com/india-news/india-addressing-climate-change-issue-efficiently-377435

Climate Change

Population exposure to precipitation extremes in the Indus River Basin at 1.5°C, 2°C and 3°C warming levels

Zhao J.-T., B.-D. Su, S. K. Mondal, Y.-J. Wang, H. Tao, and T. Jiang. 2021

Advances in Climate Change Research ISSN: 1674-9278

This study investigates the population exposure to precipitation extremes at 1.5°C, 2°C, and 3°C global warming levels in the Indus River Basin using daily precipitation data and projected population under shared socio-economic pathways (SSPs). In this study, the Intensity–Area–Duration method was applied to detect the extreme precipitation event by tracing the rainstorm process. The calculation was done based on five downscaled and bias-corrected Global Climate Model (GCM) outputs from Coupled Model Inter-comparison Project Phase 5 (CMIP5) under four Representative Concentration Pathways (RCP2.6, RCP4.5, RCP6.0, and RCP8.5). The exposure of the population was estimated by combining SSP1 with 1.5°C, SSP2 with 2.0°C, and SSP5 with 3.0°C warming levels. The results show that warming over the Indus River Basin is projected to be higher than that of the global average. Both the extreme precipitation events and the population exposure are projected to increase with the warming level. With regard to the reference period, i.e., 1986–2005, the frequency, duration, and impacted area of extreme precipitation are projected to increase by 13.2%, 7.4%, and 1.6% annually under 1.5°C in the Indus River Basin, respectively. Whereas, an additional 0.5°C and 1.5°C warming can lead to further increase in the frequency of 16.6% and 17.3%, as well as the duration of 8.6% and 12%, and areal coverage of 2.1% and 5.3%, respectively. The population exposure to extreme precipitation is projected to increase by 72.4%, 122.7%, and 87.6%, respectively, at SSP1 with 1.5°C, SSP2 with 2°C, and SSP5 with 3°C warming levels compare to the reference period. The demographic change is responsible more for the tremendous increment of population exposure in the Indus River Basin. If the population was held constant to the level of 2010, the increase of population exposure would be 4.4%, 8.8%, and 17.6%, respectively, at 1.5°C, 2°C, and 3°C warming levels. Spatially, the prominent increment of population exposure is projected in the central and south-western Indus River Basin. This study highlights that limiting the increase of temperature to 1.5°C can substantially reduce population exposure to extreme precipitation events in the Indus River Basin, compared to an additional warming. Simultaneously, it suggests to formulate policies on population growth to reduce future exposure.

Achieving Paris Agreement temperature goals requires carbon neutrality by middle century with far-reaching transitions in the whole society

Huang, M.-T. and P.-M. Zhai. 2021

Advances in Climate Change Research ISSN: 1674-9278

The concept of carbon neutrality is much emphasized in IPCC's 'Special Report on Global Warming of 1.5°C' in order to achieve the long-term temperature goals as reflected in the Paris Agreement. To keep these goals within reach, peaking the global carbon emissions as soon as possible and achieving carbon neutrality are urgently needed. However, global CO_2 emissions continued to grow up to a record high of 43.1 Gt CO_2 during 2019, with fossil CO_2 emissions of 36.5 Gt CO_2 and land-use change emissions of 6.6 Gt CO_2. In such a case, the global carbon emissions must drop by 32 Gt CO_2 (7.6% per year) from 2020 to 2030 for the 1.5°C warming limit, which is even larger than the COVID-induced reduction (6.4%) in global CO_2 emissions during 2020. Recently, China announced scaling up its national commitments, aiming to peak its CO_2 emissions before 2030 and achieve carbon neutrality before 2060. Achieving these goals requires rapid and far-reaching transitions in the whole society. On the one hand, deeper emissions reduction in all sectors includes decarbonization of energy, electrification, increasing share of renewables, energy efficiency, sustainable land management, decarbonization of transport, reducing food loss and waste, as well as behaviour and lifestyles changes. And, on the other hand, possible actions by reducing CO_2 from the atmosphere involves enlarging land and ocean net carbon sink, CO_2 removal technologies (such as bioenergy with carbon capture and storage), and CO_2 capture, utilization, and storage technologies, but should be caution for their scales and trade-offs.

A novel framework for risk assessment and resilience of critical infrastructure towards climate change

Kumar, N., V. Poonia, B. B. Gupta, and M. K. Goyal. 2021

Technological Forecasting and Social Change ISSN: 0040-1625

The persistent extreme weather events (floods, droughts, heat waves, etc.) are increasing the risks towards critical infrastructure. Therefore, it is essential to enhance the resilience of our critical infrastructure to withstand such events in the present and future. In this publication, a review of current and projected impacts of climate change in context to extreme events and their possible implications on critical infrastructure was carried out. The review suggests that such events can have a severe impact on critical infrastructures. Also, two studies on the behaviour of precipitation extremes and temporal evolution of drought across India were carried out, taking into account the corresponding impact on critical infrastructures. It indicated that north-western, north-eastern, western-most regions, and Western Ghats are highly susceptible to floods and northern, central-eastern, western, and central regions are prone to co-occurrence of floods and droughts. Also, a case study on Kharif paddy yield forecasting using different machine learning models was carried out, for which a random forest was found to be the most suitable model for yield prediction. Finally, the authors put forward a robust framework for risk assessment and improving the resilience of critical infrastructures based upon the principles of flexibility, diversity, and industrial ecology, incorporating both short- and long-term impacts of climate risk.

Renewable Energy

Design optimization of off-grid hybrid renewable energy systems considering the effects of building energy performance and climate change: Case study of Algeria

Mokhtara, C., B. Negrou, N. Settou, B. Settou, and M. M. Samy. 2021

Energy ISSN: 0360-5442

This paper presents a methodology for optimal design of diesel/photovoltaic (PV)/wind/battery hybrid renewable energy system (HRES) for the electrification of residential buildings in rural areas. Contrary to previous work, in this study, the effects of climate diversity and building energy efficiency on the size optimization of HRES are investigated. First, a multi-criteria spatial analysis through a common geographical information system tool (ArcGIS 10.2) was undertaken to develop the renewable energy potential map for Algeria. Then, particle swarm optimization algorithm and ε-constraint method were used to solve the multi-objective problem, which was formulated to minimize the cost of energy (COE) as the primary objective, while maximizing system reliability and a renewable fraction. According to the resulting renewable potential map, seven zones were identified, and then seven locations were selected (one from each zone) to execute the optimization of the proposed HRES. By considering low-efficient buildings, PV/wind/diesel/battery HRES was found as the best configuration for Adrar and Tindouf, while PV/diesel/battery HRES was found best for other locations. However, in the case of high-performance buildings, other optimal HRES configurations were obtained. The better one was acquired in Biskra and Tamenrast, which includes PV battery (100% renewable energy) and fulfilling COE of 0.21 $/kWh.

Clean energy transitions and human well-being outcomes in lower and middle income countries: A systematic review

Liao, C., J. T. Erbaugh, A. C. Kelly, and A Agrawal. 2021

Renewable and Sustainable Energy Reviews ISSN: 1364-0321

In this study, researchers reviewed 107 peer-reviewed articles to examine systematically household energy transitions in lower and middle income countries (L&MICs). The authors considered factors that have a potential causal impact and identified associations between clean energy adoption and household well-being. They found substantial variation in energy transition pathways across L&MICs. Higher levels of household education, incomes, asset holdings, and the presence of credit and subsidy programmes are associated with clean energy adoption, and such adoption likely facilitates a suite of socio-economic benefits. The review thus advances knowledge about the mechanisms for achieving Sustainable Development Goal 7 and promoting greater human well-being through clean energy adoption.

A review of hybrid renewable energy systems in mini-grids for off-grid electrification in developing countries

Come Zebra, E. I., H. J. van der Windt, G. Nhumaio, and A. P. C. Faaij. 2021

Renewable and Sustainable Energy Reviews ISSN: 1364-0321

In this study, hybrid renewable energy systems (HRESs) were analysed, which were designed to overcome the fluctuating nature of renewables, for off-grid electrification. The results of this study – which covers many countries and examples – show that the successful integration of HRES is influenced by factors such as government support and community organization, which is essential to keep these systems operating over the project lifetime. The levelized cost of energy (LCOE) of different mini-grids was compared and analysed. The results reveal that by comparing the LCOE range of diesel (between USD 0.92/kWh and USD 1.30/kWh), solar photovoltaic (between USD 0.40/kWh and USD 0.61/kWh), and hybrid solar PV/diesel (from USD 0.54/kWh to USD 0.77/kWh), diesel is the most expensive technology. Additionally, the study addressed barriers that can hinder the implementation of mini-grids, such as lack of supportive policies and high capital cost. However, governments' incentives are instrumental in lowering capital costs. These results are of particular importance for developing countries, where electricity supply via HRES is often quicker and cheaper than grid extension. The insights from this paper are a good starting point for in-depth research on optimal local design and ownership models which can help accelerate the implementation and lower the costs of sustainable electricity supply in remote areas.

SOLAR ROOFTOP: PERSPECTIVE OF DISCOMS

A study to highlight the perspective of DISCOMs on technical, financial, operational, administrative, and regulatory aspects of solar rooftop systems and on the 'Grid-Connected Solar Rooftop Programme' in India.

Introduction

The Energy and Resources Institute (TERI), with the support of Shakti Sustainable Energy Foundation (SSEF), launched a Distribution Utilities Forum (DUF) that brings together various distribution utilities across India to a single platform to discuss issues and challenges in the distribution sector towards enabling distribution reforms. TERI acts as the secretariat of the Forum.

Despite considerable decline in the cost of solar rooftop installations and cost of per unit electricity discovered through auctions of large projects, along with the advantages which these systems provide, the solar rooftop market has not fully developed. There is a need to accelerate the present deployment rate to realize the potential of solar rooftop in India. Distribution companies (DISCOMs), being at the tail-end of electricity supply chain, constitute a crucial link with the consumers and can, therefore, help accelerate the growth of the solar rooftop sector.

On behalf of the Forum, DUF Secretariat undertook a study to capture the perspective of DISCOMs on the solar rooftop systems. The study is focused on understanding the challenges and opportunities associated with integration of solar rooftop with the distribution network, with respect to technical, financial, operational, administrative, and regulatory aspects. The study also reviews recent literature available on this theme in the country and examines current policies and regulations notified by the central and state governments meant to drive the growth of the sector in the country.

Objective

The study aims to:

- Review the literature on solar rooftop with regard to the technical, financial, operational, administrative, and regulatory aspects of solar rooftop
- Present an overview of DISCOMs' perspective in regard to the aforementioned aspects of solar rooftop implementation
- Highlight key implementation and post-implementation challenges identified by DISCOMs while executing solar rooftop programme
- Present some of the leading operational and institutional best practices that have enabled specific DISCOMs to achieve better progress in implementation of solar rooftop in their license area

Approach & Methodology

The approach adopted to achieve the objectives of this study included a combination of literature review and consultations with DISCOM officials. A total of 10 DISCOMs in 7 states – Delhi, Madhya Pradesh, Gujarat, West Bengal, Assam, Karnataka, and Uttar Pradesh – were selected for consultation. The selection was done with a view to include DISCOMs from states that have larger potential for solar rooftop, different consumer mix, and ownership structure of the utility. The detailed approach and methodology are explained in Figure 1.

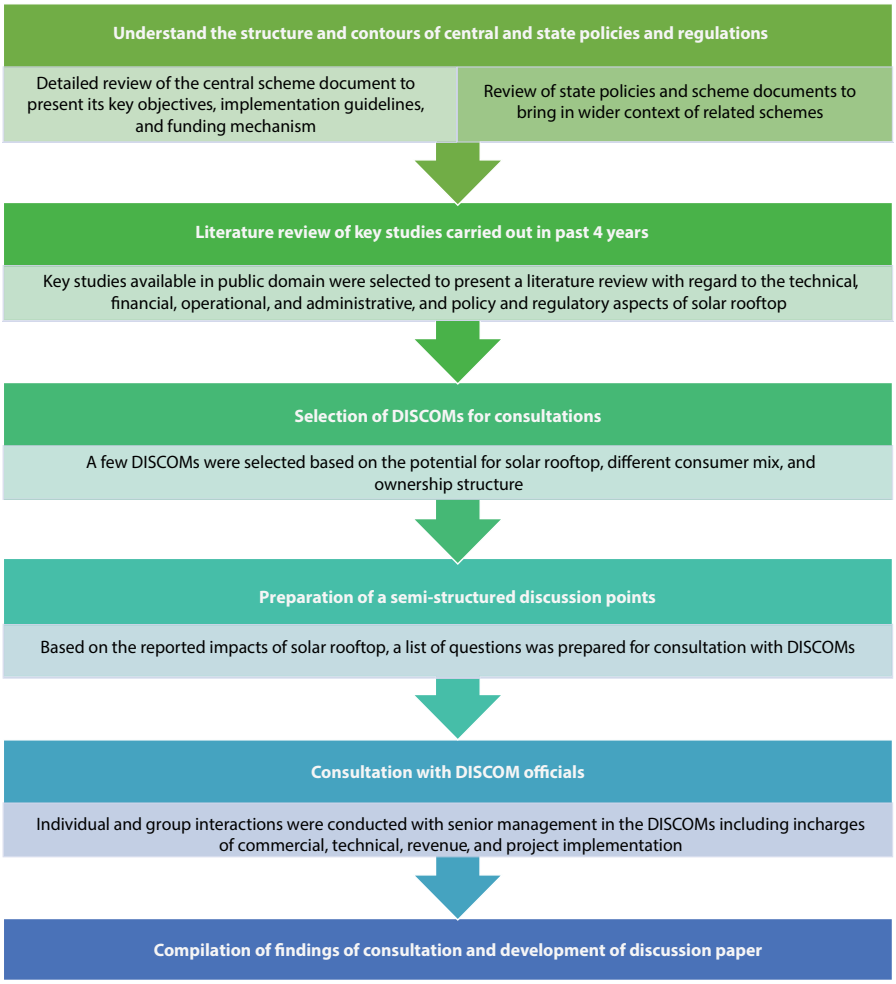

Figure 1. Approach and methodology adopted for the study

Findings of Study

The discussions held at the third DUF meeting and various interactions with key officials of the distribution utilities provided views and perception of the DISCOMs in regard to the implementation of solar rooftop. The study found that all DISCOMs face a common set of challenges in terms of technical, financial, operational, administrative, and regulatory aspects of solar rooftop adoption. While there was a general consensus with regard to quite a few issues/challenges affecting the uptake of solar rooftop, and some of the issues stemmed from state-specific on-ground conditions. According to the DISCOMs, solar rooftop can be a profitable business proposition for them if they are mandated an 'anchor' role in its implementation by the central and/or state government along with regulatory interventions and customized business models.

The key technical, financial, operational, and administrative issues and challenges as well as policy and regulatory aspects identified by the DISCOMs are summarized in Figure 2.

Suggested Way Forward

No single solution to address the issues brought out by DISCOMs in regard to solar rooftop can be suggested. Given the fact that the DISCOMs differ in regard to the technical potential of solar rooftop, consumer mix, and retail tariff for different categories of consumers, etc., DISCOMs may like to adopt a different approach for promotion, facilitation, and implementation of solar rooftop systems. DUF secretariat can take up specific studies of identifying key important issues of respective DISCOM on case-to-case basis and suggest suitable measures to the DISCOMs for the challenges faced by them in implementing solar rooftop. A few suggestions that can facilitate all DISCOMs in uptake of solar rooftop systems are summarized further.

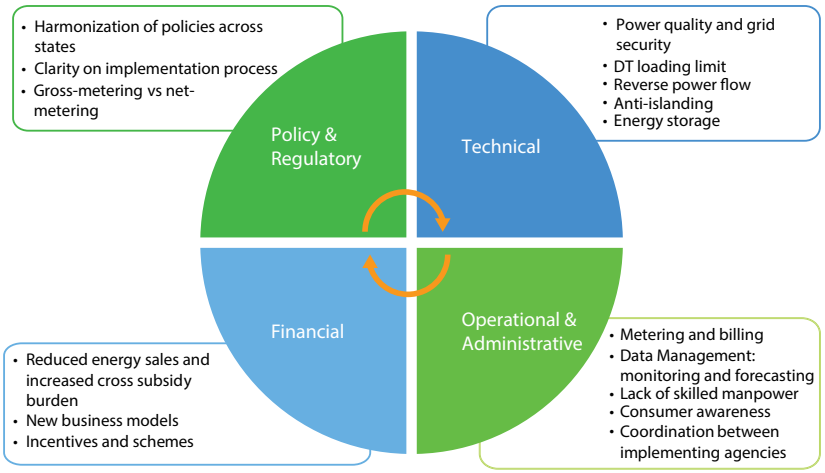

Figure 2. Overview of findings

Technical Studies

To identify different recommendations in regard to various mitigation techniques, DISCOMs may conduct detailed power system simulation studies for representative urban and rural feeders on technical impacts for current levels of solar penetration and rising levels of penetration under various load and PV growth scenarios in the coming years. **DUF secretariat could help in developing a suite of simulation studies in consultation with interested distribution utilities.**

Consumer Awareness and Capacity Building

Capacity building in various aspects of solar rooftop, such as implementation, monitoring, and so on, is also needed. DISCOMs should coordinate capacity building programmes to train their officials on various aspects of solar rooftop systems. The practices and approaches followed by a few DISCOMs in recent times could also help other DISCOMs to draw learnings while moving forward. **DUF secretariat could help in organizing and conducting such workshops and seminars in order to help the DISCOMs.**

New Business Models

To address the challenges faced by the DISCOMs, new business models are required to promote the adoption of solar rooftop systems with DISCOM acting as the anchor. **DUF Secretariat suggests a *'utility-based' business model'* for promotion of solar rooftop systems, as shown in Figure 3.**

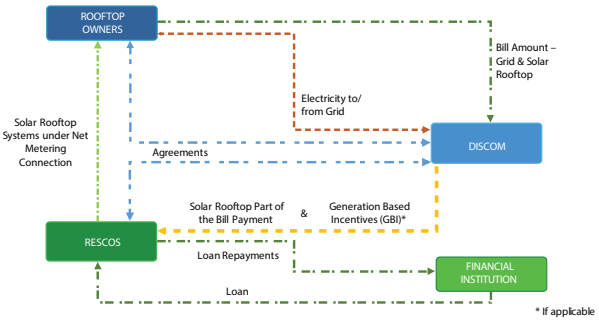

Figure 3. Proposed utility-based business model based on net metering connection

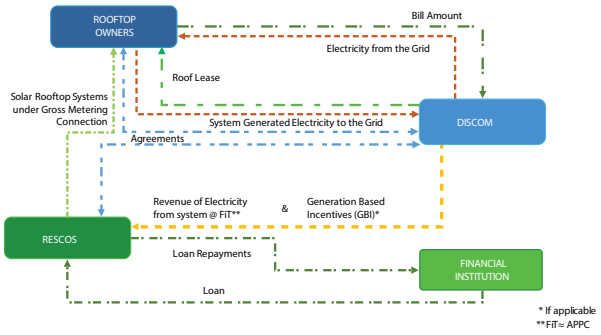

Figure 4. Proposed utility-based business model based on gross metering connection and roof-lease arrangement

Support for DISCOMs

Under the phase II of 'Grid-Connected Rooftop Solar Programme', the Government of India is focusing on increased active participation of DISCOMs with performance-based incentives for solar rooftop capacity achieved in a financial year. The state governments and State Electricity Regulatory Commissions may also revisit their existing programmes, policies, and regulations, so as to encourage the DISCOMs to take a lead role in the implementation of solar rooftop.

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GREEN SKILL DEVELOPMENT PROGRAMME ON SUSTAIN AND ENHANCE TECHNICAL KNOWLEDGE IN SOLAR ENERGY SYSTEMS

Green skills contribute to preserving and restoring the natural environment for a sustainable future. The skills lead to jobs that protect ecosystems and biodiversity, increase efficiency in energy consumption, and minimize waste and pollution. In line with the Skill India Mission of the Hon'ble Prime Minister, the Ministry of Environment, Forest and Climate Change (MoEF&CC), Government of India, utilizing the vast network and expertise of Environment Information System (ENVIS) Hubs/Resource Partners (RPs), has taken up an initiative, named as 'Green Skill Development Programme (GSDP)', for skill development in the environment and forest sector to enable India's youth to earn gainful employment and/or self-employment.

Under this scheme, TERI ENVIS RP conducted a programme, titled 'Sustain and Enhance Technical Knowledge in Solar Energy Systems' in Kolkata, West Bengal for 240 hours or 36 days from February 17 to March 23, 2021. Through this programme, unemployed youth including 10th and 12th dropouts and ITI-qualified candidates are provided an opportunity to learn about solar energy technologies. The course intends to make the participants self-reliant and employable so that they can earn a decent living. The following are the objectives of the training programme:

- Help in understanding and assessing the market needs and skills required to start a carrier in the field.
- Inculcate a step-by-step understanding of the methodology to design a grid-connected photovoltaic (PV) system.
- Help in identifying different types of solar devices, assessment of power, and customization of solar system and its importance.
- Help in acquiring a basic understanding of actual project implementation and design principles of solar PV.

Training Location

The selection of area and ideal training venue is crucial for the necessary outreach and outcomes under this programme. Salt Lake Institute of Engineering and Management Limited (SLIEM), which is part of the prestigious IEM-UEM Group, was selected for this programme. The institute is committed to provide the necessary training and skill competencies through coveted association with various central and state government programmes which aim to deliver employment and livelihood creations for unemployed and underprivileged societies of rural and urban communities, in particular. It has excellent training infrastructure, training equipment, and residential facilities as per the mandate of the programme.

Course module of GSDP

Selection of the Candidates

The training programme was advertised well in advance in a local newspaper, and through pamphlet distribution, targeting major districts of the state. Around 75 students applied for the training programme through online and offline modes. The candidates included 10th/12th dropouts, ITI pass, graduates, postgraduates, etc., who displayed keen interest to be trained on the solar energy systems during the interview. The interview was conducted online on February 12, 2021, for which students were present at SLIEM Institute, Kolkata. The selection of the candidates involved a two-stage process – a) direct interview and b) verification of certificates and experiences.

About the Training

The inauguration of the GSDP training programme was done on February 17, 2021. Participants were made aware of the purpose of the programme as well as the mode of training. Motivational speeches by the guests regarding urgent need of capable and skilled manpower for the development of the solar energy sector were appreciated by the participants. The half-day session witnessed the launch and distribution of the training course module amongst the participants. The entire training programme was spread over 6 weeks comprising 50 sessions. The daily duration of the training programme was 8 hours including 1 hour of lunch break. The total number of hours of the training programme was increased to 250 hours from 240 hours (standard for the training programme). This was done due to inclusion of a few additional subjects by TERI apart from the approved course module under ENVIS programme.

Faculties for the programme included TERI experts, local experts from various institutions/universities, TERI ENVIS team members, and solar industry experts. The total number of theory and practical sessions were 23 and 27, respectively. Practical sessions were designed to strengthen the technical skills of participants. In addition, field visits were organized to provide exposure to the participants of a solar project and solar power plant installation. Their technology exposure and detailed repairing and maintenance sessions included solar water heating, solar street light, solar power plant, solar home light, solar lantern, improved biomass cook stove, solar drinking water, solar pumping, among others. Technical experts from TERI, industry experts from Havells India Ltd, Globe Enterprises, Exide Industries Limited, etc., were engaged in all the practical sessions.

As per the mandate of the training programme, a 1-kW solar PV power plant was procured by TERI. TERI, with support of SLIEM, selected National Highway 34, Doltala, Madhyamgram, Kolkata for setting up of a solar power plant on March 19, 2021. TERI found that the location is ideal for the installation as it will showcase well the benefits of the solar PV system.

Assessment of the Students

In an endeavour to understand the impact of the sessions and gauge the involvement of the participants, regular assessments were conducted by subject experts. It included weekly theoretical and practical assessments and a final assessment.

Glimpses of the inauguration ceremony, wherein participants received the course module

Training sessions and installation activity

Certificate distribution ceremony

Valedictory Session and Certificate Distribution

The programme concluded on a very positive note as every participant was happy, enthusiastic, and positive about their future. The valedictory session of the programme was successfully conducted at SLIEM on March 23, 2021. During the valedictory session, all the students who successfully completed the course were provided certificates in the quest to make them self-reliant and pursue a carrier in the sector. Immensely happy and proud of the learnings acquired during the 250-hour course, the participants expressed their gratitude to TERI and MoEF&CC for this noble initiative; many of them even shared ideas to become entrepreneurs in the field.

1. State-wise installation of waste-to-energy capacity as of December 2020

	Biogas		BioCNG		Power		Total	
State/UT	**Installed capacity (m^3 per day)**	**No. of projects**	**Installed capacity (kg per day)**	**No. of projects**	**Installed capacity (MW)**	**No. of projects**	**Installed capacity (MWeq)**	**No. of projects**
Andhra Pradesh	90,540	7	850		44	19	52	26
Bihar	12,000						1	1
Chhattisgarh			400		0		0	2
Delhi					52	3	52	3
Goa					0	1	0	1
Gujarat	24,800	4	39,538	7	11	10	22	21
Haryana			4250	3	5	3	6	6
Himachal Pradesh	12,000							
Karnataka	58,060	3	9521	3	8	6	15	11
Kerala	2760						0	
Madhya Pradesh	27,014	5	1200		18	5	20	11
Maharashtra	144,636	12	27,723	4	30	16	48	32
Punjab	34,800	5	1847		15	7	18	13
Rajasthan			4000	2	3		4	3
Tamil Nadu	150,218	28			12	8	24	35
Telangana	37,100	5			47	6	50	11
Uttar Pradesh	62,320	6	2000		45	22	50	29
Uttarakhand	73,260	6	5880	2	2	2	9	10
West Bengal	14,000	2						2
Grand Total	**743,508**	**86**	**97,209**	**26**	**291**	**110**	**374**	**219**

Source: Details available at https://renewablewatch.in/, last accessed on April 14, 2021

2. Stand-alone solar pumps installed under Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan (PM-KUSUM) scheme as of December 2020 (in figures)

State/UT	Under previous schemes	Under PM-KUSUM scheme	Total
Andhra Pradesh	34,045		34,045
Arunachal Pradesh	22		22
Assam	45		45
Bihar	2813		2813
Chhattisgarh	61,970		61,970
Delhi	90		90
Goa	15		15
Gujarat	11,522	2	11,524
Haryana	1293	3721	5014
Himachal Pradesh	6	9	15
Jammu & Kashmir	39		39
Jharkhand	4670	130	4800
Karnataka	7420	15	7435
Kerala	818		818
Madhya Pradesh	17,813	5343	23,156
Maharashtra	11,315		11,315
Manipur	40		40
Meghalaya	19		19
Mizoram	37		37
Nagaland	3		3
Odisha	9551	48	9599
Punjab	4413	250	4663
Rajasthan	48,175	5248	53,423
Tamil Nadu	5459	830	6289
Telangana	424		424
Tripura	151		151
Uttar Pradesh	28,650	950	29,600
Uttarakhand	26		26
West Bengal	653		653
Andaman & Nicobar Islands	5		5
Chandigarh	12		12
Puducherry	21		21
Others	609		609
Through NABARD	4012		4012
Total	**256,156**	**16,546**	**272,702**

Source: Details available at https://renewablewatch.in/, last accessed on April 13, 2021

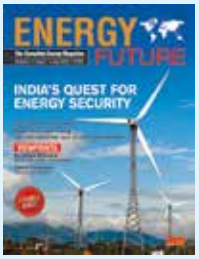
3. State-wise renewable energy production from 2018–19 to 2020–21

States	2018–19	2019–20	2020–21 (up to December 2020)
Chandigarh	13.51	13.33	6.57
Delhi	287.64	423.69	329.90
Haryana	662.36	733.50	529.75
Himachal Pradesh	2287.93	2167.24	1981.56
Jammu & Kashmir	312.20	443.13	373.28
Punjab	2445.20	2739.42	2177.96
Rajasthan	11,863.40	14,332.06	12,652.29
Uttar Pradesh	5694.81	5143.21	3388.06
Uttarakhand	1104.97	1193.95	1027.35
Chhattisgarh	945.10	1107.87	1131.96
Gujarat	13,966.18	17,716.92	13,526.60
Madhya Pradesh	8257.15	8297.87	6465.47
Maharashtra	14,974.88	13,985.79	9971.78
Dadra & Nagar Haveli	5.76	6.19	3.99
Daman & Diu	18.94	21.83	26.55
Goa		0.82	1.06
Andhra Pradesh	14,550.51	13,993.20	10,626.31
Telangana	7045.99	6794.23	5004.51
Karnataka	21,657.54	25,648.42	21,316.37
Kerala	770.32	804.75	892.87
Tamil Nadu	16,898.49	19,763.89	18,238.43
Lakshadweep	1.11	0.66	0.36
Puducherry	2.58	4.15	3.33
Andaman & Nicobar Islands	30.43	17.30	30.63
Bihar	488.14	358.68	185.54
Jharkhand	21.72	24.18	20.54
Odisha	653.43	783.20	668.33
Sikkim	28.11	60.62	44.12
West Bengal	1486.19	1475.04	1113.57
Arunachal Pradesh	1.75	2.23	1.53
Assam	20.73	58.76	31.85
Manipur	1.88	4.20	5.86
Meghalaya	50.51	62.73	41.26
Mizoram	40.08	50.00	30.76
Nagaland	87.46	75.87	57.89
Tripura	82.08	28.10	9.52
Total	**126,759.09**	**138,337.02**	**111,917.72**

Source: Details available at https://renewablewatch.in/; last accessed on April 14, 2021

ENERGY FUTURE

The Complete Energy Magazine



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