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नवीकरणीय ऊर्जा मंत्रालय
MINISTRY OF
NEW AND
RENEWABLE ENERGY

सत्यमेव जयते

Renewable Energy Akshay Urja

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Renewable Energy
Akshay Urja

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From the **Editor's Desk...**

Dear readers,

Wish you all a very Happy New Year, 2025!

The winter season in this part of the world generally assembles a number of bright minds in the scientific and academic world to discuss and deliberate on the pressing issues of the world. In the fields of climate change and renewable energy, there have been a few notable ones in which the MNRE and the Government of India were seriously involved.

At the top is the recently concluded COP29 in Baku. As the world grapples with the urgent need for climate action, the focus on renewable energy has never been more vital. Baku underscored the critical role of climate finance, emphasizing the need for robust mechanisms to bridge the gap between ambition and action. The cover story brings to you an overview of COP29.

The Research and Development 20 (RD20) summit held in New Delhi brought together G20 nations to foster collaboration in clean energy research and innovation. The event highlighted advancements in hydrogen technologies, energy storage systems, bioenergy, and smart grid solutions, among others. RD20 has called for collaborative R&D initiatives between and among G20 nations.

Energy storage remains a cornerstone of the renewable energy revolution. *Akshay Urja* has captured the key takeaways from the workshop held on this subject for its readers. The 16th GRIHA Summit held in New Delhi has pushed for climate action in the built environment through renewable energy integration.

The Chintan Shivir brought together policymakers, industry leaders, and experts to deliberate on strategies for India's energy transition. One of the key takeaways was the proposal to establish 'Renewable Energy Hubs' across the country. These hubs aim to integrate generation, storage, and distribution systems while creating employment opportunities and boosting local economies.

Apart from stories covering major events, there is a story on plasma pyrolysis and gasification technologies to tackle the environmental challenges emanating from waste.

The convergence of global and national efforts demonstrates a shared commitment to combating climate change. By continuing to prioritize renewable energy, energy storage, and sustainable development, India and the world are poised to achieve a resilient and sustainable energy future.

May the year 2025 strengthen our resolve further to work for a 'greener world' through renewable energy!

Best wishes

Arun K Tripathi

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RENEWABLE ENERGY NEWS

MP CABINET APPROVES SOLARISATION OF ALL RURAL FEEDERS TO CUT SUBSIDY BURDEN

In an effort to reduce power subsidies and alleviate the financial burden of upgrading power substations, the Madhya Pradesh cabinet has approved a proposal to solarise all 11 KV feeders in the state. The solar-powered 11 KV feeders will provide last-mile electricity supply to farms, effectively making it free for farmers. This move is expected to reduce the subsidy burden on power distribution companies, which currently offer cheaper or free electricity to agricultural consumers. According to an official statement, once the scheme is implemented, farmers will receive electricity during the day for irrigation, helping them better organise their schedules and improve their lifestyle.

Source: https://www.business-standard.com/india-news/mp-cabinet-approves-solarisation-of-all-rural-feeders-to-cut-subsidy-burden-124122600921_1.html

RECORD RE ADDITION OF 30 GW, POLICY PUSH FOR STORAGE, HYBRID ENERGY

As per Deloitte, FDI in the renewable sector increased by 50% to $3.76 billion in 2023-24. Cumulative disbursements by PFC, REC, and IREDA reached Rs 3,14,200 crore in 2023-24, up 71.1% on year. India made significant progress in the renewable energy (RE) sector in 2024 with total RE capacity reaching 205.5 GW as of November in the current fiscal year 2024-25. To achieve the target of 500 GW non-fossil fuel capacity, the government has adopted multifaceted strategy. Apart from rapid RE capacity addition, this includes streamlining the supply chain, bringing in hybrid and storage solutions, and strengthening the domestic production of raw materials. However, even as meeting peak demand looks a lot easier, grid integration of RE emerged as a critical challenge, with variable generation exceeding 30% in several states, necessitating sophisticated grid management systems and enhanced forecasting capabilities. Also, the debt of electricity discoms is still on the rise. Major capacity additions were bolstered by solar power projects which stood at 94.17 GW as of November, data from the Central Electricity Authority showed.

Source: https://www.financialexpress.com/business/industry-record-re-addition-of-30-gw-policy-push-for-storage-hybrid-energy-3699980

GOVERNMENT SIGNS $500 MN LOAN DEAL WITH ADB TO BOOST GREEN INFRA PROJECTS

The Centre and Asian Development Bank (ADB) has signed a $500 million (about Rs 4,250 crore) loan to support green and sustainable infrastructure projects aligned with the country's climate commitments. The ADB loan, with a sovereign guarantee, will be extended to the India Infrastructure Finance Company Ltd (IIFCL), the finance ministry said in a statement on 23 December 2024. The signatories to the Financing Environmentally Sustainable Growth in Infrastructure Project were Ms Juhi Mukherjee, Joint Secretary, Department of Economic Affairs, Ministry of Finance, and Country Director Ms Mio Oka for ADB.

Source: https://www.tribuneindia.com/news/business/government-signs-500-mn-loan-deal-with-adb-to-boost-green-infra-projects/

INDIA'S RE CAPACITY REGISTERS 14.2% YEAR-ON-YEAR GROWTH: TOTAL RE INSTALLED CAPACITY REACHES 213.70 GW; SOLAR GROWS BY 30.2%

Ministry of New and Renewable Energy (MNRE) has reported significant progress in India's renewable energy sector from November 2023 to November 2024. As of November 2024, the total non-fossil fuel installed capacity has reached 213.70 GW, marking an impressive 14.2% increase from last year's 187.05 GW. Meanwhile, the total non-fossil fuel capacity, which includes both installed and pipeline projects, surged to 472.90 GW, a substantial 28.5% increase from the previous year's 368.15 GW. During FY 24-25 a total of 14.94 GW of new RE capacity was added till November 2024, nearly doubling the 7.54 GW added during the same period in FY 23-24. In November 2024 alone, 2.3 GW of new capacity was added marking a dramatic fourfold increase from the 566.06 MW added in November 2023.

Source: https://pib.gov.in/PressReleasePage.aspx?PRID=2083317

MNRE ANNOUNCES SIGNIFICANT AMENDMENT TO ALMM ORDER 2019 TO ADVANCE SOLAR MANUFACTURING

Ministry of New and Renewable Energy (MNRE) has announced a significant amendment to the Approved Models and Manufacturers of Solar Photovoltaic Modules (ALMM) Order, 2019 which will have far-reaching implications for India's solar power sector and its clean energy transition. This amendment, set to take effect from 1 June 2026, introduces the long-awaited List-II for solar PV cells under the ALMM framework, marking a major step towards boosting domestic manufacturing and fostering self-reliance in India's renewable energy industry. All solar PV modules used in projects including government-backed schemes, net-metering projects, and open access renewable energy initiatives will be required to source their solar cells from ALMM List-II, ensuring quality and reliability in solar PV cells used in India's energy infrastructure.

Source: https://mnre.gov.in/

CENTRE APPROVES 2 GW SOLAR PARK FOR RAJASTHAN

The Centre has approved a 2,000-MW solar energy park in Rajasthan with central financial assistance of 30% of the cost, Union Minister for New and Renewable Energy, Shri Pralhad Joshi on said on 9 December 2024. Addressing a session on Transition Towards a Sustainable Energy Economy at the 'Rising Rajasthan Summit' in Jaipur, the minister lauded the recent launch of Rajasthan's Integrated Clean Energy Policy 2024, which aims to achieve 125 GW of renewable energy capacity by 2030.

Source: https://economictimes.indiatimes.com/industry/renewables/centre-approves-2-gw-solar-park-for-rajasthan/articleshow/116149565.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst

COP29: Key Takeaways

COPs continue to overlook the reality that climate action is a global common good – without binding financial agreements such as the NCQG. Without significant funding on the table, the lofty promises of climate finance remain hollow, pushing meaningful progress further out of reach. Read Chandra Suman's take on the recently held COP29 at Baku.

The United Nations Framework Convention on Climate Change (UNFCCC) negotiation process, held annually at the Conference of the Parties (COP), is the world's foremost platform for addressing climate change. Bringing together nearly 200 countries, amongst other stakeholders, it serves as a critical space where global leaders, climate stakeholders, and civil society converge to shape climate action. Through intense negotiations, COP drives forward ambitious agreements, such as the Paris Agreement, which set the goal to limit global warming to well below 2 °C. At its core, the COP is about balancing equity, responsibility, and urgency – paving the way for transformative policies and collective efforts to combat climate change and protect future generations.

Renewable energy acceleration is inextricably linked to the progress made through the UNFCCC negotiation process, as the global climate action framework forms the foundation for the policies and investments needed to transition to a sustainable, low-carbon future.

The 29th COP to the UNFCCC was held in Baku, Azerbaijan, in November 2024. The outcomes of COP29 serve as both a reflection of the challenges we face and a call to action. While most newspapers covered only the protests at the concluding plenary but there is more to the process that shapes the climate action globally. Here is an agenda wise insider scoop on Baku.

I. United Arab Emirates Just Transition Work Programme (JTWP)

The Just Transition Work Programme (JTWP) is a key agenda item aimed at facilitating a fair transition towards sustainable development, aligned with the Paris Agreement's principles. The agenda item has sparked varied interpretations, with some Parties

emphasizing workforce-centric elements, while others advocate for a broader, equity-based approach.

The G77 and China maintained a unified stance, advocating for a negotiation text based on a compilation of all Party inputs. Meanwhile, the African Group of Negotiators (AGN), Arab Group, and Like-Minded Developing Countries (LMDC) proposed an alternative text, calling for a Work Plan tied to specific outcomes. By the end, the Alliance of Small Island States (AOSIS) diverged from the G77 and China position on the JTWP. India emphasized a JTWP aligned with the Paris Agreement, emphasizing nationally determined contributions (NDCs) and the principles of Equity and Common but Differentiated Responsibilities and Respective Capabilities (CBDR-RC). India also opposed a narrow, workforce-focused definition of Just Transition and the creation of a structured Work Plan, favoured by some Parties, including within the developing countries.

During COP29, the divisions deepened. Developed countries, particularly the European Union (EU) and the Environmental Integrity Group (EIG), prioritized mitigation strategies, while developing nations, including the G77 and China, emphasized the need for stronger focus on adaptation and financing. Contentious issues included calls for an actionable workplan supported by international cooperation. Further discord arose over incorporating human rights and linking measures to broader climate targets. Developed countries also resisted language opposing unilateral, trade-restrictive actions. In the final days, attempts to revive negotiations through revised texts and last-minute sessions proved ineffective.

COP29 concluded without an agreement on the Just Transition Work Programme (JTWP), a significant setback for advancing equitable climate policies.

II. Sharm el-Sheikh Mitigation Ambition and Implementation Work Programme

In November 2021, by Decision 1/CMA3, para. 27, Parties established a work programme to urgently scale up mitigation ambition and implementation in this critical decade in a manner that complements the global stocktake. Four events focused on Dialogues and Investments have been held under Mitigation Work Programme (MWP) so far.

At COP29, disagreements emerged over integrating global stocktake outcomes with NDCs. Developed nations pushed for including fossil fuel transitions in NDCs, while developing countries, including the LMDCs and the Arab Group, resisted what they saw as an overreach beyond the MWP's mandate. Developing nations opposed prescriptive measures like phasing out coal and fossil fuel subsidies, arguing for a focus on dialogue rather than top-down targets. Despite efforts to revive discussions, no consensus was reached in the first week, and second-week revisions reaffirmed NDCs but omitted references to stocktake outcomes and fossil fuels. The final draft, released on

November 22, softened the language, omitted 1.5 °C targets, and emphasized procedural continuation, reflecting the divide between developed and developing countries. The decision was adopted, underscoring ongoing geopolitical tensions.

III. Article 6

COP29 concluded with an agreement on carbon trading under Article 6 of the Paris Agreement, marking the end of longest of intricate negotiations.

Article 6.2: An agreement on Article 6.2 provides a clearer foundation for cooperative trading between nations, enhancing transparency and accountability. This decision mandates more detailed reporting, addressing concerns about potential opacity in carbon credit exchanges. Importantly, the agreement restricts modifications to carbon credits after their initial transfer unless mutually agreed upon, addressing industry concerns about market stability and private sector participation. The dual-layer registry system established under Article 6.2 aims to support countries without national infrastructure for tracking carbon credits. However, the enforcement mechanisms for addressing inconsistencies remain relatively weak, a point of contention for stakeholders seeking stronger compliance measures.

Article 6.4: The newly established Paris Agreement Crediting Mechanism (PACM) under Article 6.4 introduces a standardized framework for carbon credits, aiming to align with global climate goals. The framework has been hailed as a breakthrough, but concerns persist about its alignment with the Paris Agreement and its robustness, especially regarding carbon removals and methodologies. Despite progress at COP29, following setbacks at COP25 and COP28, observer groups remain wary of its effectiveness. The mechanism includes safeguards like sustainable development tools and baseline adjustments to prevent high emissions. The supervisory body continues refining methodologies for carbon reduction, with the first expected by late 2025, while guidelines for issues like nature-based solution reversals are also in development.

Article 6.8: The discussions on non-market approaches under Article 6.8, reinforcing the broader spectrum of cooperative climate actions beyond market mechanisms.

IV. Further Guidance on Features of NDCs

This agenda item, originating from the 2018 COP decision in Katowice, initially appeared to be a technical or routine matter. However, it has become a point of contention as some developed countries, notably led by Switzerland and the United States, sought to introduce guidance on 'features' of future NDCs. These proposed features were aimed at embedding specific elements related to mitigation targets into the NDCs of Parties, potentially shifting the framework towards a more prescriptive approach.

At COP29, developed countries like Norway and South Korea expressed concerns that new measures could undermine the voluntary nature of NDCs in the Paris Agreement, while some developing nations, including LDCs, AILAC (Independent Association of Latin America and the Caribbean [La Asociación Independiente de América Latina y el Caribe – AILAC], and SIDS (Small Island Developing States), supported the proposals. In contrast, the Arab Group and other developing countries opposed any top-down measures, fearing they would infringe on national determination.

India warned that such efforts could harm international cooperation and erode trust, stressing the importance of upholding the Paris Agreement's core principles.

V. New Collective Quantified Goal

At COP29, a new global climate finance target was set, with developed nations expected to lead efforts in raising $300 billion annually for developing countries by 2035. This target is part of the 'New Collective Quantified Goal on Climate Finance' (NCQG), which builds upon the $100 billion per year commitment made under the Paris Agreement, aiming for a broader, more substantial funding approach. The NCQG will source funds from various channels, including public finance, development bank loans, and private investments mobilized through government expenditure.

The climate finance issue has been a persistent point of contention. Developing nations, particularly in the Global South, require substantial financial support to transition to greener economies and address climate change impacts. Historically, only 24 developed countries, including the US, EU, and Japan, have been required to provide climate finance, with efforts to include the private sector and other contributors. However, developing countries have been firm in their demand for these funds to come predominantly from developed nations.

The NCQG stipulates that at least $1.3 trillion should be raised annually by 2035, combining contributions from both public and private sources. Unlike the earlier $100 billion target, the new goal also allows for voluntary contributions from countries that had not previously provided climate finance, such as China. This expansion has led to tense negotiations, particularly regarding whether the funds should include loans, grants, or solely government-provided financial assistance.

Intense discussions marked the lead-up to COP29, with various proposals debated. One favoured by developing countries suggested that developed nations should contribute trillions of dollars to help fund climate mitigation and adaptation efforts in the Global South, focusing primarily on public financial support, with additional mobilized private investments. On the other hand, developed countries favoured a more expansive goal that could incorporate a wider range of financial sources, including private investments, which they argued were essential for scaling up climate action.

Tensions increased as countries disagreed on the framework for the goal. Developing nations rejected an initial draft, calling for a stronger emphasis on direct financial contributions rather than investments and loans. There was also widespread resistance to the idea of including wealthy developing countries in the financial responsibility. As negotiations continued, some developed countries expressed dissatisfaction with the

proposed figures, and there was no clear agreement on the exact amounts or structure of the finance goals.

Ultimately, after extensive negotiations and revisions, a new draft emerged that set a core goal of raising at least $300 billion annually, alongside a broader $1.3 trillion target, with contributions from both developed and developing countries. This new text emphasized the flexibility (read requirement albeit voluntary) for countries to voluntarily contribute without losing their developing status, a key point for many emerging economies.

The NCQG also introduced a new mechanism – the "Baku to Belém roadmap" – to set a clear pathway towards reaching the $1.3 trillion goal by the next COP30. The outcome of COP29 reflects a significant shift towards a more inclusive and flexible climate finance framework but remains a work in progress, with ongoing debates over how best to structure and mobilize funds to support the global climate transition.

VI. Global Stocktake and UAE Dialogues

At COP 28 in Dubai Global Stocktake of NDCs happened (supposed to take place every five years to take stock of progress). It was supposed to be followed with the UAE Dialogues to track the progress. At COP29, billed as the 'finance COP,' intense debates arose over the follow-up to the climate commitments made during COP28, particularly regarding the global stocktake and the transition away from fossil fuels. The UAE dialogue, created under the outcomes of COP28's stocktake, was central to these discussions. However, divisions among Parties quickly became apparent, with disagreements on whether the dialogue should focus solely on finance or also include broader issues such as fossil fuel transitions. Some countries, particularly from the EU and vulnerable regions, pressed for a comprehensive follow-up to the stocktake outcomes, including explicit references to fossil fuel transition and the 1.5 °C climate goal.

Ultimately, the COP29 presidency proposed postponing a decision until June 2025, at the Bonn talks, with the hope of reaching a resolution at COP30. (No decision is better than bad decision considering what happened in NCQG). While some observers noted the rejection of low-ambition texts as a positive development, there were concerns about the lost momentum in the transition away from fossil fuels and the lack of concrete progress on climate finance.

VII. Overall Reflection

While India may claim a moral victory owing to the strong stance at the plenary taken by NCQG negotiators of India and its wide media coverage, the reality is that COP29 has resulted in a deeply flawed deal and a long lock-in period. Although the agreement touts a $1.3 trillion climate finance commitment, the practical implications are far less promising. Only $300 billion of this amount is expected to come in the form most needed by developing countries – grants and low-interest loans from developed nations. Meanwhile, the annual Sustainable Development Goals (SDGs) investment gap in developing countries has ballooned to an alarming $4 trillion, jeopardizing the very foundation of sustainable development. Of this, $2.2 trillion annually is required solely for the energy transition, a crucial pillar in the fight against climate change totally undermined in negotiation approach.

COPs continue to overlook the reality that climate action is a global common good – without binding financial agreements such as the NCQG. Current NCQG imperils our climate approach as given wider news items on outcomes nations like India may simply choose inaction. Which means that our children will continue to bear the heavy burden of deteriorated natural resources and the private sector investing less and less in tangible mitigation and adaptation efforts. Without significant funding on the table, the lofty promises of climate finance remain hollow, pushing meaningful progress further out of reach.

Chandra Suman
Director, Ministry of New and Renewable Energy, Government of India

Readers of *Akshay Urja* are encouraged to contribute your stories about technology, and innovations, along with your views on future developments in the renewable energy sector. Contributions can be 400, 800, or 1600 words long, accompanied by high-resolution photographs that complement your story. Please write to:

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India Hosts the RD20 Summit

RD20 (Research and Development 20) is a global framework that was constituted in 2019 to foster international collaboration in clean energy technologies among G20 countries. Leading G20 research institutions come together under the RD20 framework to facilitate the sharing of renewable energy R&D efforts, experiences, and best practices among nations and regions. It also provides a forum for investigating collaborative research opportunities and forming new alliances between and among governments, academia, and businesses.

G20 Member Organizations of RD20 Framework

Instituto Nacional de Tecnologia Industrial (INTI) Argentina • Commonwealth Scientific and Industrial Research Organization (CSIRO) Australia • Universidade Federal de Sao Carlos (UFSCar) Brazil • National Research Council Canada (NRC) Canada • Dalian Institute of Chemical Physics, Chinese Academy of Sciences (CAS-DICP) China • Joint Research Centre (JRC) EU • Centre national de la recherché scientifique (CNRS) France • Commissariat a l'energie atomique et aux energies alternataives (CEA) France • Fraunhofer Institute for Solar Energy Systems (Fh-ISE) Germany • The Energy and Resources Institute (TERI) India • National Research and Innovation Agency (BRIN) Indonesia • Italian National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA) Italy • Centre for Research and Advanced Studies of the National Polytechnic Institute (CINVESTAV) Mexico • Korea Institute of Energy Research (KIER) Korea • King Abdullah City for Atomic and Renewable Energy (KACARE) Saudi Arabia • Council for Scientific and Industrial Research (CSIR) South Africa • TUBITAK Marmara Reserch Center (TUBI TAKMAM) Turkey • UK Energy Research Centre (UKERC) UK • National Renewable Energy Laboratory (NREL) USA • National Institute for Materials Science (NIMS) Japan • RIKEN Japan • National Institute of Advanced Industrial Science and Technology (AIST) Japan

6th RD20 International Conference in Clean Energy Technologies

TERI and MNRE (Ministry of New and Renewable Energy), Government of India, co-hosted the 6th RD20 International Conference in India during 2–6 December 2024 at the India Habitat Centre in New Delhi. This historic global conference brought together 64 research leaders from leading G20 research institutions as well as subject matter experts from Indian government, academia, and industry. The forum enabled experts to exchange ideas and best R&D practices related to clean energy technologies as well as to identify R&D priorities in the subject domain.

The conference comprised three Technical Sessions, a Leaders' Session, three Closed Door Workshops, and one Technical Site Tour to MNRE, NISE (National Institute of Solar Energy), and TERI GRAM biofuel laboratory facilities.

L–R: Dr Haruhiko Obara, Dr Vibha Dhawan, Shri P K Singh, Dr William Tumas, Dr Hebling Christopher

Opening Session

Dr Vibha Dhawan, Director General, TERI, opened the conference by welcoming the delegates. Shri P K Singh, Secretary, MNRE, delivered the inaugural address. He stated that the conference's focus on biofuel, bioenergy, and green hydrogen is extremely important if we aspire for a cleaner and greener world. The other dignitaries who spoke at the opening session included (a) Dr Haruhiko Obara from Advanced Industrial Science and Technology (AIST) Japan; (b) Dr Bill Tumas from National Renewable Energy Laboratory (NREL), USA; and (c) Dr Christopher Hebling from Fraunhofer, Germany.

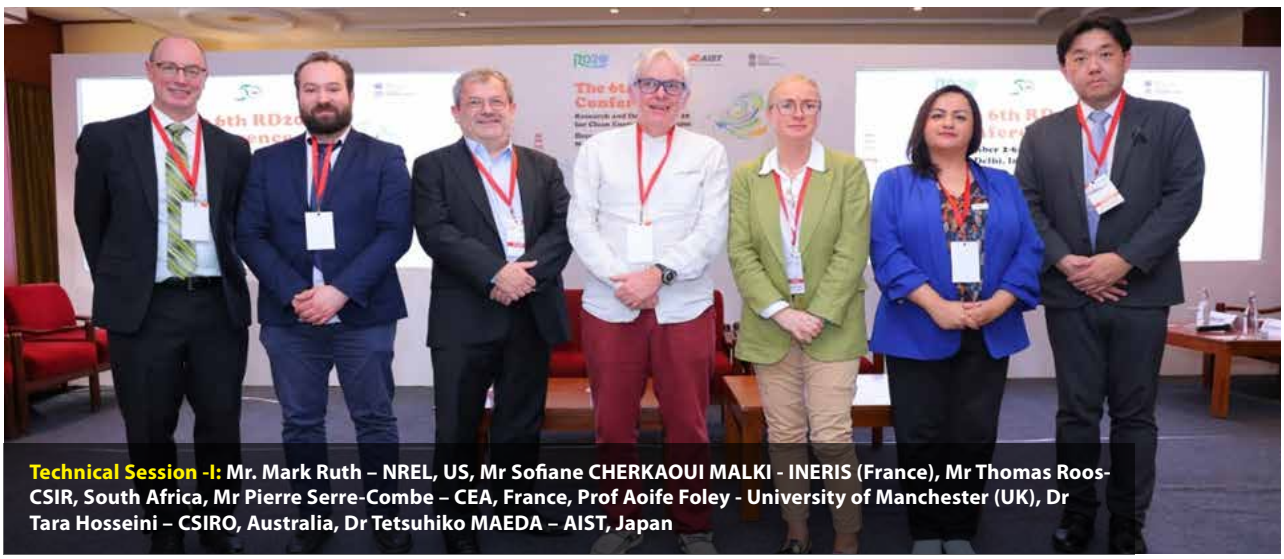
Technical Sessions

The first technical session focused on 'Addressing Technical Barriers to Hydrogen Implementation'. The session was led by Mr Pierre Serre-Combe (CEA, France) and Mr Mark Ruth (NREL, USA).

Key outcomes of the first technical session included identifying shared priorities such as multicriteria decision-making, safety tools, and TRL harmonization, with a proposal for an RD20 task force to focus on these. While no single priority was finalized, volunteers expressed interest in collaborative efforts, suggesting the need to align with other RD20 task forces and technical sessions for impactful progress. The session highlighted global perspectives and experiences in hydrogen technologies, including safety, decision analysis, and project demonstration.

The second technical session was on **'Sustainable Biofuels and Biochemicals'.** Dr Sanjukta Subudhi (TERI, India), Dr David Harris (CSIRO, Australia), and Dr Randy Cortright (NREL, US) led the session.

The deliberations of this technical session focused on R&D leads and achievements in this domain among G20 countries. Key goals identified include promoting commercial deployment, achieving complete biomass valorization, and ensuring process sustainability. Challenges highlighted are feedstock availability, cost, and the need for standardization across sectors like aviation and shipping. The session underscored integrating biofuel production with high-value biochemicals for zero-waste processes and reducing costs. It advocated adopting multiple technological pathways (e.g., Alcohol to Jet) and performing lifecycle and



Technical Session -I: Mr. Mark Ruth – NREL, US, Mr Sofiane CHERKAOUI MALKI - INERIS (France), Mr Thomas Roos-CSIR, South Africa, Mr Pierre Serre-Combe – CEA, France, Prof Aoife Foley - University of Manchester (UK), Dr Tara Hosseini – CSIRO, Australia, Dr Tetsuhiko MAEDA – AIST, Japan

Technical Session-II: Mr Ravi Gupta, General Manager, IOCL Bioenergy R&D Center, India, Prof. Sary Awad from CNRS-IMT Nantes, France, Dr Vibha Dhawan, (DG, TERI, India), Dr Mitsuharu Oguma – AIST, Japan, Dr Rachel Martins Henriques, EPE, Brazil, Dr Sanjukta Subudhi, TERI, India, Dr Randy Cortright (top row), NREL, US, and Prof David Harris (bottom row), CSIRO, Australia)

techno-economic analyses for greener, scalable solutions.

The third technical session dwelled on the topic **'Sustainability, Circularity, and Resilience in R&D'.** Prof. Myriam Merad (CNRS, France) and Dr Liz Doris (NREL, USA), as chairpersons, steered the deliberations of this session.

Dr A K Tripathi (Senior Advisor, MNRE), in his plenary talk, highlighted the critical role of RE in achieving sustainability goals. Dr (Ms) Myriam Merad, Research Director at the French National Centre for Scientific Research (CNRS) and affiliated with the LAMSADE laboratory at Université Paris Dauphine, explored the philosophical underpinnings and operational strategies necessary for achieving sustainability and resilience in energy transitions.

This session laid emphasis on (a) integrating the principles of sustainability, circularity, and resilience in R&D into energy transition strategies; (b) tackling regional and global challenges, public policy dynamics, and innovations that drive sustainable energy transitions; and (c) analytics for responsible R&D, public engagement observatories, and resilient infrastructure to address disparities and extreme conditions.

Technical Session-III: Dr Alberta Carpenter, NREL, US, Mr Thomas Roos- CSIR, South Africa, Dr Myriam MERAD (CNRS, France), Dr Tara Hosseini – CSIRO, Australia, Dr Keiichiro Sakurai, AIST, Dr Vibha Dhawan, DR TERI, India

Leaders Session (Open Session)

The Leaders Session on the second day of RD20 brought together global policymakers, researchers, and thought leaders to discuss collaborative pathways for clean energy transitions. The session was moderated by Dr Vibha Dhawan (TERI) and Dr Haruhiko Obara (AIST). Shri Sudeep Jain, Additional Secretary, MNRE, gave the 'Special Address', in which he highlighted the significant progress made by India in RE.

Mr. Takashi Naruse (NEDO) and Shri Abhay Bakre, Director General of the Bureau of Energy Efficiency, Government of India, delivered plenary presentations. Dr. William Tumas, Associate Laboratory

Director at NREL, USA, provided an update on the RD20 status and its ongoing activities. He also highlighted the RD20 Summer Schools initiative, which aimed to equip young researchers from G20 countries with advanced knowledge in decarbonization and sustainable energy transitions.

Representing the RD20 Secretariat, Dr Kiyotaka Tsunemi, Director of the Zero Emissions Research Planning Office in the Energy and Environment Area at the National Institute of Advanced Industrial Science and Technology (AIST), shared the highlights of the RD20 Tokyo Symposium and COP29 Seminar.

Mission Innovation (Clean Energy Ministerial and G20): Opportunities for Collaboration

Dr Michio Kondo (AIST) moderated this session. Dr Vineet Saini of the Department of Science and Technology, Government of India, provided India's perspective on 'Mission Innovation' highlighting the various innovative programmes undertaken by MNRE.

Speaking on the occasion, Professor (Dr) Michio Kondo – the Supervisory Innovation Coordinator at the Fukushima Renewable Energy Institute, National Institute of Advanced Industrial Science and Technology (AIST), Japan – highlighted the collaboration opportunities between RD20 and Mission Innovation. Ms Helen Fairclough – Collaborative Research and Innovation Specialist & Member of Mission Innovation Secretariat Team – provided an overview of Mission Innovation.

Dr (Ms) Rachel Martins Henriques, who is associated with the Energy Research Office at the Brazilian Ministry of Mines and Energy, presented Brazilian perspectives on the collaboration opportunities between Mission Innovation and RD20.

Workshops

Three workshops were organised. In the Workshop of Sustainable Biorefinery, Dr Vibha Dhawan, DG, TERI; Dr (Ms) Sanjukta Subudhi, Associate Director, TERI's Advanced Biofuel Division; and Shri Sanjay Ganjoo from IFGE, India, spoke about various issues and opportunities surrounding bioenergy. Dr Sangita Kasture, from MNRE presented an overview of India's Bioenergy Programme.

In the second 'Workshop on Hydrogen Techno-economic Assessment', Dr Mark Ruth from NREL and Dr Sujit Pillai from MNRE provided deep insights into the latest developments in this area.

In the third 'Workshop on Sustainability, Circularity, Social Acceptance', Dr Myriam Merad gave the opening remark and discussed briefly about various sustainability challenges of R&D in the clean energy domain to identify R7D priorities.

Conclusion

- Intense discussions and deliberations over the five days event helped the research leaders to share their best learning practices and challenges in clean energy technologies and to identify R&D priorities.
- The technical session on green hydrogen highlighted global perspectives and experiences in hydrogen technologies, including safety, decision analysis, and project demonstration. Key outcomes included identifying shared priorities such as multicriteria decision-making, safety tools, and Technology Readiness Level (TRL) harmonization for country-/region-wise cost economics analysis of green hydrogen production in gigaton scale. To execute these tasks specific task forces were constituted among RD20 member institutions of G20 countries. While no single priority was finalized, volunteers expressed interest in collaborative efforts, suggesting the need to align with other RD20 task forces and technical sessions for impactful progress.
- Technical session of Sustainable Biofuels and Biochemicals focused on large scale deployment of bioprocesses for biomass valorisation, advanced biofuel production from agriculture residue biomass and oil based feed. Challenges highlighted are feedstock availability, cost, and the need for standardization across sectors like aviation and shipping. To foster this, a specific Biofuel task force has been constituted to identify common R&D priorities for joint research explorations through global platforms such as Global Biofuel Alliance and Mission Innovation.
- Key takeaways from the technical session on Sustainability, Circularity, Social Acceptance included actionable insights for policymakers, tools for assessing sustainability, and fostering collaboration among stakeholders. Deliverables included guidelines on methodologies for sustainability and frameworks for strengthening scientist–policymaker relationships in energy transition efforts. To foster collaboration through this global platform, specific task group constituted to continue discussion in these subject domains to address the underlying challenges through joint R&D and knowledge sharing.

Sanjukta Subudhi, Arun k Tripathi & Vibha Dhawan

Plasma Pyrolysis and Gasification Facility

For Syngas Production from Biomass Residues

This article offers a comprehensive overview of plasma pyrolysis and gasification technologies, which are emerging as transformative solutions to the escalating environmental challenges and increasing waste generation. As part of its renewable energy goals, India is embracing plasma gasification in its efforts to establish itself as a global leader in sustainable practices.

Plasma pyrolysis and gasification stand out as game-changing technologies in the face of growing environmental problems and waste production. In addition to managing organic residues, these state-of-the-art procedures provide novel avenues for resource recovery and energy generation. Our research and experimental set-up explore these solutions with an emphasis on practicality and environmental impact. This novel method converts wood-based biomass residue and other wastes into energy-dense syngas and recyclable by-products. Plasma technology, which uses ultra-high-temperature plasma, not only addresses environmental problems but also adheres to circular economy principles and India's expanding energy demands. Plasma gasification is more than just a technological achievement; it represents innovation meeting accountability. It supports transition to sustainability and turns trash into wealth.

Redefining Energy Conversion

The plasma pyrolysis process takes place at searing temperatures ranging from 1,200°C to 3,000°C. This ensures that biomass is not only decomposed, but also completely transformed into high-calorific syngas. Syngas, a mixture of carbon monoxide (CO), hydrogen (H2), and methane (CH4), is a versatile energy carrier used for electricity generation, hydrogen synthesis, and other industrial purposes. Plasma gasification is more efficient than typical pyrolysis and combustion systems because it uses high temperatures, an unmatched heat density, and practically total waste conversion into syngas and slag.

India's Waste Management Scenario

India produces huge amounts of agricultural waste on a daily basis, but present treatment methods—pyrolysis and gasification—are inefficient and the gases that come out are not clean. Plasma gasification offers a cleaner alternative, aligning with India's National Action Plan on Climate Change (NAPCC) and the Swachh Bharat Mission by addressing organic waste and energy challenges simultaneously.

Advantages for India

1. **Urban Waste Reduction:** With cities like Mumbai generating over an extensive organic-based waste, plasma gasification can significantly reduce burden of traditional techniques used.
2. **Energy Security:** Plasma gasification converts trash into high-calorific syngas, contributing to India's renewable energy targets under the NAPCC.
3. **Environmental Benefits:** The plasma gasification technology lowers dangerous emissions that come with combustion.
4. **Circular Economy:** The technology encourages sustainability and resource efficiency by turning trash into resources such as slag and syngas.

The Road Ahead

Plasma gasification is part of India's renewable energy ambitions as the country strives to become a global leader in sustainable practices. It easily fits in with the goals of the Swachh Bharat Mission, India's National Solar Mission, and Sustainable Development Goals (SDGs) 7 and

12. India can set a good example by using this revolutionary technology, demonstrating its commitment to a cleaner and more sustainable future.

The Sustainable Development Goals (SDGs) 7 and 12 are:

- **Goal 7:** Affordable and clean energy

  This goal aims to ensure that everyone has access to affordable, reliable, and modern energy services. It also aims to increase the share of renewable energy in the global energy mix and double the rate of improvement in energy efficiency.

- **Goal 12:** Responsible consumption and production

  This goal aims to promote responsible consumption of resources and energy. It also aims to cut food waste in half and promote environmentally friendly waste management.

The SDGs are a set of international development goals that were adopted by the UN in 2015. The goals are intended to be achieved between 2016 and 2030.

The Plasma Gasification Facility at IIT Roorkee

The plasma gasification reactor is designed to handle wood-based biomass, sugarcane bagasse and rice husk, and other organic wastes. The plasma technology for biomass gasification has been successfully demonstrated, and it is aimed to further extend it for bio-waste management at IIT Roorkee campus. The detailed engineering of the project has been done by the CSIR-CMERI, Durgapur and IIT Roorkee. Figures 1a, 1b and 1c show the plasma gasification process flow diagram, facility installed, and the plasma arc, respectively, at IIT Roorkee, and the plasma arc generated during the experimentation. Further, the details about the plasma reactor are presented in Table 1. Figure 2 shows the samples of the syngas collected during the experiments.

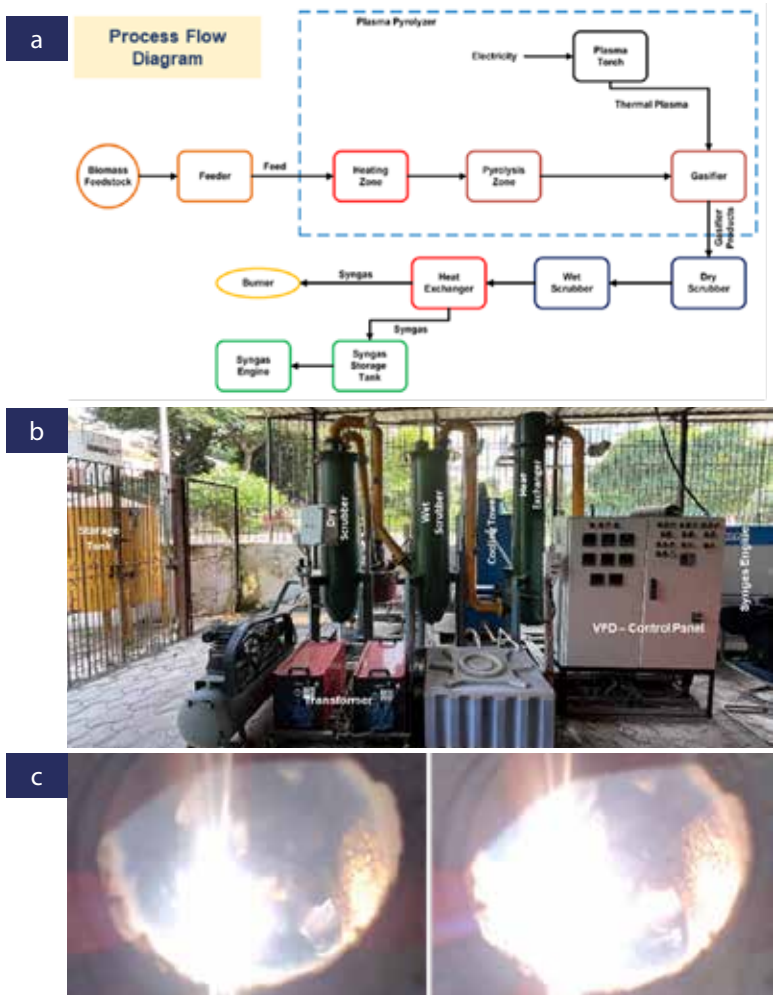


Figure 2: Syngas produced using wood biomass residue in the plasma gasification facility at IIT Roorkee

Plasma Reactor Specification	
Capacity	5Kg/hr Biomass Residue
Configuration	Verical Reactor
Ports (Torch Mounting)	4 Nos. at 90 degree
Ports (Sensor Mounting)	4 Nos. at 90 degree
No. of Peep Hole	2 Nos. (Dia: 100 mm)
No. of Manhole	1 No. (Dia: 200 mm)

Figure 2: Syngas produced using wood biomass residue in the plasma gasification facility at IIT Roorkee

Prof. Vimal Kumar
Indian Institute of Technology, Roorkee

Workshop on Energy Storage

Sustainably Integrating 500 GW of Renewables into Grid and the Role of Energy Storage

During the COP-26 held in Glasgow, Hon'ble Prime Minister of India has announced 'Panchamrit' which inter alia include achieving about 50% cumulative electric power installed capacity from nonfossil fuel-based energy by 2030 and net-zero by 2070. Majority of these capacities would be coming from solar and wind energy sources, which are intermittent in nature and possess challenges with the grid integration. Energy Storage technologies are necessary to address these challenges of intermittency and also reduce the Renewable Energy (RE) curtailments. As per the National Electricity Plan (NEP), Central Electricity Authority (CEA) has estimated the requirement of 236 GWh of Battery Energy Storage System (BESS) and 175 GWh of Pumped Hydro Power (PHP) by 2032. As of November, 2024, India has ~219-megawatt hour (MWh) installed BESS capacity.

In order to create an awareness about the benefits of energy storage and have a detailed discussion with states/ central agencies and to understand their plans for increasing renewable penetration in their respective states in a sustainable manner, a series of workshops have been planned under the Accelerating Smart Power and Renewable Energy in India (ASPIRE) Programme, of the India-UK strategic partnership. The first of such workshop was held during 27-28 April, 2023 at Gandhinagar, Gujarat and the second one under this series was held during 13-14 July, 2023 at Hyderabad, Telangana. The third workshop under this series was held during 22-23 August, 2024 at Pune, Maharashtra.

Workshop was inaugurated in the presence of (left to right) Mr. Nishant Singh (BHC), Mr. Ajay Yadav (JS, MNRE), Mr. Barun Kumar Ray (ACS, Govt. of WB), Mr Ghanshyam Prasad (Chairperson, CEA), . Ms. Laura Aylett (Head of Climate and Energy, BHC) and Ms. Archana Chauhan (BHC)

In this series, fourth workshop under ASPIRE programme was organized on

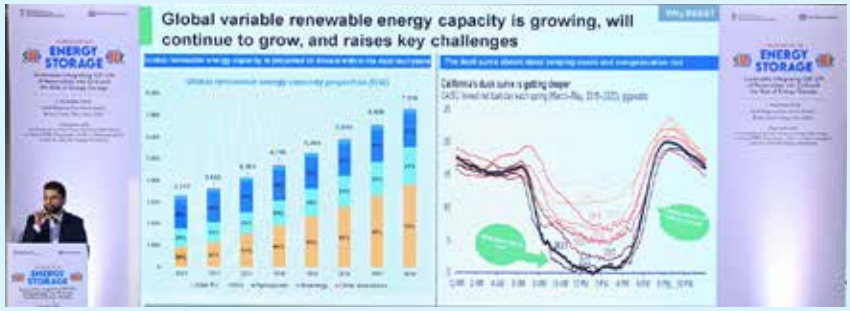
Launch of report on 'Assessment of the Global Landscape for Sodium-Ion Batteries and their Potential in India'

2nd December 2024 in New Delhi. The workshop included seven main sessions covering keynote session, technical session, panel discussion, UK experience session, BESS technologies, experience sharing session and closing session.

The report covers aspects across the SIB ecosystem, including technology, markets, supply chains, manufacturing, policies, and more. The report also identifies areas to address to support deployment of SIBs and provides targeted recommendations on the same.

Mr. Paritosh Moghe, Associate Director, KPMG in India, showcased the need for energy storage, demand and supply trends, cost trajectories, and potential use cases. He also provided an overview of the Indian BESS and UK BESS markets, and identified potential areas where the two countries could collaborate to accelerate BESS deployment and enable sectoral development.

The technical session was followed by a panel discussion on achieving 200+ GWh of battery energy storage systems by 2030. The panel was moderated by **Mr. Abhishek Shah, Partner (Power and Utilities), KPMG in India,** and included senior representatives from across the battery sector value chain. The panellists included **Mr. Rajesh Kumar, Chief Engineer (Energy Storage and System Division), CEA,**



Mr. Rakesh Rathore, Section Head-Business Development, JSW Energy Limited, Mr. Naveen Nagpal, Assistant Vice President (AVP) (Renewables, BESS & new initiatives), BSES Rajdhani Power Limited (BRPL), and Mr. Umang Maheshwari, Director- Solution Deployment, Global Energy Alliance for People and Planet (GEAPP).

The panel discussion was followed by a session on UK experience, which included presentations from Innovate UK, Battery Associates, and Connected Energy. Mr. Thomas Bartlett, Deputy Director (Faraday Battery Challenge), Innovate UK, presented on innovation across the battery sector, covering the UK's projected battery demand by 2035, and the UK automotive battery technical requirements by 2030. Mr. Simon Engelke, Founder and Chair, Battery Associates, presented on key learnings

identified from scaling up battery manufacturing in international markets. Mr. Matthew Lumsden, Chief Executive Officer (CEO), Connected Energy, presented on the importance of utilising second life batteries to enable circularity in the energy storage sector.

The session on UK experience was followed by a session on BESS technologies which included presentations by Indi Energy, VFlowTech, and Sumitomo SHI FW (SFW). Dr. Yogesh Kumar Sharma, Co-founder, Indi Energy,

presentation on SIBs. He highlighted the potential of SIBs to meet India's BESS requirements by leveraging a cost-effective indigenous supply chain, thus mitigating import reliance and geopolitical risks. Mr. Avishek Kumar, Co-founder and CEO, VFlowTech, presented on flow batteries, highlighting their potential to meet Long Duration Energy Storage (LDES) needs due to their cost characteristics, scalability, and ability to address diverse use cases. Mr. Saurav Mitra, Director, Market Development, Energy Storage Business, SFW, presented on LAES technology, showcasing the workings of the technology, its technical advantages, and its potential to enable dispatchable RE generation plants.

The session on BESS technologies was followed by an experience sharing session which included presentations on learnings from installed BESS projects. Mr. R.S. Surani, Superintendent Engineer (RE), Gujarat State Electricity Corporation Limited GSECL, presented a case study on the key learnings obtained from deployment of solar and BESS projects in Modhera and in Kachchh. Mr. S. Eswara Rao, Additional General Manager (AGM) (R&D), BHEL discussed about the learnings from a pilot project of 1 Megawatt-hour (MWh) of BESS for RE integration deployed by BHEL wit three different technologies, namely LIBs, advanced lead acid batteries, and flow batteries. The experience sharing session was followed by closing session wherein reflections from the workshop discussions and vote of thanks was given by Mr. Nishant Singh, Senior Adviser- Energy Security, Lead- Renewable Energy, BHC.

The workshop provided the following insights:

- Grid-scale energy shifting is the most prominent use case for energy storage, enabling the balancing of supply and demand on a large scale. This is followed by residential energy storage, which helps homeowners manage energy use, reduce costs, and increase reliance on renewable energy sources.
- LIB is the preferred technology of BESS for various stakeholders, enjoying a high level of awareness due to its market maturity. However, there is growing interest among policymakers, developers, and manufacturers in exploring emerging technologies such as Sodium-ion batteries, Redox Flow batteries, Liquid Air Energy Storage and others.
- There is a need to manage supply chain and geopolitical risks along with development of cells and batteries manufacturing ecosystem in the country.
- There is a need to develop skilled workforce in the sector of energy storage in the country.
- Potential of energy storage should be leveraged in the distribution side

Dr. Kuldeep Rana
Scientist E, Ministry of New and Renewable Energy
Government of India

Hydrogen: Key Enabler for a Sustainable Energy Transition

The hydrogen ecosystem comprises different steps starting from production, storage to end-use wherein digitalization will play a crucial role to ensure secure and efficient operation considering that safety is paramount in the hydrogen value chain. This article by Sarvesh Devraj, Ram Krishan, Shashank Vyas and Rakesh Bohra presents the scope of digitalization in the hydrogen value chain, especially to optimize production and storage processes.

Hydrogen is considered as a critical technology for transitioning towards a sustainable and clean energy system. It is a key pillar of the overall energy transition movement. Though hydrogen can be produced from different sources using distinct techniques, green hydrogen, which is produced using electricity generated from clean energy sources such as solar, wind and biomass, has gained significant prominence in recent years. This is chiefly attributed to continuous technological advancement in electrolysers and anticipated fall in production costs. Hydrogen generated through these clean renewable energy (RE) sources can be utilized for a variety of applications in power, transportation, and hard-to-abate industrial sectors. In the power sector, hydrogen-powered fuel cells can facilitate seamless integration of large share of renewables in the electricity grid. Fuel cell vehicles (FCVs) will help transform towards an emission-free transportation sector and are a more sustainable and competent alternative for long-haul heavy-duty vehicles like long-distance trucks.

The hydrogen ecosystem comprises of different steps starting from production, storage to end-use wherein digitalization will play a crucial role to ensure secure and efficient operation considering that safety is paramount in the hydrogen value chain. This paper presents the scope of digitalization in the hydrogen value chain, especially to optimize production and storage

Introduction

The undergoing energy transition: The entire energy value-chain is undergoing a transformation to mitigate the emissions at each stage – generation, transmission, storage, and consumption. Principally, de-carbonization is a major approach for limiting the emission of greenhouse gases (GHGs) into the atmosphere from the activities associated with the energy sector. It has become all the more important after considering the fact that emissions from energy-releasing combustion and industrial process reached their highest level in 2021, when they were 6% higher than in the previous year.[1]

Hydrogen as an important energy carrier: Hydrogen is going to play a crucial role in enabling energy transition at various levels and scales. Figure 1 shows several ways by which hydrogen can help in achieving the clean energy transition goals. It also broadly covers hydrogen value chain that includes generation, transmission & storage, and its potential use cases. The Power to X (P2X) technology allows the conversion of electricity to hydrogen gas (using electrolysis) that can further be converted to any useful energy carrier such as ammonia (used as on-board energy carrier in ships) or feedstock for an industrial process or any other useful product.

[1] Global Energy Review: CO_2 Emissions in 2021 – Analysis - IEA

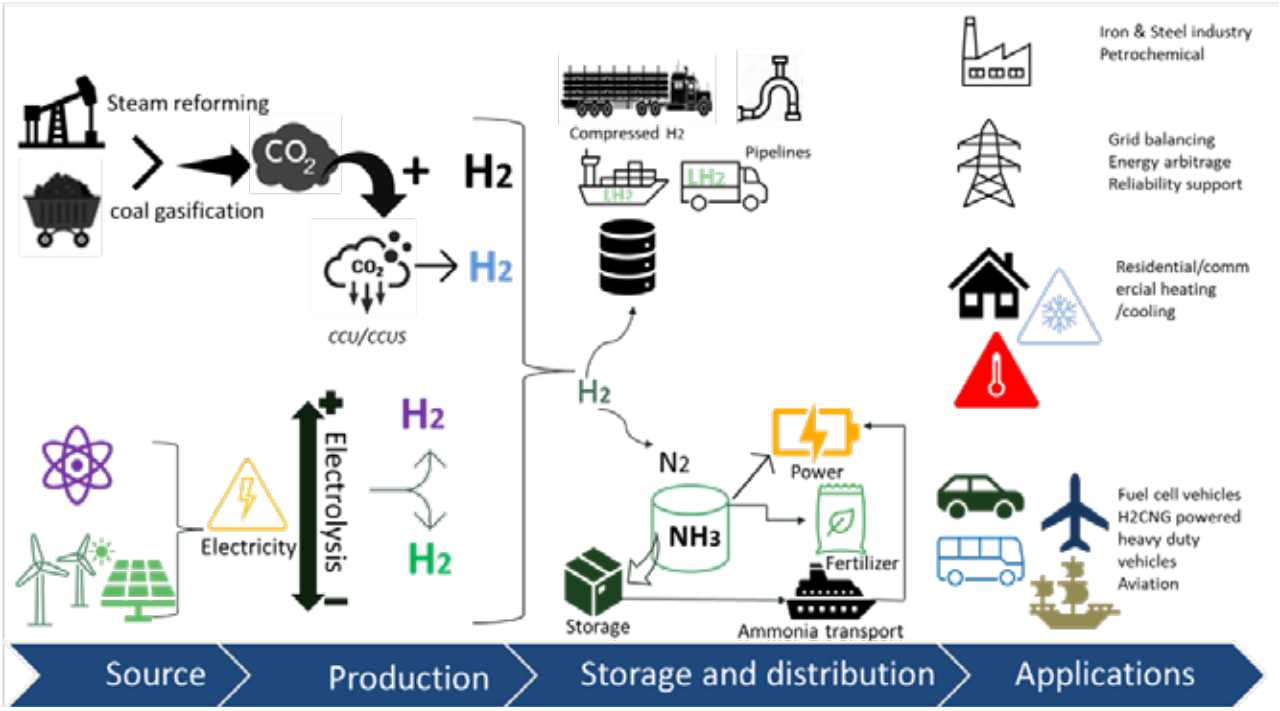


Figure 1: Hydrogen value chain

The hydrogen economy: As an energy carrier, hydrogen can empower many sectors like transportation, power generation, agriculture, steel, refinery, etc. The use of fuel-cells would be essential in this aspect. The electricity produced by hydrogen in fuel-cells will help in stabilizing the intermittent generation of RE sources and in providing flexibility to the power system. Hydrogen can act as a substitute of carbon for many industrial processes like in reduction of iron during steel production. Green ammonia from clean energy-produced hydrogen is itself a valuable feedstock for the global fertilizer industry and is also an energy carrier aboard ships.

The global hydrogen demand was 95 million metric tonnes (Mt) in 2022 and expected to reach 430 Mt by 2050.[2] In 2022, approximately 99% of the total hydrogen production was consumed by industries and refineries, while less than 0.1% was used in emerging applications within heavy industry, transportation, or power generation. As of 2022, natural gas and coal have been major resources for hydrogen production with share of 62% and 21%, respectively.[3] In 2022, global hydrogen production resulted in over 900 million tonnes of CO_2 emissions. As per International Energy Agency's (IEA's) goal of achieving net-zero emissions by 2050, hydrogen could play a pivotal role in decarbonization through many of the hydrogen technologies.

Ammonia is one of the main components of fertilizers widely used in agriculture sector and hydrogen and nitrogen are the major elements used in ammonia production. It is estimated that around 80% of the ammonia produced annually is used in fertilizer production.[4]

Green Hydrogen: Technology maturity and new trends

Hydrogen can be produced via different routes as mentioned above. Accordingly, there are different colours of hydrogen to indicate the method of production from various resources. Based on these, hydrogen can be grey, blue, green, turquoise, and pink as indicated in Figure 2. Grey hydrogen is produced by utilizing coal or natural gas through gasification or steam methane reforming (SMR) process. Green hydrogen is produced through electrolysis by utilizing electricity from RE resources such as solar, wind, etc. Additionally, pink or purple and turquoise hydrogen is produced through electrolysis using electricity from nuclear power and from methane pyrolysis, respectively.

[2] IEA (2023), Hydrogen, IEA, Paris https://www.iea.org/reports/hydrogen-2156
[3] IEA, Global Hydrogen Review 2023
[4] https://www.yara.com.au/crop-nutrition/grow-the-future/sustainable-farming/green-ammonia/?

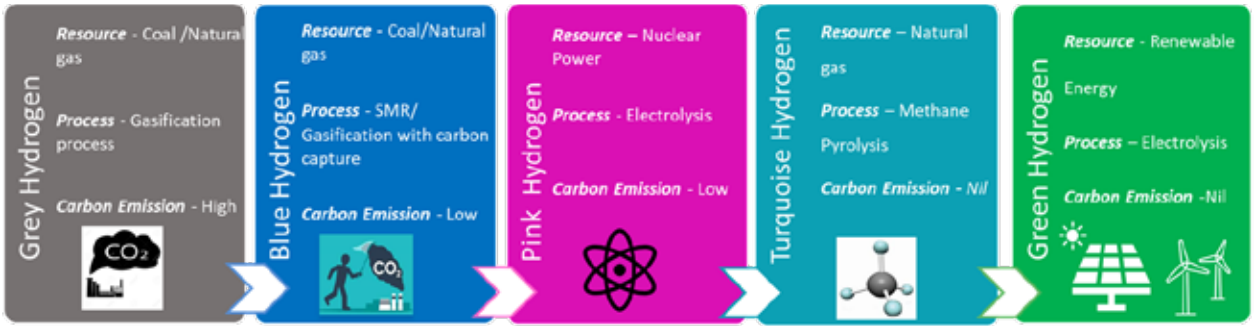


Figure 2: Types of hydrogen

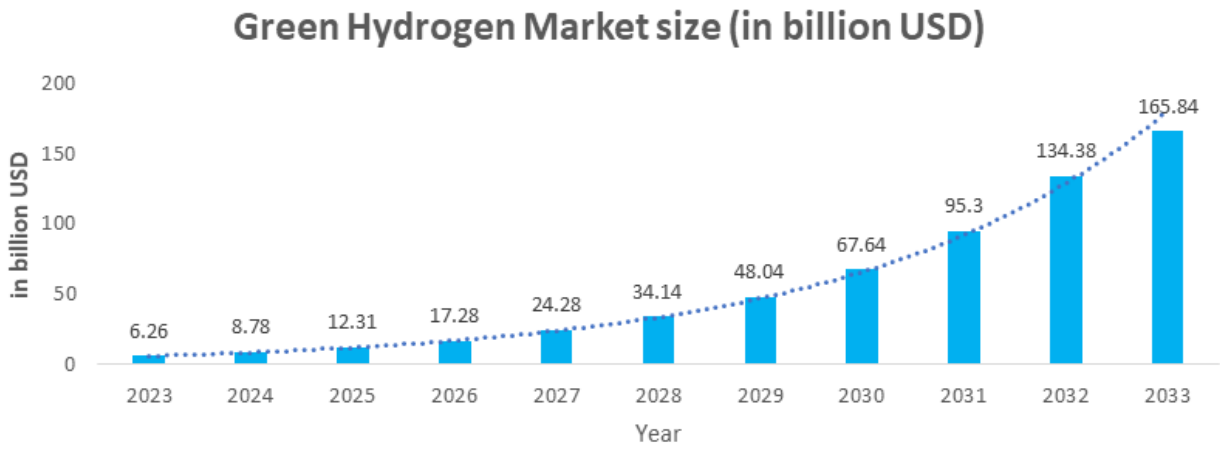


Figure 3: Green hydrogen market size trends[6]

SMR*: Steam methane reforming: Currently, green hydrogen production costs are high. However, according to projections, it is expected to fall to USD 1/kg by 2050[5] due to continued electrolyser cost reductions (USD 100/kW by 2050). Green hydrogen is likely to dominate the hydrogen industry by 2050, accounting for roughly 80% of the global hydrogen generation.

The Global Hydrogen Market

According to the International Renewable Energy Agency's (IRENA's) Global Energy Transitions Outlook 2021, the global market for hydrogen electrolysers and infrastructure is estimated to be worth USD 116 billion average per year till 2033. The spend for the green ammonia and methanol market as hydrogen P2X products is estimated to be an average of USD 45 per year till 2050 (production of ammonia and methanol from hydrogen feedstocks). The demand for hydrogen, especially for green hydrogen, has been increasing significantly over the years and its market size is expected to reach USD 165.84 billion (in 2033) as depicted in Figure 3.

Opportunity for Digitalization

Digitalization is one of the critical levers for a smooth transition towards green hydrogen production and its end-use, which will not only help decision makers in appropriate technology selection during planning stage but will also optimize the operational energy consumption in the whole supply-chain starting from generation to end-use. Artificial intelligence of things (AIoT) – a combination of Artificial Intelligence (AI) and Internet of Things (IoT) technology which enables real-time data monitoring and intelligent decision making through advanced data management and analytics can be aptly explored in hydrogen production thereby optimizing energy consumption as well as reducing the operational downtime by real-time health monitoring of all associated components. Integrated supply chain planning through advanced software could leverage the existing oil & gas network for optimizing the model parameters associated with the hydrogen value chain. Figure 4 shows a schematic diagram depicting an

[5] https://about.bnef.com/blog/green-hydrogen-to-undercut-gray-sibling-by-end-of-decade/
[6] Green Hydrogen Market Size to Hit Around USD 165.84 Bn by 2033 (precedenceresearch.com)

integrated system view for hydrogen production and storage that illustrates how digitalization can help achieve strategic planning decisions, improve the performance, reduce downtime and ensure operational safety. Since safety is paramount across the hydrogen value chain, be it generation, transportation, storage or end use, critical process parameters need to be monitored continuously with high accuracy. This can be achieved by installing IoT sensors coupled to a centralized monitoring system wherein field data can be aggregated and monitored in real-time. Moreover, the aggregated field data can be further utilized for model-based simulation and for performing advanced analytics to take decisions intelligently, as explained previously.

Digital Twin – Strategize Planning Decisions

A digital twin showcases the visual representation of actual onsite operation by utilizing real-world data. The investment decision can be strategized by utilizing digital twin concept which will optimize planning decisions and maximize the return on investment, and accordingly appropriate system configuration along with optimal size of the components used in hydrogen production can be selected. A Digital Twin reportedly reduces CAPEX by 10-15% while minimizing the risk by 30-50% and can also potentially reduce the operational cost up to some extent.[7]

Real-time Monitoring and Control

Real-time monitoring of key field parameters such as amount of RE generation, gas flow rate & leakage status, breaker positioning, yield, etc., will enable secure and efficient operation of the various processes along the hydrogen value chain. The data repository that will be generated through real-time parameter monitoring will also help in carrying out performance assessment as well as predictive analytics such as forecasting of local electricity demand (if any), RE generation, hydrogen production, etc. Accordingly, the hydrogen production schedule and dispatch of energy to meet local electricity demand can be intelligently planned in advance.

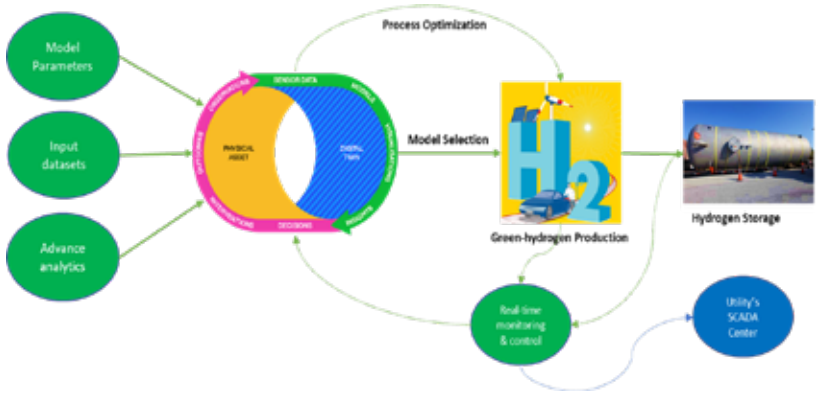


Figure 4: System integration schematic to enable digitalization in hydrogen-related processes

AI-enabled Advanced Analytics

AI-enabled advanced analytics combined with econometric modelling (for cost-trends and optimization) can help technology innovators in the field of electrolyser manufacturing to make further improvization and can also increase the hydrogen yield. AI-assisted predictive analytics can also potentially reduce the system downtime and improve reliability and safety by continuously monitoring the asset health and predicting any catastrophic failure. Accordingly, the maintenance schedule can be pre-planned which will eventually reduce the cost associated with unplanned failure of any asset. Short-term forecasting techniques can be used to intelligently manage the hydrogen production schedule on an hour/day-ahead basis and accordingly energy can be optimally dispatched for end-use. Additionally, the mid-term forecast of such distributed energy sources can help in carrying out mid-term energy planning from an efficient power system operation perspective.

Conclusion

Hydrogen as a fuel will also enable decarbonization of hard-to-abate sectors like iron & steel manufacturing, transitioning them towards a green and more sustainable energy route thus solving a tougher sub-problem of the overall energy transition. Through fuel-cells and internal combustion engines based on the gas, hydrogen can comprehensively de-carbonize the transportation sector with a significant impact. Green hydrogen costs are expected to follow a declining trend and many countries across the globe have taken measurable steps to enhance the commercial viability. Since a lot of industrial processes and complex steps are involved in the overall hydrogen value chain, a huge opportunity exists for optimizing the same through digital interventions. Some of the cutting-edge digital technology-led solutions have been identified in this article which can accelerate hydrogen adoption and empower a safe and optimized way of hydrogen production, storage, and transportation.

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[7] https://fuelcellsworks.com/news/4-technologies-that-are-accelerating-the-green-hydrogen-revolution/

16th GRIHA Summit
Accelerating Climate Action in the Built Environment

Launch of GRIHA Council's Annual Magazine - Shashwat: Let Nature Be - during the inaugural session of the 16th GRIHA Summit

Background

Conforming to the globally shared vision of 2070, India took a monumental step towards furthering the sustainable energy transition by introducing the five nectar elements, Panchamrit, at UNFCCC COP26 in 2021. With the target to reach 500 GW non-fossil energy capacity by 2030 and become a net-zero nation by 2070, India launched various missions and programmes including the *National Action Plan on Climate Change (NAPCC), National Solar Mission, National Mission for a Green India, National Mission for Enhanced Energy Efficiency, National Mission on Sustainable Habitat, and Mission LiFE (Lifestyle for Environment).*

In 2023, the vision of *Viksit Bharat@2047* presented a roadmap to accelerate the development of a green nation, thereby contributing to the larger goal of net zero by 2070. Initiatives such as *National Green Hydrogen Mission, PM KUSUM, Pradhan Mantri Suryodaya Yojana, PM-Surya Ghar: Muft Bijli Yojana,* and the development of the *Long-term Low Carbon Development Strategy* are some of the programmes/schemes undertaken by the Government of India, to transform the nation's energy infrastructure landscape which is propelled largely by renewable sources. These initiatives address the challenge

from both top-down and bottom-up perspectives, enabling the role of every stakeholder at all levels in sustainable energy transition.

With the bulk of infrastructure yet to be built, there will be significant reliance on renewables due to the growing energy demand in India. For instance, the Government of India's flagship programme – the Pradhan Mantri Awas Yojna – Urban (PMAY-U) 2.0, 'Housing for All', aims at providing all-weather pucca houses to 1 crore eligible beneficiaries in the urban areas. This offers a great opportunity to boost the uptake and integration of renewable energy sources in these households.

16th GRIHA Summit 2024

Contributing to the Government of India's vision towards 2070 and the shared goal of decarbonizing the construction and building sector by 2050, the GRIHA Council has been actively working towards the sustainable transformation of the construction and building sector. GRIHA was jointly established by The Energy and Resources Institute (TERI) and the Ministry of New and Renewable Energy (MNRE), Government of India, to advance the development of sustainable habitats in the Indian subcontinent. India, in its Nationally Determined Contributions NDC) document submitted at COP 21 in Paris has highlighted GRIHA as an indigenous green building rating system. In its third biennial report submitted to the United Nations Framework Convention on Climate Change (UNFCCC), India has acknowledged the work done by GRIHA in the field of carbon mitigation in the building sector.

Since its inception in 2007, the GRIHA Council has been advancing sustainable infrastructure development through administering GRIHA ratings and certifications, conducting capacity-building training, outreach and awareness programmes, stakeholder engagement programmes and encouraging the adoption of green building products and materials. Along with its ratings developed for diverse building typologies, the GRIHA Council launched the *Decarbonizing Habitat Programme* to assist businesses, industries, or organizations in evaluating and reducing their carbon footprint across six parameters - Energy, Water, Waste, Transport, Social, and Lifestyle. Going by the old adage *'what gets measured, gets managed',* GRIHA attempts to quantify aspects such as energy consumption, waste generation, and renewable energy adoption to manage, control, and reduce the same to the best possible extent.

Shri. Abhay Bakre, Mission Director, National Green Hydrogen Mission, Ministry of New & Renewable Energy (MNRE), Government of India addressing the gathering at the Inaugural Session of 16th GRIHA Summit.

As part of its stakeholder engagement programme, the GRIHA Council hosts annual summits and regional conclaves, bringing together national and international stakeholders, such as government agencies, business executives, academic institutions, and building professionals, to deliberate on climate resilience and enable sustainable development in the built environment. Aligning with India's larger goal of ***Viksit Bharat @2047,*** which includes social progress, economic prosperity, environmental sustainability, and good governance, GRIHA Council hosted the ***16th GRIHA Summit*** centered around the theme ***'Accelerating Climate Action in the Built Environment'*** during 4th and 5th December in New Delhi.

The Summit encapsulated various facets of sustainable development and climate mitigation such as community-based adaptation, policy advocacy, sustainable building materials, biophilic architectural designs, cool roofs, the role of stakeholders, green incentives, retrofitting etc. A plenary session – **Decoding the Future Energy Transition** – was organized aligning with India's 2070 climate goals. The session was aimed at understanding the challenges such as efficient energy storage, grid reliability, societal awareness, energy security, technological advancements in the industries, redesigning habitable spaces, economic feasibility and market dynamics, and policy and regulatory frameworks. The session underscored the critical imperative for collaboration across sectors, the role of smart grids, enabling policies, and strategic investments to ensure a sustainable and

Dr. Arun Tripathi, Scientist G, Ministry of New and Renewable Energy (MNRE), Government of India addressing the gathering at the technical session titled 'Innovative Strategies for Sustainable Construction: Scaling Up Building-Integrated Photovoltaics (BIPV) Applications in India' conducted under 16th GRIHA Summit.

inclusive energy transition. The panel also highlighted the need for gender justice in the energy sector, socio-economic considerations and energy governance for a just and scalable transition.

Another technical session was organized on **'Innovative Strategies for Sustainable Construction: Scaling Up Building-Integrated Photovoltaics (BIPV) Applications in India'** by the GRIHA Council in association with TERI. The event, which was supported by Ornate Solar and organized under GIZ India's dPP initiative, brought together developers, architects, and government representatives to discuss the prospects and problems of growing BIPV technology.

The launch of the **New and Innovative Solar Applications (NISA) programme** with GIZ and MNRE, Government of India, marks a significant step towards unlocking India's potential in BIPV. It has the potential to contribute to the regulatory, technical, and application-related prerequisites for reducing the land demand for solar PV technology. Extending the dual functionality of structural integrity and renewable energy generation, it offers an efficient, land-neutral solution, replacing conventional materials. Retrofitting existing buildings and integrating BIPV into new construction can enhance sustainability and energy efficiency through innovative, design-driven energy solutions, enabling India to reach its net-zero target.

GRIHA rating variants have actively promoted the deployment of renewable energy across all its projects. Over time it intends to drive the adoption of BIPVs in the market through its ratings to facilitate integration into Indian building materials and technologies – whilst generating energy. The 16th GRIHA Summit reaffirmed the role of innovative solutions, like BIPV, in driving this transition and highlighted the need for continued commitment to sustainability at every level of society. As an outcome of the sessions on sustainable energy transition, it was emphasized that India's energy transition requires digitization, decarbonization, and increasing electricity's share in the primary energy mix. With respect to BIPV, mass penetration of BIPV must focus on affordable housing, public infrastructure, and inner-city developments. It was highlighted that decentralized renewable energy solutions and urban planning present significant opportunities for India to serve as a model for the global south.

India's energy transition is not just an environmental imperative but also a vast opportunity for innovation, equitable and inclusive development and green economic growth. As India accelerates, showcasing global leadership in energy transition, the GRIHA Council continues to work in tandem with the Government of India's vision. It intends to facilitate the adoption of renewable energy, improve energy efficiency, and integrate sustainability into the built environment, thereby, paving the way for a resilient future for generations to come.

Ms Aditi Dev
Senior Project Officer, GRIHA Council
Mr Yash Nayyar
Assistant Project Officer, GRIHA Council
Ms Shabnam Bassi
Deputy CEO & Secretary, GRIHA Council, and Director, Sustainable Buildings, TERI

A special structure on the Morpho butterfly's wing gives the impression of saturated colour. Scientists from Fraun-hofer ISE copied this structure to develop coloured solar modules with almost no efficiency losses. It can be de-ployed on glass and foul. © Fraunhofer

Integration of Custom-coloured PV Modules in Buildings

A study by Fraunhofer ISE shows higher solar acceptance of coloured PV modules in buildings

For integrated photovoltaic (PV) applications, colour options other than the typical black and dark blue are needed for solar modules. However, aesthetically appealing PV has been a huge challenge for researchers until now, as there is a crucial balance to be struck with coloured solar panels. They need to behave optically like a traditional coloured ele-ment while still generating as much energy as possible. Taking inspiration from the 3D photonic structures of the Morpho butterfly's shimmering blue wings, scientists at Ger-many's Fraunhofer Institute for Solar Energy Systems ISE have successfully developed coloured solar panels that achieve this balance. The solar modules can be incorporated into a building's exterior practically invisibly while maintaining high efficiencies.

Photovoltaics on buildings can make a significant contribution to the decarbonization of the building sector and built infrastructure without taking up additional land area. This 'double use' of already sealed surfaces appeals to urban areas all over the world and al-lows cheap electricity to be generated right where it is needed. However, solar panels can sometimes look out of place when installed on roofs and façades, especially in the histor-ical centres of cities.

In 2024, the Institute of Psychology at the University of Freiburg, Germany, and the Fraunhofer Institute for Solar Energy Systems ISE conducted a joint study on the social acceptance of building-integrated photovoltaics (BIPV). The conclusions showed that the acceptance of integrated PV in urban areas is generally very high and that PV on modern buildings is viewed more positively than on historic buildings. The study also showed, however, that when PV modules are coloured to match the building's roof or façade so that they are practically invisible, then the social acceptance is increased even further.

Historic building in Eppingen, Germany, with a red roof-integrated PV system. It has been shown that a homogeneous PV integration increases their acceptance. ©Fraunhofer ISE / Photo: Sarah de Carvalho

In 2024, the Institute of Psychology at the University of Freiburg, Germany, and the Fraunhofer Institute for Solar Energy Systems ISE conducted a joint study on the social acceptance of building-integrated photovoltaics (BIPV). The conclusions showed that the acceptance of integrated PV in urban areas is generally very high and that PV on modern buildings is viewed more positively than on historic buildings. The study also showed, however, that when PV modules are coloured to match the building's roof or façade so that they are practically invisible, then the social acceptance is increased even further.

A Green PV system integrated into the façade of Fraunhofer ISE's laboratory building built in 2022. Coloured PV modules are employed as architectural detail here. © Fraunhofer ISE / Photo: Guido Kirsch

Color inspired by a butterfly

The sticking point for coloured BIPV products has been their lack of efficiency. Simply painting the cover glass of a PV module results in the colour pigments blocking out the sun and inhibiting it from reaching the solar cells. To avoid this, the researcher team at Fraunhofer ISE looked to nature for inspiration and found it in the Morpho butterfly. The 3D photonic structures on the butterfly's wings allow for an intensive, angularly stable coloured impression, thanks to a fundamentally low-loss interference effect. Following this biological model, the scientists succeeded in using a vacuum process to apply a simi-lar surface structure to the back of the glass covering their solar panels. Depending on the fine structure, glass coverings in a large variety of colours and also coloured foils can be produced.

The coating system for coloured solar panels has now surpassed the biological model in terms of its properties. Independent measurements confirm that the coloured solar pan-els with the structural rather than painted coatings can achieve about 95% of the power of a comparable uncoated panel. The plug-in solution can be used with all standard commercially available solar technologies as well as those foreseeable in the future, plus it can be manufactured industrially at low cost. Cell and panel technologies such as rear contact solar cells with a uniform appearance are an especially good fit.

Dr Thomas Kroyer, *Head of Group Coating Technology and Systems at Europe's largest solar energy research organization Fraunhofer ISE. thomas.kroyer@ise.fraunhofer.de*

More information: https://www.ise.fraunhofer.de/en/business-areas/solar-power-plants-and-integrated-photovoltaics/integrated-photovoltaics/building-integrated-photovoltaics-bipv.html

Chintan Shivir 2024: A Pitstop to Plan Renewable Energy for 2047

Shri Pralhad Joshi, the Minister of New and Renewable Energy, inaugurates the Chintan Shivir

Sprinting forward, one needs halting for a moment, taking a back step, gasping deep breaths, and leaping forward in a fashion where aerodynamics helps to run fast to achieve one's goal. Similitude to this, Chintan Shivir by its definition allows brains to pitstop and analyze the past and present achievements and to converge the plans to achieve the bigger goals in future and/or to rectify the current set of activities being followed.

From the perspective of the Ministry of New and Renewable Energy (MNRE), Chintan Shivir is a platform which helps to review the work of the Ministry and to evolve an action plan to implement and convert the Prime Minister Shri Narendra Modi's 'Vision 2047' a reality. It helps in unfolding all the challenges and solutions for effective implementation of plans/schemes through larger stakeholder consultation process with participation from line ministries/departments, organizations, experts, etc. It also helps to strengthen the seamless coordination between the Centre and state governments/UTs.

In line with the definition and the objectives of Chintan Shivir, MNRE organised a two-day Chintan Shivir on 14th and 15th November 2024 at ITC, Bhubaneswar, Odisha. The event focused on strategies to achieve the immediate target of 500 GW by 2030 and progress towards the next goal of 1800 GW by 2047. The Union Minister of New and Renewable Energy, Shri Pralhad Joshi, inaugurated the event on 14th November. Union Minister of State for New and Renewable Energy, Shri Shripad Yesso Naik; Deputy Chief Minister of Odisha, Shri Kanak Vardhan Singh Deo; Secretary, MNRE, Shri Prashant Kumar Singh; and Additional Secretary, MNRE, Shri Sudip Jain addressed the gathering of leading decision-makers, financial institutions, industrialists, CEOs, and key officials from central and state governments.

Shri Prashant Kumar Singh, Secretary, MNRE, in his inaugural address, highlighted the achievement of installing a total of 211.36 GW of non-fossil power capacity in the country as on 31 October 2024. Whereas, Additional Secretary, Shri Sudeep Jain, enumerated the details of the ongoing Renewable Energy (RE) schemes/programmes of MNRE and the measures undertaken to promote renewable power in the country.

The Chintan Shivir was spread in 17 vibrant sessions and divided in two days, each session fostering brainstorming discussions on key and emerging issues in the RE sector. The sessions were coordinated by the MNRE team along with the Knowledge Partner Grant Thornton who played a supporting role. The National Solar Energy Federation of India (NSEFI) also supported the event as the Coordinating Agency.

The day-wise key takeaways from each sessions are listed below:

Day 1, 14 November 2024

Eight sessions were held on the first day. The key takeaways from the sessions are are given below.

Session 1: PM Surya Ghar Muft Bijli Yojana - Achieving 1 Crore Rooftop Installations

- Designate a solar city in each state to serve as a model for rooftop solar adoption.
- Standardization and digitization of distribution utility and vendor work processes to reduce system deployment time to below 10 days.
- Standardization of solar kits/equipment to enhance speed of installation process.
- Coordinated incentives and subsidies by central and state governments for 1 kW systems to ensure affordable solar options for lower-income segments.
- Virtual net metering facility for high-rise residential building consumers with solar capacity installed in the common spaces.
- Grading system of vendors to ensure quality of equipment and service.
- GST exemption for PM Surya Ghar to reduce financial barriers for consumers, particularly for small-scale installations.

Session 2: Promoting Solar Ancillary Manufacturing in India

- ALMM and DCR for ancillary industry is a clear-cut ask from industry with year-wise roadmap on policy parameters.
- Collaborations between module and ancillary manufacturers.
- Long-term offtake and underwriting/ financial support can be extended by module manufacturers.
- Quality being a key concern, industry to ensure quality, taking measures for appropriate skilling and technology adoption.
- Solar manufacturing zone to be encouraged with suitable benefits for industry.
- Focus on R&D and specific skilling programs to be developed for ancillary industry. NISE to support.
- Measures to reduce glass manufacturing costs: Need to encourage RE power usage and measures to reduce tariff.

Session 3: Land and Evacuation– Key Enablers for Accelerating Indian Utility Scale Plants

- Waste land identification and allocation model in Gujarat, Karnataka, and Rajasthan, be adopted and replicated by other states.
- Exemption of NA charges and deemed conversion will expedite the execution timelines.
- Alignment of compensation for RoW in line with guidelines for determining the amount of compensation
- States to come up with state transmission utility (STU) planning aligned to resource adequacy to ease the connectivity constraints.
- In case of General Network Access (GNA), extension of timeline provided by REIA is offering opportunity to squat the CTU connectivity which needs to be addressed.
- RE Zone based incremental CTU/GEC is required from MNRE/MoP for RE rich states (RJ, Gujarat and others)
- Exempting ceiling limits for RE projects by state would ease the land acquisition process.
- MNRE to develop a model regulation/ model guidelines in prescriptive way basis the best practices of other states which shall be input for states to attract investment in RE sector by easing land acquisition process.
- Project level monitoring to be carried out by MNRE to address the issues being encountered during project development stage.
- Energy Storage System (ESS) to be integrated with existing projects to optimize the utilization of transmission.
- Agrivoltaics to be promoted to address land-related concerns in agri-based states, which are rich in RE.

Session 4: From Mines to Modules: India as Global Solar Manufacturing Hub

- ALMM on cells and wafers is requested.
- R&D Enhancement: Research and development need to be increased .

Shri Pankaj Agarwal, Secretary, Ministry of Power; Shri Kanak Vardhan Singh Deo, Deputy Chief Minister of Odisha; Shri Pralhad Joshi, Minister of New and Renewable Energy; Shri Shripad Yesso Naik, Minister of State for New and Renewable Energy; Shri Prashant Kumar Singh, Secretary, MNRE; and Shri Sudip Jain, Additional Secretary, MNRE

- Skilling: Courses dedicated to manufacturing should be developed for ITIs, with support from NISE.
- Solar Silk Road: India should secure access to African and Middle Eastern markets for raw materials.
- Global Markets: The industry needs government-to-government (G2G) support to aggressively enter markets in the US, Europe, and the Middle East.
- Standards Development: Standards catering to Indian conditions need to be developed, with NISE working alongside BIS on this.
- Innovative Measures: Exploring the creation of Solar Megaplexes and the implementation of solar laws could be beneficial.
- Circularity: A roadmap for panel recycling should be formalized.

Session 5: India as Global Wind Manufacturing Hub

- Policy stability for wind energy growth.
- Demand visibility for capacity utilization: Long-term demand projections and multi-year contracts are needed.
- Workforce upskilling and certification programs: The expansion of workforce training programs like 'Vayu Mitra' is being prioritized to meet the industry's demand for skilled technicians.
- Streamlined logistics and transportation approvals for movement of wind energy components.
- R&D and innovation incentives for blade recycling to promoting sustainability.
- Export competitiveness through subsidies may be explored to enhance global competitiveness and compete with countries like China.
- Financial incentives and schemes support for ancillary industries to build a robust supply chain.
- Domestic content requirement (DCR) enhancement: The enhancement of domestic content requirements to 60% is being prioritized to strengthen local manufacturing and reduce import dependency.

Session 6: Mismatch between Upcoming RE Capacity and Transmission Readiness

- BESS integration is needed for better utilization of transmission system.
- Taxation on ESS needs to be taken up with the Ministry of Finance.
- Counter measures on limited or no availability of suppliers for the HVDC transmission system be taken up.
- Variation in the cost of transmission per unit of electricity in different regions of the country be standardized.
- Guidelines formulated by the Government of India about compensating the land-owners be followed by states.
- Extension of Inter-State Transmission Charges (ISTS) waiver to developers be explored if the power purchase agreements (PPAs) are signed prior to June 2025, instead of the scheduled COD of June 2025.

Session 7: Agricultural Solarization

- Suggestion to devise tailored guidelines on KUSUM implementation suiting regional farming to explore
- 7.5Hp pump cap in Component C1 to be relaxed. This was a significant barrier in Gujarat where water levels were low.
- Recommendation to remove DCR for faster adoption of solar pumps and consider a centralized tender for greater cost-effectiveness.
- Implement quality standards (e.g., BIS) for solar pump efficiency ratings.
- Recommendation to make agrivoltaics a separate component under KUSUM
- Merging of Components A and C be explored to streamline policy and reduce overlap.
- Design configuration wise guidelines and specifications to be developed by MNRE for AgriPV deployment.

Session 8: India's Offshore Wind - Way Forward for Grid Integration

- Commitment of 10 GW Pipeline and Boosting Offshore Manufacturing: Policy clarity on project pipelines of minimum 10 GW to be committed and by MNRE to make investment in manufacturing infrastructure and ecosystem
- Diversification of supply chain and promoting domestic manufacturing of seabed cable to be promoted to address Supply Chain Challenges
- Auctioning of land/seabed for offshore Pooling Substation
- Reducing the offshore wind tariff through leveraging blended finance, etc be discussed
- Adopting Cost effective technologies for faster deployment of projects

Day 2, 15 November 2024

On day 2, 9 sessions were held and the key takeaways from these sessions are given below.

- Sea Vessel Policy: Policy from MNRE is needed with supports/ incentives for producing deep sea vessel in India

Session 9: Strategy for Ensuring Offtake of RE Power by DISCOMs – Bottlenecks, Possibilities, and Way Forward

- ISTS waiver for projects with PPA signing before June 2025.
- Reduction in the rating of DISCOMs for non-compliance would be one of the measures to bring about discipline in RPO compliance.
- Measures similar to late payment surcharge and regulating network access (i.e., Power Market) shall be evaluated for enforcing RPO compliance.
- Complementary procurement would result in timely signing of power purchase agreements (PPA) by DISCOMs.
- Procurement of firm and dispatchable renewable energy (FDRE) and Solar+BESS shall be continued.

- Focus towards delivering cost-effective RE shall be worked out to improve the RE penetration in DISCOMs.
- Issuance of notice to states for RPO compliance in FY25.
- Evacuation planning shall be the basis for identifying RE zones to ease connectivity and project development timelines.
- Preventing connectivity squatting:
  - ✓ Cancel the connectivity, if the project developer fails to procure 50% of land within 6 months.
  - ✓ Provision for reporting to DISCOM, CTU, STU shall be made, if developer wishes to transfer the connectivity to others.

Session 10: National Bioenergy Program

- MNRE to revamp the Bioenergy schemes and policies.
- Inter-ministerial convergence of schemes be looked at to have one ministry responsible for each sector.
- Work towards improving Centre–State coordination for program implementation.
- Promotion of new and innovative models for biomass aggregation and storage.
- Carbon financing to be introduced to enhance economic viability of the sector.
- Ensure suitable Compressed Biogas (CBG) offtake by oil marketing companies (OMCs) to ensure project's financial viability.
- Projects to be planned in cognizance with existing and future gas grid expansion plans.
- Enable project financing for CBG projects.
- Promote knowledge dissemination for industry and design suitable skilling programs.

Session 11: Emerging role of Energy storage in India - Focus of Battery Energy Storage and Pumped Storage Technologies

- Relaxation of Tax:
  - ✓ Reduction of GST and duty for BESS, which is ~31% of project capex to reduce the Levelized Cost of Storage (LCOS).
  - ✓ Payment service providers (PSP) has GST of 18%, which to be reduced to 5% for accelerating adaptation.
- Making Electricity System Operator (ESO) mandatory to optimizing the RE and transmission system.
- Improving RE penetration in the eastern states with PSP.
- Extended ISTS charges waiver till 2028 for PSP.
- Commitment of Energy Storage Systems (ESS) technology mix for investment planning.
- Facilitating interstate and departmental issues.
- Floating of aggregated PSP capacities by entities like SECI or any other can help improve the investment attractiveness.
- ESS Promotion at DRE/lower voltage system.

Session 12: Developing an Integrated Strategy for Small Hydro Power Plants in India

- MNRE should issue a National Level Small Hydro Power Policy.
- Future allotments, especially of MW scale SHP projects, may be undertaken through a competitive and transparent bidding route for projects.
- Subsidy for SHP projects to be reinstated to accelerate development and improve viability.
- To reduce delays due to forest clearances, MoEFCC may delegate the power of approvals to regional and state forest departments for all SHP projects up to 25 MW.
- Reduction of GST in line with solar and wind sectors.

Session 13: Green Hydrogen Horizons - Nurturing Electrolyzer Manufacturing Ecosystem and Strategies for Offtake Roadmap

- Program on challenge mode for MSMEs, which are involved in manufacturing of bill of process (BOP).
- Use of different electrolyser manufacturing technology to drive down cost.
- Common infrastructure facility at ports for

handling and bunkering green ammonia for exports.

- Timely connectivity of sourcing RE power for various projects.
- Policy support requested by industry regarding Single Bidding Zone needs to be addressed for export of GH2 (green hydrogen) and ammonia.
- Exploring the possibility of producing GH near RE power plants and transporting it to ports via pipeline for exports.
- Suggestion of blending of 2%–5% GH with Piped Natural Gas (PNG) to help in initial offtake.
- Building hydrogen cell charging infra to promote GH in transportation sector.

Session 14: Role of Solar Thermal in India's Decarbonization

- MNRE to revive dedicated program for promoting solar thermal/ concentrated solar thermal (CSP) applications.
- Dedicated policy on thermal storage and associated obligations for deployment.
- Reserving certain share of area of solar parks in regions of high Direct Normal Irradiance (DNI), exclusively for utility scale solar thermal/CSP power projects coupled with thermal storage.
- Exemptions in local urban body taxes and electricity rebates may be considered by states for installation of solar water heating system (SWHS).
- Explore different business models for solar thermal based centralized heating and cooling applications.
- Segment specific R&D needed for high- and mid-rise temperature application, technology transfer, skill development.
- Explore voluntary gap funding (VGF), Production Linked Incentive (PLI) for boosting the sector.

Session 15: RE Integration in NE States, Hilly Regions, and Islands

- Create separate schemes or guidelines.
- Decentralised microgrids in hilly states/ island to improve the livelihoods.
- Microgrid with biogas to help address rural-based small industries.

Session 16: Innovation in Finance and Business Model

- Preparing a framework for enhancing participation of institutional investors in green bonds.
- Expansion of sectoral exposure limits to meet the growing financing needs of RE projects.
- Long-term policy clarity will provide more stability for RE investments.
- A specialized ratings methodology for RE projects is to be established to address the challenges posed by low-rated bonds.
- Integration of innovative financing mechanisms.
- Recognition of green energy in priority sector lending.
- Acceleration of project clearance timelines.
- Promotion of climate funds and tax incentives.

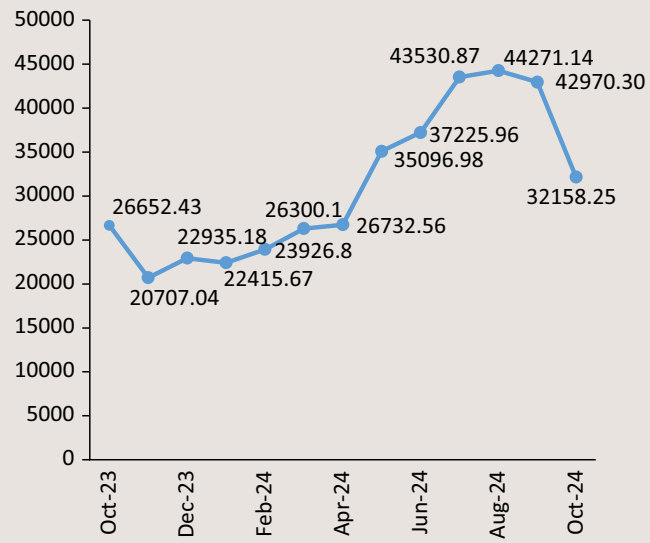
Session 17: Developing Skill Ready Workforce to Power India's Energy Transition

- Leverage the role of information technology and any other technology in supporting skill development programs.
- Establish the need for more focus on certain subject matters like Safety and Occupational Health in skilling programs.
- Emphasize the need for improving the quality of the skill development programs through better facilities, instructors/trainers, certification and training aids.
- Increase the collaboration between industry and academia to improve the quality of skill development programs.

The Chintan Shivir served as a platform for robust deliberations and devising a roadmap for VISION 2047. MNRE is currently working on preparing an action plan to execute all actionable points to build a robust framework for RE sector implementation and growth in the country.

Dr. Gaurav Mishra
Scientist F
Ministry of New and Renewable Energy,
Government of India

All India Total Renewable Energy Generation in October 2024



Source: CEA

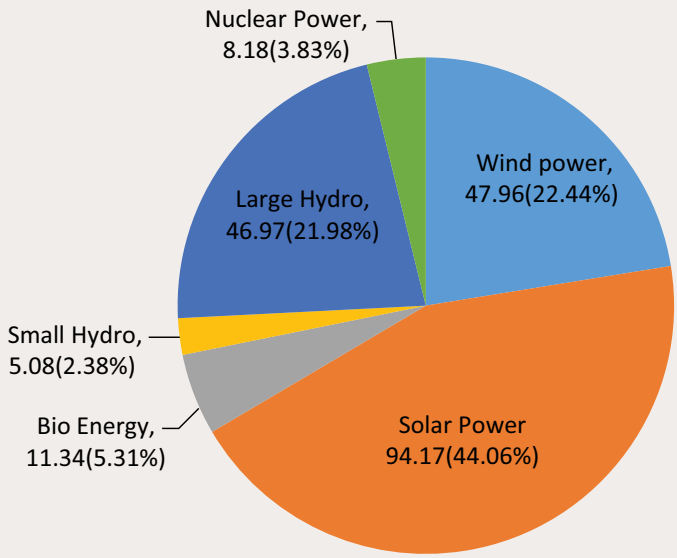
Month	Wind	Solar	Biomass	Bagasse	"Small Hydro"	"Large Hydro"	Others	"Total (MU)"
Oct-23	3548.34	10219.75	266.66	183.16	965.61	11240.45	228.46	26652.43
Nov-23	3544.27	7820.94	278.62	1439.55	774.58	6621.29	227.79	20707.04
Dec-23	5113	8594.51	306.46	1932.57	592.32	6167.11	229.22	22935.18
Jan-24	4075.12	9008.47	306.36	1967.43	482.88	6352.28	223.14	22415.67
Feb-24	4907.58	10421.22	271.07	1725.32	442.67	5928.16	230.77	23926.8
Mar-24	4578.06	12225.83	305.15	1455.71	468.22	7015.7	251.42	26300.1
Apr-24	4729.26	12021.05	278.73	781.11	581.9	8109.14	231.36	26732.56
May-24	8257.63	12645.99	295.16	317.07	734.16	12595.42	251.56	35096.98
Jun-24	10134.92	11445.66	273.43	188.61	776.37	14173.69	233.29	37225.96
Jul-24	13627.00	10356.35	284.12	132.36	1323.02	17562.91	245.11	43530.87
Aug-24	10268.88	10157.52	297.05	132.17	1600.37	21565.90	249.24	44271.14
Sep-24	8870.62	11302.62	258.15	118.58	1612.83	20574.25	233.26	42970.30
Oct-24	3238.28	12256.61	337.9	166	1457.59	14455.88	245.98	32158.25

Source: CEA

State wise RE Generation (MU)		
Name of State/UT	**Oct-24**	**Oct-23**
NORTHERN REGION		
Chandigarh	1.00	1.19
Delhi	63.31	61.21
Haryana	205.23	166.17
Himachal Pradesh	3144.83	2712.51
Jammu & Kashmir	918.63	1009.05
Ladakh	35.07	29.59
Punjab	523.82	763.49
Rajasthan	4736.43	3975.70
Uttar Pradesh	692.91	505.40
Uttarakhand	1319.40	1166.13
SUB TOTAL (NR)	**11640.63**	**10390.44**
WESTERN REGION		
Chhattisgarh	367.52	284.53
Gujarat	3476.01	2746.78
Madhya Pradesh	1616.33	1354.81
Maharashtra	1668.16	1465.66
Dadra and Nagar Haveli and Daman and Diu	2.35	2.57
Goa	5.44	5.44
Sub Total (WR)	**7135.80**	**5859.78**
SOUTHERN REGION		
Andhra Pradesh	1481.13	1228.59
Telangana	2000.29	840.68
Karnataka	3674.27	2989.04
Kerala	750.44	633.13
Tamil Nadu	2510.50	2056.06
Lakshadweep	0.01	0.01
Puducherry	1.02	1.02
SUB TOTAL (SR)	**10417.65**	**7748.52**
EASTERN REGION		
Andaman Nicobar	3.81	3.32
Bihar	26.78	21.57
Jharkhand	53.45	77.67
Odisha	1156.97	971.65
Sikkim	274.83	353.33
West Bengal	478.94	420.94
SUB TOTAL (ER)	**1994.79**	**1848.49**
NORTH-EASTERN REGION		
Arunachal Pradesh	569.17	448.46
Assam	157.17	159.17
Manipur	78.75	51.07
Meghalaya	91.30	89.91
Mizoram	48.82	29.40
Nagaland	23.65	26.67
Tripura	0.52	0.51
SUB TOTAL (NER)	**969.38**	**805.20**
ALL INDIA TOTAL	**32158.25**	**26652.43**

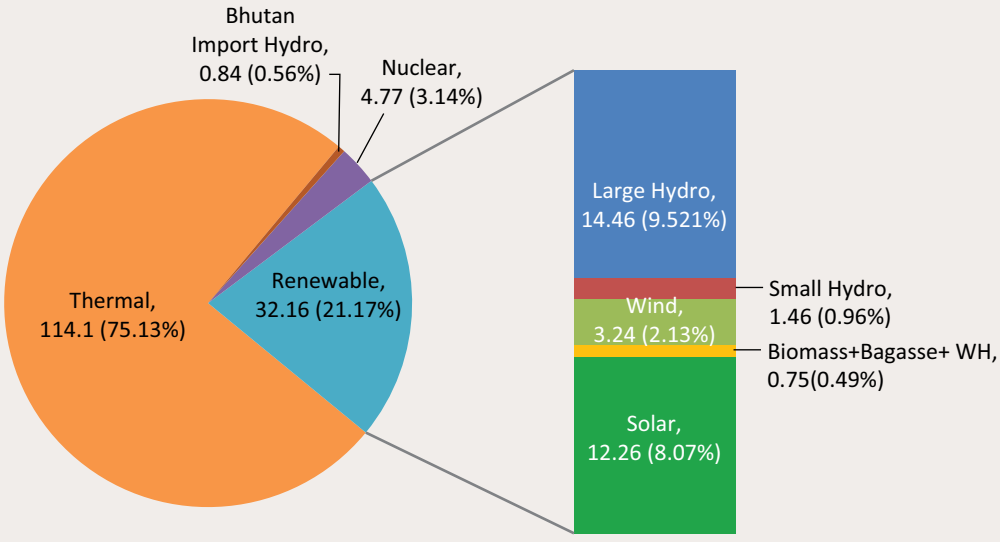
Source: CEA

INSTALLED RE CAPACITY AS ON 30-11-2024 : 213.09 GW

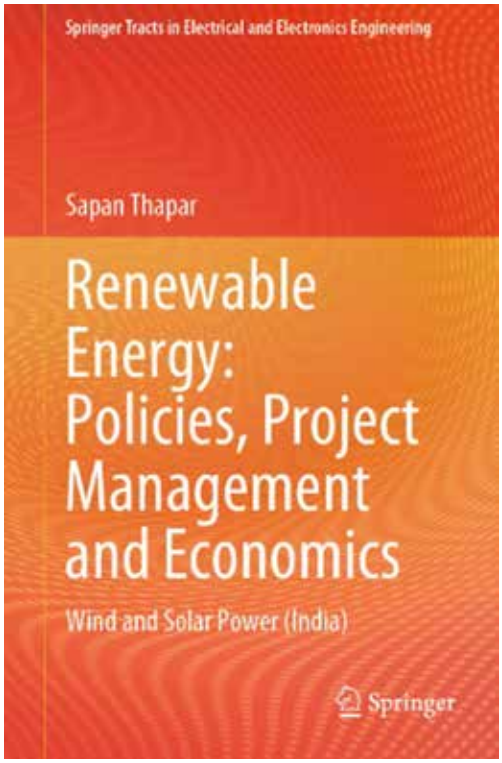


Source: MNRE

ALL INDIA MONTHLY ENERGY GENERATION IN INDIA, 151.21 BU AND SHARE OF RE, 42.97 BU (28.42%) OCTOBER 2024

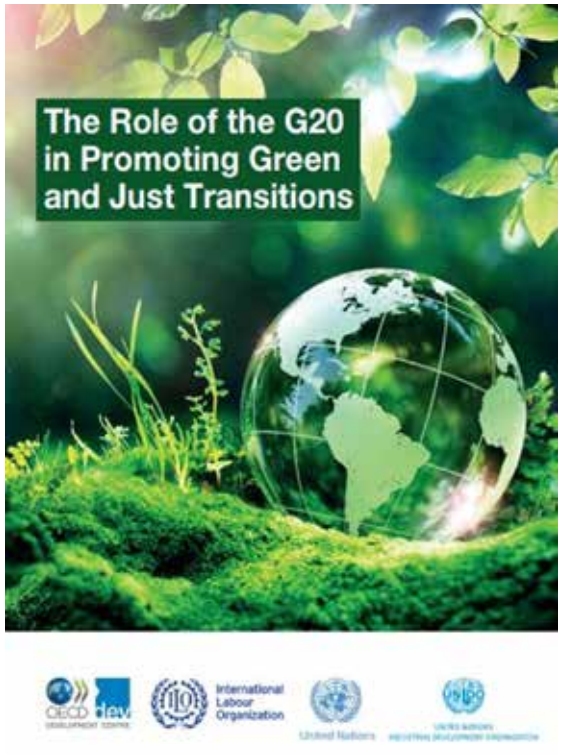


Source: CEA



Renewable Energy: Policies, Project Management and Economics: Wind and Solar Power (India)
Sapan Thapar
Year: 2024
Springer
304p.
ISBN: 978-981-99-9383-3

This book has been written with an aim to enhance the understanding of renewable energy sector policies, finance, and project management. It provides a comprehensive update on renewable energy policies and fiscal instruments, employed globally, with detailed discussions on the Indian policy regime. The book covers various stages of a renewable energy project, from concept to commissioning, and elucidates methodology for computing key financial ratios. A number of case studies, business models, and examples have been presented. Fundamental concepts on technologies, performance, financial tools, and carbon emissions have been explained to enable readers to assimilate the concepts. Data has been presented in easy-to-understand charts, figures, excel spreadsheets, and tables.



The role of the G20 in promoting green and just transitions
Organisation for Economic Cooperation and Development (OECD)
Year: 2024
Organisation for Economic Cooperation and Development (OECD)
364p.
ISBN: 978-922-04-0950-3

A green and equitable transition specifically, coordinated global and national initiatives aimed at attaining global carbon neutrality by or around mid-century, inclusively and tailored to each country context- necessitates active collaboration among all nations, both developed and developing. It also involves guaranteeing that no individual is marginalized and providing assistance to those in need, particularly least developed nations (LDCs) and Small Island Developing States (SIDS). Guided by the preamble of the Paris Agreement, this report proposes ways for G20 and developing countries to enhance the coherence of their policies towards that vision, deepen their co-operation and render the international architecture better suited to the implementation of green and just transitions.


NATIONAL
Bharat Solar Expo 2025
January 17-19, 2025 | Jaipur, Rajasthan
International Conference on Photovoltaic Solar Energy and Power Technology (ICPSEPT)
January 28-29, 2025 | Bengaluru, India -
Exhibition and Conference : The smarter E India – India's Innovation Hub for the New Energy World
February 12–14, 2025 | Gandhinagar, Gujarat
Intersolar India 2025
February 12–14, 2025 | Gandhinagar, Gujarat, India
World Sustainable Development Summit 2025
March 5-7, 2025 | Lodhi Road, New Delhi, India


INTERNATIONAL
Solar Energy Conference
12-13 February 2025 | Cologne, Germany
Solar Quality Summit 2025
February 18-19, 2025 | Barcelona, Spain
5th International Conference on Solar Technologies and Hybrid Mini-Grids to improve energy access
March 11-13, 2025 | Amsterdam
SolarPower Summit 2025
March 26-27, 2025 | Brussels, Belgium
Energy Storage Summit USA
March 26-27, 2025 | Texas, United States

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2050 MW Pavagada Solar Park in Tumkur, Karnataka in 13,000 acres is among world's largest project