Green Finance and Investment

Clean Energy Finance and Investment Roadmap of India

OPPORTUNITIES TO UNLOCK FINANCE AND SCALE UP CAPITAL

OECD

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Please cite this publication as:
OECD (2022), *Clean Energy Finance and Investment Roadmap of India: Opportunities to Unlock Finance and Scale up Capital*, Green Finance and Investment, OECD Publishing, Paris, https://doi.org/10.1787/21b6e411-en.

ISBN 978-92-64-46554-1 (print)
ISBN 978-92-64-65657-4 (pdf)
ISBN 978-92-64-45180-3 (HTML)
ISBN 978-92-64-56585-2 (epub)

Green Finance and Investment
ISSN 2409-0336 (print)
ISSN 2409-0344 (online)

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Corrigenda to publications may be found on line at: www.oecd.org/about/publishing/corrigenda.htm.

Preface

As the effects of climate change intensify, action to reduce carbon intensity and improve energy efficiency is urgently needed. India, one of the world's fastest growing economies, is also a major manufacturing economy and endowed with abundant renewable energy potential, thanks to its solar, wind and hydropower resources. Accelerating clean energy development in India would increase access to affordable and reliable energy, thus reducing dependence on fossil fuel imports and strengthening energy security at risk from the current energy crisis.

While India has achieved remarkable improvements in energy efficiency and the adoption of renewables, decarbonising the Indian economy and achieving net-zero emissions by 2070 will require an acceleration in the deployment of new technologies. Offshore wind and green hydrogen stand out as strategic opportunities to help achieve India's clean energy targets. The market uptake of these technologies would facilitate the shift to clean power generation and to low-carbon processes in industry. Significant energy efficiency opportunities also remain untapped. Drawing upon the strong Indian manufacturing ecosystem, deploying these technologies can provide quick and significant benefits across various sectors.

This publication is the result of the close engagement between the OECD, the Natural Resources Defense Council (NRDC) and the Government of India alongside other clean energy stakeholders. The *Roadmap* provides an overview of the latest developments in energy efficiency, offshore wind and green hydrogen in India, highlighting barriers to investment and identifying potential solutions. The report's tailored recommendations for the Government of India seek to strengthen the domestic enabling environment. The OECD also brings international experiences in other countries that can serve as examples and lessons learned for similar measures in India.

I hope that the OECD recommendations in this report not only help to strengthen India's domestic enabling environment but will also in turn help to mobilise private capital for investments in India's energy transition and its path towards sustainable development. The OECD stands ready to continue to support India in achieving net-zero emissions through the implementation of the report's recommendations.

Mathias Cormann
Secretary-General, OECD

Foreword

The Clean Energy Finance and Investment Roadmap of India is one of the key outputs of the Organisation for Economic Co-operation and Development (OECD) Clean Energy Finance and Investment Mobilisation (CEFIM) programme. The CEFIM programme aims to support governments in emerging economies in South and Southeast Asia, Latin America and Africa to enable finance and investment in renewable electricity, energy efficiency and decarbonisation of industry ("clean energy").

Building on fruitful co-operation between the Government of India and the OECD, this Roadmap supports India's efforts to realise its clean energy transition by providing a comprehensive overview of barriers and challenges to clean energy finance and investment, highlighting solutions to address risks and suggesting financing instruments that can help attract private capital for India's clean energy ambitions. Notably, this Roadmap identifies opportunities to scale up clean energy finance and investment for energy efficiency measures with a focus on micro, small and medium enterprises (MSMEs), offshore wind and green hydrogen production.

This report is an output of the OECD Environment Policy Committee (EPOC) and its Working Party on Climate, Investment and Development (WPCID). It was prepared with the support of the Natural Resources Defense Council (NRDC). It is authored by Joseph Cordonnier, Chetna Hareesh Kumar (OECD) and John Dulac (former OECD). Cecilia Tam, Team Leader of the CEFIM programme, oversaw the Roadmap process under the OECD CEFIM-India partnership. The Roadmap was developed under the lead of John Dulac and Poonam Sandhu (NRCD). The work was conducted under the overall supervision of Walid Oueslati, Acting Head of the Environment, Transitions and Resilience Division of the OECD's Environment Directorate.

The OECD and NRDC are grateful to the Government of India for its co-operation in preparing this Roadmap. Particular thanks is due to the Roadmap Steering Committee members: Shri Dinesh Jagdale, Joint Secretary of the Ministry of New and Renewable Energy (MNRE) and Shri Aseem Kumar, Director (MNRE); Shri Suman Chatterjee, Deputy Secretary of the Ministry of Power; Shri Abhay Bakre, Director General of the Bureau of Energy Efficiency (BEE), Shri R.K. Rai, Secretary (BEE), Shri Ashok Kumar, Deputy Director General (BEE), and Shri Arijit Sengupta, Director of International Cooperation (BEE); Md. Noor Rahman Sheikh, Joint Secretary of the Ministry of External Affairs (MEA); Shri Anand Kumar, Director at the Ministry of Finance Department of Economic Affairs (DEA); Shrimati Kanchan Bhalla, Deputy General Manager, of the Indian Renewable Energy Development Agency (IREDA), and Shri Ekansh Chaturvedi, Manager, Technical Services (IREDA); and Shri Rajnath Ram of the National Institution for Transforming India (NITI Aayog).

Additional thanks is due to the renewable energy and energy efficiency working group members under the Roadmap Steering Committee: Chalapathi Rao, Chandan Kumar, Prabir Kumar Dash, Dipesh Pherwani, Prashant Dwivedi, Rahul Rawat and Rishikesh Vaishnav (MNRE); Vineeta Kanwal, Richa Mishra, N Ganeshan, Malvi Mehrotra, Bibek Ranjan Patnaik and VK Srivastava (BEE); Kaumudi Sharma (DEA); Kannan Balaraman and Rajesh Katyal of the National Institute of Wind Energy (NIWE); Jai Prakash Singh of the National Institute of Solar Energy (NISE); Nikhil Gakkhar of the National Institute of Bio-Energy (NIBE); Abhik Debbarma (IREDA); Jatindra Nath Swain and Shailesh Kumar Mishra of the Solar Energy

Corporation of India (SECI); Rajiv Kumar and Pawan Kumar Bharti of the Small Industries Development Bank of India (SIDBI); Gagan Sidhu, Arjun Dutt, Tirtha Biswas and Rhudi Pradhan of the Council on Energy, Environment and Water (CEEW); Saurabh Kumar of Energy Efficiency Services Limited (EESL); Deepak Jain of the Power Finance Corporation (PFC); Chandrakant Salunkhe of the Small and Medium Enterprise (SME) Chamber of India; and Nisha Jayaram of the Confederation of Indian Industry (CII).

The OECD and NRDC would also like to give special thanks to Francis Jayasurya of the Global Wind Energy Council (GWEC), Amrit Singh Deo (FTI Consulting) of the India Hydrogen Alliance (IH2A), and Bhaskar Natarajan of the Alliance for an Energy Efficient Economy (AEEE), for their invaluable support throughout the Roadmap process and in carrying out consultations with key stakeholders.

This Roadmap benefitted from broad consultations with a wide range of stakeholders and with inputs from participants during the three Roadmap workshops and the review process. The OECD and NRDC are grateful for the many contributions, insights and comments from: Benjamin Denis, Alisée Pornet and Kedar Sawant (Agence Française de Développement); Satish Kumar and Deepak Tewari (AEEE); Ritu Lal (Amplus Solar); Manish Verma (Apraava Energy); Manohari Gunawardhena, Takuya Hoshino, Ashish Jindal, Takeo Konishi, Keerthi Kumar Challa, Emma Marsden, Sabyasachi Mitra, Pradeep Perera and Kenichi Yokoyama (Asian Development Bank); Rohit Shukla (Aura Safety & Risk Consultants); Narsimha Mummedy, Shivanand Nimbargi, Sharat Ranjan and Anirudh Somnath (Ayana Power); Kiran Singh (Bank of Maharashtra); Daniel Magallón (BASE Foundation); Niels Kristian Roejkjaer (Center of Excellence for Offshore Wind); Pooja Aswani, Baljinder Khurana, Jayant Prasad and Harshit Sharma (cKers Finance); Neha Kumar (Climate Bonds Initiative); Neha Khanna and Dhruba Purkayastha (Climate Policy Initiative); Kiran Ananth, Srishti Ashish, Babu Khan, Jyoti Mukul, Swati Pandey, Surender Rai and Sushmit Roy (CII);, Robert Helms, Niels Holst and Martina Tonizzo (Copenhagen Infrastructure Partners); Keld Bennetsen (Copenhagen Offshore Partners); Amit Kakde (COWI Consulting Engineers and Planners); Simon Engfred Larsen (Danish Energy Agency); Matthew Delany, Rasmus Kristiansen and Jonas Millqvist (Danish Export Credit Agency); Sunita Awadh, Sunil Sharma and Ranjeet Sinha (Darashaw and Company Private Limited); Sabreen Ahmed and Piyush Sharma (Deutsche Gesellschaft für Internationale Zusammenarbeit); Alok Kumar (DNV GL); Madhura Joshi (E3G); Mrinal Bhaskar, Sumit Gaurav, Manoj Kumar and Girja Shankar (Energy Efficiency Services Limited); Adil Daruvala, Clare Heuer and Desikan Sundararajan (Equinor); Utkarsh Mathur (Ernst & Young); Heloïse Gornall-Thode (European Investment Bank); Delphine Brissonneau, Edwin Koekoek, Laurent LeDanois and Smita Singh (European External Action Service); Shikha Jain and Rita Roy Choudhury (Federation of Indian Chambers of Commerce & Industry); Chinmaya Acharya, Daniel Bradley, Priya Joshi, Monika Khanna, Neha Khosla and Srijith Menon (Foreign, Commonwealth and Development Office of the United Kingdom); Upendra Tripathy (Former and Founding Director General at the International Solar Alliance and former Secretary to the Government of India); Rakesh Aulaya, Devanshu Jain, Subhodeep Jash and Kerban Rajdeo (FTI Consulting); Sahil Chadha (Geostat); Rajendra Narkhede (Gexcon India); Raj Sekhar (Global Leadership Partners); Alastair Dutton, Anjali Lathigara, Joyce Lee, Martand Shardul and Rebecca Williams (Global Wind Energy Council); Jeewan Prakash Gupta, Dilip Jawale, Karen Landmark and Sturle Pederson (Greenstat); Raghav Handa (HSBC); Daria Nochevnik (Hydrogen Council); Umesh Sahdev (Hydrogenium Resources Pvt. Ltd); Ashok Yadav and Philip K P (IREDA); Piotr Bojek, Hana Chambers, Sofia Rodriguez, Cornelia Schenk and Disha Sharma (International Energy Agency); Ankita Bagri, Jahangir Sohrabzadeh and Aastha Tandon (International Finance Corporation); Herib Blanco (International Renewable Energy Agency); Gaurav Daga (Invest Tamil Nadu); Sunny Mehta (ITEN Media); Ankit Agarwal, Tatsuya Fuji and Toshihiko Kurihara (Japan Bank for International Cooperation); Kunro Hino and Aditi Puri (Japan International Cooperation Agency); Bikash Chowdhury (JSW Energy); Rukmini Parthasarathy and Ramana Reddy (KfW); Pandiarajan Sangappan (Leap Green Energy); Prasad Tanikella (LM Wind Power); Sidharth Jain (MEC Intelligence); Sahil Sharma (Ministry of Foreign Affairs of Denmark); Robert Johnson, KH Leow, Jonathan NeWin and Amanpreet Singh (Mitsubishi UFJ Financial Group); Anya Bharadwaj, Ashvini Kumar, Swati Narula and Akhilesh Tilotia (National Investment and Infrastructure Fund); Akanksha Golchha (NRDC); Jawahar Lal (NITI Aayog); Mangaljyoti Meena (Nordex Group); Lalit Birla (O2 Power); Jorge Goas and

Adrian Maqueda (Ocean Winds); Andrew Ho, Pushpanjali Prasad, Ulrick Stridbeck and Øyvind Vessia (Ørsted); Naveen Seth, Devika Sharma and Kanchan Zutshi (PHD Chamber of Commerce and Industry); Mahendra Rustagi (Pioneer Polyleathers Ltd); Charu Kaistha and P.K. Sinha (Power Finance Corporation); Vibhash Garg and Vaibhav Singh (PricewaterhouseCoopers); Arvind Kumar (Punjab National Bank); Nipun Dhingra, Sandeep Rawat and Mahesh Sikaria (Reliance Industries Limited); Shashank Adlakha, Aditi Garg, Deepak Gupta, Anurag Kumar, Balram Mehta, Ishan Nagpal, Kuhoo Saxena, Nagesh Sayam and Vivek Singla (ReNew Power); Matthew Dickie, Markus Kösters, Shreyas Rajagopalan and Prithviraj Sisodia (RWE); Sandip Gandhi, Neshan Jain and Sahil Sood (Shell); Gurunathan Arumugasamy and Jaganathan Nagapattinam Suri (Siemens Gamesa); Pawan Kumar Bharti, Santhosh K R, Ravindra Kumar Singh and Pranava Piyush (SIDBI); Narayan Hari, Ravi Kaushal, Udit Vij and Sanjay Wankar (State Bank of India); Henrik Stiesdal (Stiesdal); Giorgia Pasqualetto (Sustainable Energy for All); Swati Bharadwaj, Mudit Jain and Pankaj Sindwani (Tata Cleantech Capital Limited); Nupur Atarthi, Ganesh Bagave, Ramesh C, Vivek Dhakar, Swati Mehendale, Rahul Ranade, Paresh Sahasrabudhe, Rajiv Samant, Somnath Sinha and Vishnu Tripathi (Tata Power); Sunil Dhingra, Sachin Kumar and Girish Sethi (The Energy and Resources Institute India); Mathis Benéteau and Thomas Salez (DG Trésor France); Romanas Savickas (United Nations Environment Copenhagen Climate Centre); Debajit Das and Niranjan Deevela (United Nations Industrial Development Organisation); Mahmoud Jardaneh and Tavleen Kaur (United States Department of Energy); John Speaks (United States Department of State); Bill Block and Tiffany Munoz-Zegarra (United States Treasury); Ashok Kumar (URS Verification Private Limited); Wadia Fruergaard, Morten Soerensen and Amar Variawa (Vestas); Ajay Devaraj (Wind Pro); Abhishek Bhaskar, Mani Khurana, Oliver Knight and Mark Leybourne (World Bank); Kajol, Deepak Krishnan, Soham Kshirsagar, Vaisakh Kumar, Guncha Munjal and Ashim Roy (World Resources Institute); Gaurang Gupta and Vijeta Sheth (YES Bank Limited).

The OECD is thankful to the numerous experts and advisors from OECD member countries and their embassies working in India, who were supportive throughout the Roadmap process. Special thanks are due to His Excellency Freddy Svane, Ambassador of Denmark to India, and to Mr. Peter Bertrand and Mr. Kim Cook of the Danish Embassy in India for their support of this Roadmap. We are also grateful to Eleanor Criswell, team leader for the 26th Conference of the Parties (COP26) Energy Transition Council (ETC) at the United Kingdom’s Department for Business, Energy and Industrial Strategy (BEIS), and to Sally Taylor and Sanyukta Das Gupta of the British High Commission in India, for their kind support in organising dialogues with the ETC members and international donors working in India.

The authors thank Dominique Haleva (OECD) for administrative support and editorial assistance. Kriti Peter Seghal (NRDC) provided administrative support and helped facilitate the Roadmap workshops. Thanks are also due to Ines Reale and Nassera Belkhiter (OECD) for their support in running the online workshop events.

This Roadmap was made possible through the generous contribution of Denmark.

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Acronyms and units of measure

ADB	Asian Development Bank
AFD	Agence Française de Développement
BEE	Bureau of Energy Efficiency
BEIS	Department for Business, Energy & Industrial Strategy of the United Kingdom
CAPEX	Capital Expenditures
CEEW	Council on Energy, Environment and Water
CEFIM	Clean Energy Finance and Investment Mobilisation
CGTMSE	Credit Guarantee Fund Trust for Micro and Small Enterprises
CII	Confederation of Indian Industry
CLCSS	Credit-Linked Capital Subsidy Scheme
COP26	26th Conference of the Parties
COVID	Coronavirus disease
DEA	Department of Economic Affairs
DC-MSME	Development Commissioner of the Ministry of Micro, Small and Medium Enterprises
EEFP	Energy Efficiency Financing Platform
EESL	Energy Efficiency Services Limited
ESCO	Energy service company
ESI	Energy Savings Insurance
ESG	Environmental, Social and Governance
ESMAP	Energy Sector Management Assistance Program
FEEED	Framework for Energy Efficient Economic Development
Fx	Foreign exchange
GEF	Global Environment Facility
GHG	Greenhouse gas
GoI	Government of India
GW	Gigawatt
IEA	International Energy Agency
IH2A	India H2 Alliance
INR	Indian Rupee
IREDA	Indian Renewable Energy Development Agency
JICA	Japanese International Co-operation Agency
KfW	Kreditanstalt für Wiederaufbau
LCOE	Levelised Cost of Electricity
LCOH	Levelised Cost of Hydrogen
LED	Light-emitting diode
MEPS	Minimum energy performance standards
MNRE	Ministry of New and Renewable Energy

MoCI	Ministry of Commerce and Industry
MoF	Ministry of Finance
MoMSME	Ministry of Micro, Small and Medium Enterprises
MoP	Ministry of Power
MoU	Memorandum of Understanding
MSME	Micro, small and medium enterprise
MTEE	Market Transformation for Energy Efficiency
MTOE	Million tonnes of oil equivalent
NAPCC	National Action Plan on Climate Change
NBFC	Non-banking financial company
NDC	Nationally Determined Contribution
NIP	National Infrastructure Pipeline
NMEE	National Mission for Enhanced Energy Efficiency
NMRP	National Motor Replacement Programme
NRDC	Natural Resources Defense Council
PAT	Perform, Achieve, Trade
PEM	Proton Exchange Membrane
PFC	Power Finance Corporation
PRGFEE	Partial Risk Guarantee Fund for Energy Efficiency
PRSF	Partial Risk Sharing Facility
PSL	Priority sector lending
R&D	Research and Development
RBI	Reserve Bank of India
ROSHANEE	Roadmap of Sustainable and Holistic Approach to National Energy Efficiency
RPO	Renewable Purchase Obligations
SAMEEKSHA	The Small and Medium Enterprises Energy Efficiency and Knowledge Sharing
SBI	State Bank of India
SECI	Solar Energy Corporation of India
SIDBI	Small Industries Development Bank of India
SIDHIEE	Simplified Digital Hands-on Information on Energy Efficiency
SME	Small and medium enterprise
SSEF	Shakti Sustainable Energy Foundation
TCX	The Currency Exchange Fund
TEQUP	Technology and Quality Upgradation Support to MSMEs
TERI	The Energy and Resources Institute
TWh	Terawatt hour
UJALA	Unnat Jyoti by Affordable LEDs for All
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United National Industrial Development Organization
UNNATEE	Unlocking National Energy Efficiency Potential
USD	United States Dollar

Executive Summary

Roadmap action plan

This *Clean Energy Finance and Investment Roadmap for India* outlines critical actions to help unlock finance and investment for three clean energy areas, namely energy efficiency measures with a focus on micro, small and medium enterprises (MSMEs), offshore wind and green hydrogen. The following actions highlight key steps to engage stakeholders and build an enabling environment for investments in clean energy. It also identifies financing mechanisms to support market creation and development for these three areas that can unlock barriers to mobilising capital from domestic and international financial institutions.

Energy efficiency finance with a focus on micro, small and medium enterprises

Table 1. Main recommendations for Energy Efficiency development in MSMEs

Project cycle stage	Recommendations / Mechanisms	Category	Major risks or barriers addressed	Timeline	Leadership role
Technology upgradation	Set clear policy signals and develop further incentives to seek energy efficiency	Enabling	MSME lack of incentive to adopt energy efficiency measures	Short-term	MoMSME; BEE
Facilitating finance	Implement direct interest subsidies to MSMEs for energy-efficient technology upgradations	Financial	MSME challenges with high cost of finance	Short-term	BEE
Cross-cutting	Use the Energy Efficiency Finance Platform (EEFP) as a one-stop shop for data, informational tools and knowledge products	Enabling	MSME lack of awareness; MSME lack of technology/service providers; Financial institutions lack of data	Short-term to Mid-term	BEE (with international partners)
	Training and capacity building under EEFP to pool and coordinate efforts	Enabling	MSME and financial institutions' lack of awareness and capacity to carry out energy efficiency finance and investments	Mid-term to Long-term	BEE (with international partners)
	Energy savings insurance product and complementary measures for energy services market development	Financial	MSME lack of confidence in ESCO market; Financial institutions lack of capacity; Financial institutions high default risk perception	Short-term to Long-term	SIDBI (with international partners)
	Improved flexibility and efficacy of existing credit guarantees and lowered guarantee costs	Financial	MSME lack of collateral / guarantees; MSME inability to afford high cost of available finance and / or credit guarantees; Financial institutions high default risk perception	Short-term	SIDBI, SBI, private sector banks
Supplying finance	Develop a pilot targeted foreign exchange hedging facility providing concessional hedging products	Financial	International lenders' hedging costs	Mid-term to Long-term	SIDBI (with international partners)

Note: BEE: Bureau of Energy Efficiency; MoMSME: Ministry of Micro, Small and Medium Enterprises; ESCO: Energy Service Company; SIDBI: Small Industries Development Bank of India.

Enabling investment in offshore wind development

Table 2. Main recommendations for Offshore Wind

Project cycle stage	Recommendations / Mechanisms	Category	Major risks or barriers addressed	Timeline	Leadership role
Equipment and supply chains	Enable early domestic manufacturing capacity via export credits, tax relief, concessional finance or Production Linked Incentives (PLI) scheme	Financial	Lack of domestic manufacturing capacity	Short-mid term	MNRE; MoF; MoCI; foreign Export Credit Agencies
Logistics and related infrastructure	Build a long-term infrastructure plan to support offshore wind capacity additions and track the investment within the National Infrastructure Pipeline.	Enabling	Required support infrastructure	Short-mid term	MNRE; State transmission authorities; Port authorities
Operations and maintenance	Assess role of InvITs to recycle capital from operating units	Enabling	High capital requirements	Mid-term	MNRE; MoF; NIIF
Cross-cutting (Facilitating Finance)	Design and implement the Viability Gap Fund (VGF) scheme and clarify the amount and volumes in the Strategic Paper for Establishment of Offshore Wind Energy.	Financial	High capital requirements	Short-term	MNRE; MoF
	Set up a blended finance facility to facilitate investment	Financial	High capital requirement; Lack of co-ordination across actors	Short-term	MNRE (IREDA); NIIF; International organisations and donors such as MDBs

Note: The Strategic Paper for Establishment of Offshore Wind Energy already provides several clarifications. InvITs: Infrastructure Investment Trust; IREDA: Indian Renewable Energy Development Agency; MDB: Multilateral Development Banks; MoF: Ministry of Finance; MNRE: Ministry of New and Renewable Energy; MoCI: Ministry of Commerce and Industry; NIIF: National Investment and Infrastructure Fund

Enabling investment in green hydrogen development

Table 3. Main recommendations for Green Hydrogen

Value Chain stage	Recommendations / Mechanisms	Category	Major risks or barriers addressed	Timeline	Leadership role
Upstream Resources (Renewable Energy)	Design renewable energy auctions dedicated to Green Hydrogen and Green Ammonia producers	Enabling	Input cost of electricity	Short-mid term	MNRE (SECI)
Electrolysers	Extend production linked incentives for domestic manufacturing.	Financial	Lack of domestic manufacturing capacity	Short-term	MoF / MNRE / MoCI
Hydrogen Production - Electrolysis	Explore credit enhancement mechanisms (e.g., Viability Gap Funding)	Financial	High capital requirements	Short-mid term	MoF / MNRE (IREDA)
	Develop mechanisms to reduce offtake and revenue risks (e.g., green mandates coupled with CfD or double auction process)	Financial	Offtake risk Revenue volatility	Short-term	MNRE; Design with international partners

Transport & Storage	Include green hydrogen infrastructures under the Harmonized Master List of Infrastructure Sub-sectors; and in the National Infrastructure Pipeline	Enabling	Required support infrastructures	Short-mid term	MoF
Cross-cutting	Create a blended finance facility to de-risk and mobilise private capital	Financial	High capital requirements; Lack of co-ordination across actors	Short-mid term	MoF / MNRE / MDBs (e.g., ADB, World Bank)
	Define a sustainable finance taxonomy[1)]	Enabling	Lack of recognition of environmentally sustainable investments	Short-term	MoF
	Define green hydrogen standards and implement a certification and tracking scheme	Enabling	Lack of green hydrogen standards	Short-mid term	MNRE / international organisations
	Design a pipeline of GW-scale green hydrogen hubs	Enabling	Policy mid/long-term clarity	Short-mid term	Public-Private taskforce

Note: This recommendation would apply beyond green hydrogen and could also support investment in offshore wind or energy efficiency. It is particularly salient for green hydrogen, as it is a nascent product without any consensual definition. ADB: Asian Development Bank; IREDA: Indian Renewable Energy Development Agency; MDBs: Multilateral Development Banks; MoF: Ministry of Finance; MNRE: Ministry of New and Renewable Energy; MoCI: Ministry of Commerce and Industry; NIIF: National Investment and Infrastructure Fund; SECI: Solar Energy Corporation of India.

1 Introduction

This chapter introduces India's ambitious clean energy transition goals as well as the levels of finance and investment needed to achieve them. It provides an overview of the clean energy finance and investment landscape in India, highlighting current sources of finance and the opportunities and limitations involved in scaling them up to required levels. This chapter also notes that the objective of the Clean Energy Finance and Investment Roadmap for India is to build consensus on a clear action plan to scale up finance and investment in three of India's clean energy sectors, namely energy efficiency in MSMEs, offshore wind, and green hydrogen. Finally, it describes the consultative approach employed in the development of this Roadmap and details the steps and timeline followed during the stakeholder engagement process.

India has achieved major advances in its energy sector over the last two decades, including increasing access to electricity for more than 700 million people since 2000[1] and achieving remarkable growth in clean energy technologies like solar power generation and energy-efficient appliances.

Energy policy reforms over the past decade have focused on creating enabling conditions to deliver on the government's ambitions to achieve an affordable, secure and sustainable energy system. The result has been spectacular deployment of renewable energy capacity additions and energy efficiency measures, with equally remarkable drops in technology costs. For example, the Government of India launched the UJALA light-emitting diode (LED) scheme[2] in 2015 to help households to save money on their electricity bills through efficient lighting. By January 2022, more than 365 million LED lights were distributed, saving an estimated 48 terawatt-hours (TWh) of electricity over seven years and bringing the retail price of bulbs down from INR 300-350 (USD 3.80-4.50) per unit to less than INR 80 (USD 1) per bulb (PTI, 2022[1]).

Progress on clean energy technology deployment in India continues, for instance with 1.5 gigawatts (GW) of renewable electricity capacity added in the first four months of 2022, bringing the cumulative installed renewable power total to more than 155 GW.[3] Still, investment in renewable energy additions and in energy efficiency measures will need to scale up considerably if India is to meet the government's ambitions to have 50 percent cumulative electric power installed capacity from non-fossil fuel-based energy resources and reduce emissions intensity of its GDP by 45 per cent by 2030, compared to 2005 levels (Government of India, 2022[2]).

The COVID-19 pandemic and consequent recession in India also brought forward the critical need to align India's clean energy ambitions with the country's economic recovery plans, notably putting people back to work and ensuring a just energy transition, whilst enhancing India's capacity to achieve its sustainable development goals. For example, more than 110 million people are employed by micro, small and medium enterprises (MSMEs) in India, whose energy expenses can be as much as 35-50% of total manufacturing costs (SIDBI and ISTSL, 2016[3]). High energy intensiveness, due in part to widespread use of less-efficient technologies, can make MSMEs vulnerable to fluctuations in energy prices and can impact their overall competitiveness (Biswas, Sharma and Ganesan, 2018[4]).

Aligning recovery efforts with the clean energy transition, for instance through targeted financial vehicles for MSME energy efficiency upgradation, is therefore an enormous opportunity to spur affordable, reliable and sustainable growth in India. Not only will this realise positive impacts on climate, but it also will enable economic multiplier effects, for instance through clean energy infrastructure development and in skilled labour creation to implement India's clean energy transition.

To unlock these opportunities, targeted application of public funds, alongside international climate and development finance, can help to increase the overall flow of capital to renewable energy and energy efficiency development in India, for instance by addressing risks in financing projects. By targeting such barriers to finance and investment, these tailored interventions – ranging from training and capacity building to support for capital market tools such as green bond issuance – can "crowd in" investors and channel private capital at the required scales to meet India's clean energy ambitions to 2030 and beyond.

Overview of clean energy finance and investment in India

India's intended Nationally Determined Contribution (NDC) in 2016 estimated that the country required around USD 2.5 trillion (INR 163 lakh crores) between 2015 and 2030, or roughly USD 170 billion (INR 11 lakh crores) per year, for climate action (Acharya et al., 2020[5]). Subsequent estimates suggested that as much as USD 30-33 billion (around INR 2.1-2.4 lakh crores) per year in investment was needed to reach India's renewable energy target of 450 GW installed capacity by 2030 (Dutt et al., 2019[6]); (Government of India, 2020[7]). The government also highlighted an investment potential of INR 8.4-12.6 (USD 120-175 billion), or roughly INR 1 lakh crore (USD 15 billion) per year on average, to achieve the country's energy-intensity reduction targets of 33-35% by 2030 (Kumar et al., 2020[8]). Financing needs could increase to achieve the updated NDC submitted by the Government of India in August 2022.

These investment needs are a substantial increase in comparison to current levels of spending on these sectors. In financial year 2019-2020, green finance flows in India amounted to USD 18 billion (INR 1.2 lakh crores) for energy efficiency and USD 22 billion (INR 1.5 lakh crores) for clean energy, driven by solar, onshore wind and hydro power (Khanna, Purkayastha and Jain, 2022[9]). India's renewable energy sector reached USD 14.5 billion in investment in the 2021-22 financial year (Garg, 2022[10]). This was an increase of 125% over 2020-21 investments and a 72% increase over pre-COVID pandemic levels in 2019-20. Still, it is less than half the average yearly estimated investment needed to reach 2030 targets. When grid firming (e.g. batteries and demand response management) and transmission and distribution infrastructure to accommodate 450 GW are included, this annual spending would need to more than triple over the next decade (Buckley and Trivedi, 2021[11]).

Announcements made by the Honourable Prime Minister Shri Narendra Modi at the 26th Conference of the Parties (COP26) to the United Nations Framework Convention on Climate Change (UNFCCC) in November of 2021, including India's goal to reach net-zero emissions by 2070,[4] mean investment needs may be even greater. The International Energy Agency (IEA) estimates India could need as much as USD 160 billion (INR 12 lakh crores) in clean energy investment every year on average over the next decade to meet these new targets. That is more than a tripling of current estimated investment levels in clean energy development (Birol and Kant, 2022[12]). Yet, it also is an enormous opportunity to spur a major clean energy market in India.

Current sources and limitations for clean energy finance and investment

Scaling up the levels of investment needed to achieve India's clean energy potential is feasible, but it will require new channels of financing beyond domestic financial institutions such as Larsen and Toubro, Yes Bank and Power Finance Corporation (PFC), which currently provide the bulk of clean energy finance, primarily through term loans (Esser, Gadre and Jaiswal, 2021[13]); (Vaze et al., 2019[14]). Given the quantum of financing required to 2030, these traditional lenders do not have the headroom to finance India's 2030 targets by themselves (Garg and Sidhu, 2021[15]).

Investments in renewable energy and energy efficiency come mostly by domestic banks, such as the State Bank of India (SBI), and non-banking financial companies (NBFCs) (Dutt, Arboleya and Mahadevan, 2019[16]). There has been a sharply increasing interest from international banks to finance clean energy projects via the external commercial borrowing route set up by the Reserve Bank of India, in particular through green bonds and sustainable bonds (The Hindu Business Line, 2022[17]). As these financings are usually denominated in USD, the competitiveness and attractiveness of these instruments may be challenged by the recent spike in the global interest rates.

One important challenge for current debt market financing of clean energy projects in India is the capacity to scale up this lending. For instance, exposure limits and bank liability profiles can be an issue for increased financing of energy efficiency projects, particularly in extending additional credit to segments such as MSMEs, which already fall under priority sector lending rules. Power sector credit exposure ceilings and bank liability profiles also affect capacity to increase lending for renewable energy projects. In fact, aggregate power sector exposure (across all generation types, transmission and distribution) for Indian banks was around INR 6 lakh crores (roughly USD 77 billion) in March of 2020, or around ten times the annual lending to renewable energy projects. When including Rural Electrification Corporation Limited and Power Finance Corporation, the two predominant NBFCs that lend to power projects, this outstanding exposure was more than INR 13 lakh crores (USD 168 billion) (Garg and Sidhu, 2021[15]).

Changes in late 2020 by the Reserve Bank of India (RBI) doubled the loan limit for individual renewable energy projects as priority sector lending to INR 30 crores (about USD 4 million) (RBI, 2020[18]). Yet in practice, this regulatory change does not necessarily address limits in lending for large-scale projects, such as capital-intensive offshore wind installations (Jai, 2020[19]). The RBI guidelines also did not directly address an underlying issue facing domestic financial institutions in extending new credit to clean energy projects: notably that already stressed assets, including non-renewable power generation, are a challenge to increased lending for clean energy projects. This challenge was only exacerbated by the global health pandemic and subsequent economic recession (Kaur, 2019[20]); (Dutt, 2021[21]); (PTI, 2021[22]).

A secondary loan market could help to address some of these limitations in sector lending, as has been the case in countries with robust clean energy markets. Yet, such a secondary market was only recently established in 2021 under a new self-regulatory body set up by ten lenders, including the State Bank of India, as per recommendations by an RBI taskforce (ETBFSI, 2021[23]). A deeper and more liquid bond market in India would also help to recycle capital by offloading existing assets from banks and NBFCs to institutional and retail investors (Sandhu et al., 2018[24]). In fact, foreign bond markets have already been used by a number of Indian renewable energy developers to refinance debt at more attractive terms, mainly for projects that have reached operational phase and therefore bear limited or no construction risks. Yet, use of these secondary markets for capital recycling remains limited, in part due to concentration of India's bond market in highly rated securities (i.e. AA and AAA ratings), which can be challenging for clean energy projects to achieve without an enhancement mechanism such as credit guarantee (Singh, Purkayastha and Shrimali, 2019[25]).

There are other, additional challenges to current clean energy finance and investment in India. One is that domestic financiers typically do not provide fixed-price loans for long-term tenure (15-18 years) for clean energy projects (Sandhu et al., 2018[24]). This is a particular challenge for capital-intensive clean energy projects, such as large-scale wind farms, especially when projects have longer payback periods. Many "deep" energy efficiency measures that achieve substantial energy reductions (e.g., 30-50% or more) also often have longer returns on investment, and thus can require long-term financing.

These issues are compounded by the overall cost of debt in India, including high variable interest rates, especially for smaller-scale clean energy projects like distributed renewable energy generation and MSME energy efficiency upgrades. For example, the cost of finance accounts for 50-60% of renewable energy tariffs in India (Chawla, Aggarwal and Dutt, 2016[26]). High cost of finance equally affects private sector spending. For instance, Indian corporates looking to issue bonds for clean energy projects can pay high coupons, as rates of the government-issued bonds are equally high (Vaze et al., 2019[14]). Thus, concessional finance could alleviate real and perceived risks and play a catalytic role to attract private sector participation. MDBs have engaged to provide consistent financial flows to support country's low-carbon pathways and have committed USD 66 billion in climate finance globally in 2020 (EBRD et al., 2021[27]). For instance, the Climate Investment Funds' (CIF) Clean Technology Fund has track record of supporting technologies such as solar power in India, working with Multilateral Development Banks (MDBs) that implement CIF funding (Invest India, 2021[28]).

Addressing these limitations and enabling the scale of capital needed to achieve India's clean energy targets to 2030 and beyond will thus require measures to address current risks and limitations in financing renewable energy and energy efficiency projects. This includes extracting lessons learned and good practices from global experiences in applying public funds to leverage private capital for clean energy projects (Box 1.1), especially as the Covid pandemic since 2020 and the global energy crisis since 2021 have shed light on the limited availability of public finance to achieve clean energy objectives. The overall scale of financing needed in India also requires use of instruments that can attract new investors and tap into capital markets, particularly as domestic banks and NBFCs realistically cannot double or triple their current levels of lending to projects.

Box 1.1. Global experiences in catalysing clean energy finance and investment

Lessons from global experiences in clean energy finance and investment show that targeted public interventions can support increased flows of capital to projects (Steffen, Egli and Schmidt, 2020[29]); (Wuester, Jungmin Lee and Lumijarvi, 2016[30]). For example, risk mitigation tools, such as the Partial Risk Sharing Facility (PRSF) for energy efficiency projects in India, have mobilised commercial capital for clean energy projects. Other transaction enablers, such as on-lending and co-lending structures, have helped financial institutions to gain confidence in lending to clean energy projects.

Common threads from experiences in applying and developing these financing vehicles highlight the importance of identifying the right instrument, where tailored solutions that address specific needs help to pave the way for private capital (OECD, 2021[31]). For instance, blended finance mechanisms have helped to de-risk investment in solar energy development and to leverage commercial finance for those projects. These solutions work best when interventions engage the right partners to ensure effective design and application. Lessons equally show that interventions are most effective when considering the eventual needs and risks of potential investors (OECD, 2022[32]).

The OECD Clean Energy Finance and Investment Mobilisation (CEFIM) programme works with governments, international partners and private sector actors to build evidence-based analysis on these tools and the market conditions that can improve finance and investment in clean energy development. A growing compendium of case studies and crosscutting analysis is available online and aims to provide a knowledge hub on experiences with solutions that can mobilise capital for clean energy projects.

Note: More information on the PRSF is available at www.sidbi.in/en/prsf-project. Further information on CEFIM programme analyses can be found at www.oecd.org/cefim/cross-cutting-analysis/.

Investor appetite and opportunities to channel capital for clean energy development

Clean energy projects in India already attract a wide variety of domestic and foreign investors, where India was ranked the most attractive emerging market for clean energy investment in Bloomberg New Energy Finance's Climatescope in 2019 (BloombergNEF, 2020[33]). In recent years, large clean energy players such as ReNew Power, Adani Green Energy, Greenko, Hero Future Energies and Azure Power have looked to tap into this investor appetite, issuing green bonds in overseas markets with an average oversubscription of 370%. Strong market response equally helped developers to tighten bond pricing, with an average interest rate of 4.2% in 2021 (Garg and Sidhu, 2021[15]).

Clean energy development is also attracting growing investment in Indian companies. For example, a consortium of investors led by BlackRock and the United Arab Emirates sovereign wealth fund, Mubadala, announced in April of 2022 that it was buying a 10.5% stake in Tata Power Renewables for USD 525 million (around INR 4 thousand crore) (Proctor, 2022[34]). In 2021, Total France acquired a 20% stake in Adani Green Energy, including a 50% stake in 2.35 GW of operating solar assets, for a landmark USD 2.5 billion (INR 18 000 crore) (Jai, 2021[35]). Emerging clean energy segments, such as green hydrogen development, have likewise raised considerable interest with international players. This includes a number of announcements in 2021 and 2022 for direct investments, joint ventures and co-operative agreements, such as a memorandum of understanding signed in 2021 between Ayana Renewable Power and the Norwegian company, Greentat (REGlobal News, 2021[36]).

These positive developments highlight the opportunity to channel private capital to clean energy projects in India and to increase the overall flow of financing for India's clean energy transition beyond traditional lending by domestic financial institutions. The growing use of capital market instruments like green bond issuances also illustrates the central role environmental, social and governance (ESG) funds can play in scaling up finance and investment in clean energy development. ESG loans and green bonds in India already represent more than USD 40 billion in cumulative debt issuances since 2010, where the energy sector has been the biggest recipient to date (Srivastava, 2022[37]). Substantial opportunity remains to tap into this growing market for India's clean energy development ambitions, where nearly USD 650 billion poured into ESG-focused funds globally in 2021 (Kerber and Jessop, 2021[38]).

Objective of this Roadmap

Enabling the prospects for sustainable recovery and unlocking the necessary capital to achieve India's clean energy ambitions requires a paradigm shift in current finance and investment. This includes channelling considerably greater levels of private capital to clean energy projects and attracting new investors such as ESG-focused funds.

Achieving this transformation will require a variety of measures that address risks and barriers for clean energy finance and investment through more targeted application of public finance, international climate and development funds, and other related support mechanisms. These can increase the pipeline of clean energy projects in India, redouble investor opportunities and crowd-in private sector finance.

This Roadmap thus aims to bring government and private sector stakeholders together to agree upon a clear action plan that identifies and addresses bottlenecks complicating or constraining finance and investment in India's clean energy sector (Figure 1.1). Specifically, the Roadmap seeks to identify solutions that can scale up finance and investment in offshore wind, green hydrogen and MSME energy efficiency upgradation.

The three focus areas have been selected in line with government priorities to unlock the potential for these segments within India's economic recovery plans and its Aatma Nirabhar Bharat (Self-reliant India) ambitions. The energy efficiency focus is on MSMEs, specifically addressing the challenge to access finance for these actors, although some recommendations can be extended to all sectors and industries. For renewable energy, OECD and NRDC discussed multiple priority areas with stakeholders, at distributed and utility-scale renewable additions, including for emerging market opportunities. The choice of offshore wind and green hydrogen lies in the need to anticipate solutions to develop emerging sectors to overcome issues with early inertia and to bring down costs down, even as mature markets like solar and onshore wind continue to evolve.

Figure 1.1. Roadmap overview

Note: Unless otherwise noted, figures by the CEFIM programme.

In the following sections, this Roadmap outlines key challenges to scaling up capital for these three clean energy segments, as well as opportunities to tailor policy and market interventions to unlock private capital for these sectors whilst lowering the overall cost of finance for projects. Through stakeholder consultations and engagement across a number of fora, including the three workshops (described below), the Roadmap takes into account current market conditions, including as global economy recovers from the COVID-19 recession. It also considers investor expectations and emerging market trends in order to identify solutions that can scale up finance and investment in India's clean energy projects, for instance as financial actors increasingly look for more climate and ESG-aligned investments.

Lastly, the Roadmap provides recommendations on actions that can be operationalised by the government with development partners, international donors and private sector stakeholders in order to unlock the capital needed to finance the clean energy transition in India. This includes suggestions on policy tools and potential investment vehicles that will help attract private capital at suitable scales.

Roadmap process and approach

The Roadmap is a strategic plan that describes the steps needed to unlock clean energy finance and investment for offshore wind, green hydrogen and MSME energy efficiency upgradation. This strategy was developed through a process that is as important as the plan itself, as the Roadmap aims to engage stakeholders in a common course of action that outlines priority areas and that assesses opportunities to address barriers to clean energy finance and investment through targeted actions. Through this process of engagement, the Roadmap aims to bring forward best practices and innovative solutions to improve the overall flows of capital to offshore wind, green hydrogen and MSME energy efficiency measures, both by improving the bankability of these projects and by attracting new investors to them.

The Roadmap process (Figure 1.2) was launched in June of 2021 with the formation of a government Steering Committee and Technical Working Groups (see below). Over the course of 2021-22, the core

Roadmap team, led by the OECD and NRDC, engaged with stakeholders in a series of consultations and three workshops.

These dialogues and stakeholder consultations highlighted several policy and market issues that may be hindering the flow of finance for clean energy development, in addition to recommendations on potential ways to overcome these barriers. The Roadmap subsequently proposes actions to implement these solutions in the next three to five years and aims to build consensus across government and partners on steps to operationalise these measures and unlock India's clean energy potential to 2030 and beyond.

Figure 1.2. Roadmap process through stakeholder engagement

Note: The colour coding suggests which actors can lead some key process steps, but several steps would involve several, if not all, listed stakeholder groups.

Roadmap Steering Committee & Technical Working Groups

The Roadmap was developed under the guidance of a Steering Committee comprised of representatives from diverse ministries across the government of India and chaired by the Ministry of New and Renewable Energy. Steering Committee members included:

- Shri Dinesh Jagdale, Joint Secretary of the Ministry of New and Renewable Energy (MNRE)
- Shri Aseem Kumar, Director (MNRE)
- Shri Suman Chatterjee, Deputy Secretary of the Ministry of Power
- Shri Abhay Bakre, Director General of the Bureau of Energy Efficiency (BEE)
- Shri Ashok Kumar, Deputy Director General (BEE)
- Md. Noor Rahman Sheikh, Joint Secretary of the Ministry of External Affairs
- Shri Anand Kumar, Director, Ministry of Finance, Department of Economic Affairs
- Smt. Kanchan Bhalla, Deputy General Manager, Indian Renewable Energy Development Agency
- Shri Rajnath Ram, Advisor, Advisor, National Institution for Transforming India (NITI Aayog).

In addition, two Technical Working Groups were formed under the Steering Committee on renewable energy and energy efficiency (Table 1.1). These working groups deliberated key issues for clean energy projects and provided valuable feedback throughout the Roadmap process. They were comprised of representatives from government, industry, financial institutions and policy advisors.

Table 1.1. Technical Working Group Members

Renewable Energy	Energy Efficiency
Ministry of New and Renewable Energy (MNRE)	Ministry of Power (MoP)
National Institute of Wind Energy (NIWE)	Bureau of Energy Efficiency (BEE)
National Institute of Solar Energy (NISE)	Small Industries Development Bank of India (SIDBI)
National Institution of Bio-Energy (NIBE)	Energy Efficiency Services Limited (EESL)
Indian Renewable Energy Development Agency (IREDA)	Power Finance Corporation (PFC)
Solar Energy Corporation of India Limited (SECI)	Confederation of Indian Industry (CII)
	Small & Medium Enterprises (SME) Chamber of India
Ministry of Finance Department of Economic Affairs (DEA)	
Council on Energy, Environment and Water (CEEW)	

Stakeholder consultations

To prepare the Roadmap and gather stakeholder inputs, the OECD and NRDC held consultations with more than 115 people across 54 organisations leading to the Roadmap workshops (see below). These consultations helped to improve understanding of the critical needs and expectations (e.g. risk and return profiles) of key actors engaged in clean energy project development, finance and investment. Stakeholders consulted included a range of actors from project developers and energy firms, industry and industry associations to government officials, financial actors, international donors and multilateral institutions, think tanks and non-governmental associations. Inputs and information from these consultations helped to frame the three Roadmap workshops. Stakeholders also provided invaluable feedback on recommendations for actions that can be taken to improve finance flows and attract investors for clean energy development in India.

Workshops

The Roadmap process brought together stakeholders through a series of three workshops:

- Workshop I (March 2022) to assess critical barriers and opportunities to prioritise action that improve clean energy finance and investment;
- Workshop II (May 2022) to identify and assess innovative solutions and effective investment vehicles that can deepen capital markets and mobilise stakeholders and investors;

- Workshop III (August 2022) to deep dive into two selected recommendations: an Energy Savings Insurance scheme for India (see Annex C) and blended finance facilities for Offshore Wind and Green Hydrogen (see Annex D).

In total, the three workshops brought together more than 200 participants from over 85 organisations representing government, civil society, industry, developers, financial institutions, international donors and multilateral development agencies. These workshops helped to bring forth a number of key opportunities and barriers that form the foundation of the *Roadmap* action plan, built on consensus from the workshop discussions. Summaries of the workshops are available at www.oecd.org/cefim/india/roadmap/.

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Notes

[1] For more information on energy access improvements, see: https://www.iea.org/topics/energy-access.

[2] For more information on the UJALA LED scheme, visit: http://ujala.gov.in/.

[3] Installed renewable electricity capacity includes large hydropower. For more information on renewable energy additions and total installed power generation capacity, see: https://mnre.gov.in/the-ministry/physical-progress and https://powermin.gov.in/en/content/power-sector-glance-all-india.

[4] See Prime Minister Shri Narendra Modi's remarks at COP26: www.mea.gov.in/Speeches-Statements.htm?dtl/34466/National+Statement+by+Prime+Minister+Shri+Narendra+Modi+at+COP26+Summit+in+Glasgow.

2 Energy efficiency upgradation, with a focus on MSMEs

This chapter dives into the opportunities and challenges to financing energy efficiency in India with a focus on MSME sector and proposes a set of recommendations to scale it up. It provides an overview of past and existing policy initiatives aimed at awareness, training, and capacity building as well as providing financial support to energy efficiency projects. It also illustrates the various challenges across a project cycle and highlights future opportunities to address them. Building on this background, this chapter sets forth seven recommendations on improving the enabling environment and financial support schemes to step up finance and investments for energy efficiency, in the MSME sector and beyond.

Industry is India's largest energy consumer, accounting for more than half of final energy consumption in the country and nearly one-quarter of India's total greenhouse gas (GHG) emissions (GoI, 2022[1]); (Gupta et al., 2019[2]). Industry energy intensity (energy consumption per unit of gross domestic product) could decline by nearly 50% over the next three decades, if energy efficiency measures are actively pursued (EIA, 2019[3]). Achieving these energy efficiency improvements would require more than INR 5-6 lakh crore (USD 62-73 billion) in total investments over 2017-2031, translating to annual investments of about 0.33-0.4 lakh crore (USD 4-5 billion) (BEE, 2019[4]).

Micro, small, and medium enterprises (MSMEs), which constitute more than 90% of all industrial units in India, play a critical role in industry energy consumption, even if their individual energy use is smaller than larger industries (GoI, 2022[1]). MSMEs are categorised on their annual investment and turnover amounts (Table 2.1), and altogether employ more than 111 million people. They also contribute to about 30% of India's gross domestic product, including around 40% of India's exports in value added (MoMSME, 2020[5]); (BEE, 2022[6]).

Table 2.1. MSME classification by investment and annual turnover in India

	Micro	Small	Medium
Criteria for investment in plant, machinery and equipment	Not more than INR 1 crore (USD 128 000)	Between INR 1-10 crore (USD 128 000-1.3 million)	Between INR 10-50 crore (USD 1.3 million-6.4 million)
Criteria for annual turnover	Not more than INR 5 crore (USD 640 000)	Between INR 5-50 crore (USD 640 000-6.4 million)	Between INR 50-250 crore (USD 6.4 million-32 million)

Note: Classifications are for revised criteria applicable with effect from 1 July 2020. Currency conversions based on USD 1 = INR 79.9.
Source Retrieved from: (MoMSME, 2020[7])

MSMEs in India consume around 50 million tonnes of oil equivalent (Mtoe) in energy each year, or roughly the total final energy consumption of Argentina in 2020 (IEA, 2021[8]). This represents roughly 25% of all the energy consumed by the industrial sector. Energy-intensive operations in MSMEs, due to use of less efficient technologies, disproportionately impacts their profitability and overall competitiveness (Biswas, Sharma and Ganesan, 2018[9]). Without measures to address this energy intensity, overall MSME energy demand could increase by an annual growth rate of 6% over the coming decade (BEE, 2021[10]).

MSME units in India are typically characterised by geographical and industrial clusters representing various energy-intensive sectors like foundries, refractories, metallurgy, brass, brick, glass, ceramics, textiles, dyes, chemicals and processed foods. These clusters can depend on obsolete and energy-intensive technologies that result in high energy consumption. For instance, electric motors and motor-driven systems account for about 69% of the total industrial energy consumption in India. While all imported and domestically manufactured motors are required to conform to minimum IE2[1] class of efficiency since 2018, a minor share (~5%) of the current motor stock in India is IE3 level or better (U4E, 2020[11]). Energy audits conducted as part of a joint MSME project by The Energy and Resources Institute (TERI) and Shakti Sustainable Energy Foundation (SSEF) in the Ankleshwar chemical cluster in Gujarat found that energy savings of 5%-6% could easily be obtained by upgrading or replacing existing motors with IE3 motors. If integrated with systems like variable frequency drives and soft starters, savings could easily reach 10-15% in energy reductions (SSEF, 2017[12]). 20-30% reductions are feasible through adoption of other known energy efficiency measures.

Overview of MSME energy efficiency developments and trends to date

Investment in energy-efficient technologies will play a critical role in addressing high energy costs for MSMEs, which affect their economic competitiveness as well as their capacity to expand production and market activities. The Government of India highlighted energy efficiency as a key priority area under its 2008 National Action Plan on Climate Change (NAPCC). Energy efficiency was also enshrined in the National Mission for Enhanced Energy Efficiency (NMEEE) in 2011, which included four priority schemes to support energy efficiency uptake through market-based mechanisms (BEE, 2021[10]); (Natarajan et al., 2021[13]):

- the Perform, Achieve, Trade (PAT) cap-and-trade scheme to reduce energy consumption in energy-intensive sectors;
- the Market Transformation for Energy Efficiency (MTEE) bulk procurement programme for energy-efficient appliances;
- the Energy Efficiency Financing Platform (EEFP) for raising awareness and building capacity of financial institutions, as well as to facilitate stakeholder interaction through a digital platform; and
- the Framework for Energy Efficient Economic Development (FEEED) to develop fiscal instruments that leverage finance for energy efficiency projects.

The Bureau of Energy Efficiency (BEE) acts as the statutory body under the Ministry of Power (MoP) for directing energy conservation and energy efficiency efforts under the NMEEE. From 2011 to 2019, NMEEE delivered a 15% decline in India's overall energy intensity (from 65.5 tonnes of oil equivalent per INR crore to 55.5 tonnes per crore), reducing carbon dioxide (CO_2) emissions by an estimated 178 million tonnes annually (Natarajan et al., 2021[13]).

In 2019, following the success of NMEEE, BEE developed a new strategic plan called Unlocking National Energy Efficiency Potential (UNNATEE) for 2017-2031 that identified energy efficiency opportunities to fulfil India's 2030 targets under its 2016 Nationally Determined Contributions (NDC) submission. UNNATEE set forth a framework for a revised and detailed action plan, called the Roadmap of Sustainable and Holistic Approach to National Energy Efficiency (ROSHANEE) to 2031, which outlines strategies to achieve India's NDC and the opportunities identified within UNNATEE. Specifically, ROSHANEE identifies 12 focal areas, including industries and MSMEs, each linked to new and existing energy efficiency programmes, such as the PAT scheme and its proposed expansion to certain MSME segments (BEE, 2021[10]).

Other past and existing initiatives address energy efficiency at the national, sub-national or sectoral levels.

Awareness, training and capacity building schemes

A key challenge hindering energy efficiency uptake in MSMEs is lack of awareness and technical capacity. Several initiatives have worked to address awareness and to provide training and capacity building for implementing energy efficiency measures in MSMEs (Table 2.2). These initiatives build on the success of BEE's National Programme on Energy Efficiency and Technology Upgradation of MSMEs (commonly referred to as the BEE SME Programme), launched in 2007, which focused on accelerating the adoption of energy-efficient technologies and practices in energy-intensive segments. The programme supported 100 technology demonstration projects in five sectors, including the preparation of cluster manuals, awareness raising, knowledge sharing and technical support (BEE, 2021[10]). Several other initiatives financed and supported by international funds, such as the Climate Investment Funds' (CIF) Clean Technology Fund (CTF) and Global Environment Facility (GEF), also have awareness and capacity building components, in addition to financial support (see Table 2.3 below on such schemes).

Table 2.2. Notable initiatives targeting awareness, training and capacity building of MSMEs

Name	Agencies	Timeframe	Description
National Programme on Energy Efficiency and Technology Upgradation of MSMEs (BEE SME Programme)	BEE	2007 (ongoing)	Flagship programme covering awareness and capacity building, energy benchmarking, and technology demonstration projects in 35 MSME clusters
Energy Conservation Guidelines for the MSME sector	BEE	2019	A document compiling best operating practices and equipment information for 25 energy intensive MSME sectors
CII-Godrej GBC Resource Centre	CII-Godrej GBC	-	A resource centre providing sector-specific analysis, technology compendiums, benchmarking manuals, and case study booklets
Energy Saving Equipment List	JICA	2008 (ongoing)	A list of energy-efficient technologies, technical specifications, and technology providers produced as part of the JICA-SIDBI MSME Energy Saving Project (Phase I) and regularly updated in subsequent phases
Energy Efficient Technologies List for Financing	BEE	2022	A list of energy-efficient technologies and their technical specifications, average investment amounts, savings, and payback periods.
Simplified Digital Hands-on Information on Energy Efficiency (SIDHIEE)	BEE	2019	A knowledge portal compiling resources like case studies, best operating practices, and details of latest energy efficient technologies
Small and Medium Enterprises Energy Efficiency Knowledge Sharing (SAMEEKSHA)	BEE, TERI	2017	A platform for knowledge-sharing and supporting collaboration among industry, technology specialists, research institutions, government bodies, training institutes, funding agencies and academia
SIDBI Knowledge Repository	SIDBI	-	Digital portals providing MSMEs with simplified access to handholding support and expert mentors for financial and non-financial needs
Multimedia tutorials	BEE	2007-2017	50 multimedia tutorials on energy efficient technologies developing for over 20 energy intensive SME sectors showcasing their benefits and operation
TERI-SDC Scaling up Energy Efficiency in Small Enterprises	TERI, SDC	2014-17	Promoting the use of energy-efficient technologies in MSME sectors (foundry, aluminium, etc.) by sharing best practices and providing implementation support

Note: This list in non-exhaustive. CII = Confederation of Indian Industry; GBC = Green Business Centre; JICA = Japanese International Cooperation Agency; SDC = Swiss Agency for Development and Cooperation; SIDBI = Small Industries Development Bank of India; SME = Small and medium enterprises.
Source: (Mishima, 2018[14]); (BEE, 2020[15]); (Natarajan et al., 2021[13]); (Biswas, Sharma and Ganesan, 2018[9]), (BEE, 2022[16]).

Financial support schemes

Other initiatives have looked to address the financial barriers to energy efficiency in MSMEs. The Small Industries Development Bank of India (SIDBI) is the apex financial institution providing concessional financial products or risk mitigation instruments, including credit guarantees, microfinance, SME ratings, technology support, and use of fund-of-fund support for venture capital funds. SIDBI also plays a nodal role in financing and implementing programmes in partnership with international organisations and financial institutions such as World Bank, GEF and the United Nations Industrial Development Organisation (UNIDO) (Table 2.3).

In addition, international finance has been channelled through SIDBI's bilateral credit lines with partners such as the German Kreditanstalt für Wiederaufbau (KfW), the French Development Agency (Agence Française de Développement, AfD) and the Japanese International Cooperation Agency (JICA). These credit lines have extended more than USD 1 billion (INR 7 800 crore) in financing for equipment, technologies and process improvements to about 6 000 MSMEs (Agrawal, 2016[17]).

Several initiatives have tried to address the high perceived default risk of financial institutions lending to MSMEs by providing a first loss facility. In 2012, BEE set up the Partial Risk Guarantee Fund for Energy Efficiency (PRGFEE), covering up to 50% of energy efficiency loans up to INR 10 crore (USD 130 000) per project (Natarajan et al., 2021[13]). However, the programme did not receive any applications from financial institutions during its seven years of operation and was eventually closed. Subsequently, the World Bank partnered with SIDBI to set up the Partial Risk Sharing Facility (PRSF), which provides up to

75% risk coverage on energy efficiency loans and had guaranteed over USD 18 million (INR 14 lakh crore) in energy efficiency projects by March 2020. The PRSF has also earmarked funding for technical assistance and capacity building initiatives (Reddy, 2020[18]).

Table 2.3. Notable initiatives providing financial support to MSMEs

Name	Agencies	Timeframe	Funding	Description
Partial Risk Sharing Facility (PRSF)	SIDBI, WB, GEF, CIF's CTF, EESL	2015 (ongoing)	USD 43 million (INR 336 crore)	Provides partial default risk coverage to 14 partner financial institutions on loans to energy efficiency projects implemented by 18 approved ESCOs via energy savings performance contracts; also provides technical assistance and capacity building to ESCOs
Credit Guarantee Fund Trust for Micro and Small Enterprises (CGTMSE)	MoMSME, SIDBI	2000 (ongoing)	INR 7500 crore (USD 960 million)	Facilitates access to collateral-free credit for micro and small enterprises by providing credit guarantee cover of up to 85% on loans up to INR 200 lakh (USD 256 thousand)
Promoting Energy Efficiency and Renewable Energy in Selected MSME Clusters in India	GEF, UNIDO, BEE, MNRE, MoP, MoMSME	2011-2019	USD 33 million (INR 258 crore)	Supports market environment for energy-efficient technologies in energy-intensive applications, initially through pilot projects in 12 MSME clusters across 5 sectors
Financing Energy Efficiency in MSME Programme (FEEMP)	GEF, WB, SIDBI, BEE	2010-2019	USD 16 million (INR 125 crore)	Provides concessional financing through a revolving fund and support for awareness and capacity building, energy audits, and implementation of measures
Promoting market transformation for energy efficiency in MSMEs	GEF, EESL, UNIDO, BEE, MoMSME SIDBI	2021 (ongoing)	USD 31 million (INR 242 crore)	Providing demonstrations of 35 energy-efficient technologies in 10 energy-intensive MSME clusters for possible demand aggregation through ESCO financing model; aims to set up a revolving fund mechanism to ensure replication
SIDBI Venture Capital Limited (SVCL)	SIDBI	1999 (ongoing)		An investment management company under SIDBI providing equity capital to start-ups and early-stage SMEs in manufacturing, agricultural and service sectors

Note: This list is non-exhaustive. EESL = Energy Efficiency Services Limited; ESCO = Energy service companies; MoMSME = Ministry of MSMEs; MNRE = Ministry of New and Renewable Energy; WB = World Bank.
Source: (Natarajan et al., 2021[13]); (BEE, 2021[10]); (BEE, 2020[15])

Other MSME support schemes

Other initiatives targeting MSMEs have played a complementary role in encouraging energy efficiency uptake (Table 2.4). For example, support schemes offered by the Ministry of Micro, Small and Medium Enterprises (MoMSME) do not explicitly target energy efficiency but can indirectly result in energy efficiency uptake. This is especially the case for erstwhile MoMSME schemes supporting technology upgradation, including the Credit Linked Capital Subsidy (CLCS) component of the Credit Linked Capital Subsidy and Technology Upgradation Scheme (CLCS-TUS) and Technology & Quality Upgradation Support for MSMEs (TEQUP). These schemes offered capital investment subsidies (up to 25% of project cost) for MSMEs to upgrade to improved (often energy-efficient) technologies. Though a large proportion of funds allocated to the TEQUP scheme was left unutilised, MoMSME disbursed around INR 5685 crore (USD 711 million) to almost 88 000 MSMEs through the CLCS component of the CLCS-TUS scheme over its lifetime (Biswas, Sharma and Ganesan, 2018[9]), (MoMSME, 2021[19]). Although both schemes have been discontinued, MoMSME is considering a new and revised capital subsidy scheme to support micro and small enterprises in the manufacturing and services industry to upgrade to domestically-produced technologies (MoMSME, 2021[19]).

Table 2.4. Other MSME support schemes relevant to energy efficiency

Name	Agencies	Timeframe	Description
Credit Linked Capital Subsidy (CLCS) component of the Credit Linked Capital Subsidy for Technology Upgradation Scheme (CLCS-TUS)	MoMSME, SIDBI, 9 empanelled PSBs	2000-2020	Provided capital investment subsidy (up to 15% of project amount) for MSME technology upgradation projects along with linked credit from nine empanelled financial institutions for the remaining project amount.
Technology & Quality Upgradation Support for MSMEs (TEQUP)	MoMSME	2010-2017	Provided capital investment subsidy (up to 25% of project amount) to encourage MSMEs to adopt Energy Efficient Technologies (EETs) along with linked credit from empanelled financial institutions for the remaining project amount.
Interest Subvention Scheme for Incremental Credit to MSMEs	MoMSME	2018-2021	Provided interest relief of 2% per annum on the incremental amount of working capital sanctioned or incremental term loan disbursed by eligible institutions to eligible MSMEs. Maximum financial assistance was capped at INR 100 lakh (USD 125 000) per MSME.
Zero Effect-Zero Defect (ZED)	MoMSME	2016 (ongoing)	Provides financial and technical assistance for MSMEs to achieve ZED certification, which certifies the quality and environmental friendliness of manufactured goods.

Note: This list is non-exhaustive. PSB = Public Sector Banks.
Source: (Natarajan et al., 2021[13]); (BEE, 2021[10]); (BEE, 2020[15])

Energy efficiency ambitions to 2030

In its latest NDC submission of August 2022, India has committed to 45% emissions intensity reduction of its GDP by 2030 compared to 2005 levels ((PIB, 2022[20])). Given the sizeable and growing contribution of MSMEs in India's industry energy consumption, promoting the uptake of energy-efficient technologies and process improvements for MSME units will play a central role in achieving India's energy efficiency ambitions to 2030.

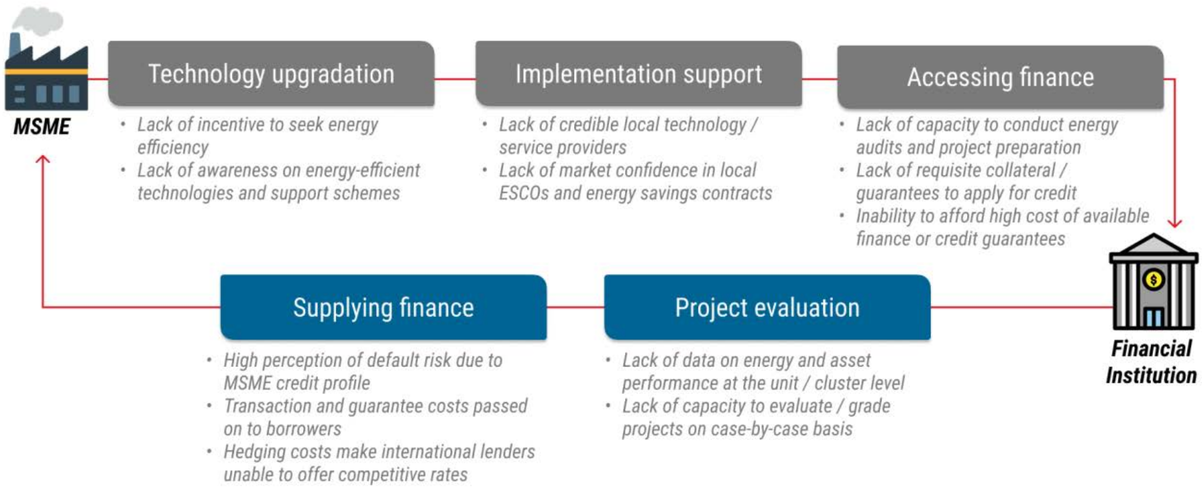
Barriers and challenges

While past schemes and policy programmes have led to considerable progress, several barriers continue to impede MSME energy efficiency adoption, including challenges financial institutions face in offering energy efficiency finance to MSMEs.

Broadly speaking, typical barriers can be categorised as challenges linked to awareness, capacity, and the costs of financing energy efficiency (Figure 2.1). For example, MSMEs often lack knowledge and awareness about energy-efficient technologies, good practices and the process to avail of financing, for instance through government schemes (ACMFN, 2019[21]). Part of this is also due to lack of incentive to voluntarily seek energy efficiency investments that are not directly linked to improvements in production capacity or export competitiveness, such as energy conservation measures (SSEF, 2017[22]). The result is a shortage of demand for energy efficiency measures by MSMEs.

Capacity to undertake the necessary steps to implement efficiency measures or to access financing is another challenge for MSMEs. One study on the factors influencing uptake of energy efficiency in MSMEs found that whilst 56% of surveyed enterprises monitored and recorded their energy use, only 35% had had conducted an investment-grade energy audit within the previous three years (Biswas, Sharma and Ganesan, 2018[9]). Many MSMEs also lack technical expertise or capacity to fulfil project preparation and documentation requirements for financing. Low availability of credible providers of energy-efficient technology and services (e.g. energy savings companies or ESCOs) at the local level, as well as the lack of confidence in energy service contracting, further impedes MSMEs capacity to implement efficiency measures.

Figure 2.1. Illustrative challenges in MSME energy efficiency finance along project cycle



Source: Authors

Absence of comprehensive data on energy consumed in the roughly six thousand MSME clusters in India also hampers efforts to improve energy efficiency uptake in MSMEs (Biswas, Sharma and Ganesan, 2018[9]). Efforts such as a 2012 benchmarking and data mapping of 36 MSME clusters across India helped to assess energy savings potential from specific energy-efficient technologies, but work is still needed to track MSME energy consumption to inform energy efficiency opportunities (TERI, 2012[23]). Available data and sharing of success stories also can be an issue to encourage replication of energy efficiency measures in other MSME units (SSEF, 2017[22]).

Access to affordable financing is another critical challenge for MSMEs, particularly given their smaller operations and smaller capital base (Natarajan et al., 2021[13]). In fact, self-financing was listed as the major source of financing for both capital and operational expenses for a majority of enterprises (Biswas, Sharma and Ganesan, 2018[9]). MSMEs looking for financing also often feel that their project loan proposals get rejected due to lack of requisite collateral or guarantees (SSEF, 2017[22]). While schemes like the CGTMSE enable access to collateral-free loans by providing a credit guarantee (up to 85% of project amount), the cost of availing such guarantees is often prohibitively high for MSMEs. Another challenge is the overall lack of suitable finance solutions, such as cash-flow based financing options, to support energy efficiency investments by MSMEs.

These barriers are compounded by similar challenges for financial institutions. For instance, commercial banks and non-banking financial companies (NBFCs) often lack sufficient awareness and capacity to apply energy efficiency financing concepts (e.g. technical risk factors in the appraisal process) (BEE, 2021[10]). Energy and asset performance data is also scarce, both at the unit or cluster level, contributing to an already high perception of risk by financial institutions. Lack of data and standardised documentation contributes to high transaction costs as well, for instance from due diligence to assess the expected return of measures on a case-by-case basis. This contributes to the high turnaround time for processing MSME loans and can further hamper financial institutions' willingness to lend to MSME energy efficiency projects (RBI, 2019[24]). Other issues, like hedging costs faced by international lenders, can further increase the overall cost of financing.

There can be other issues that compound these barriers due to awareness, capacity and cost of finance. For example, a number of initiatives, such as the erstwhile CLCS-TUS and TEQUP, provided considerable financial support to MSME technology upgradation, including for energy-efficient technologies. Yet, these did not necessarily require energy efficiency measures to qualify under the schemes. Credit guarantee schemes like the CGTMSE and the PRSF likewise face challenges, such as delays in support payments, which may limit their use in practice. Programme costs (e.g. for processing and fees) also can add to cost of finance, discouraging use of these support mechanisms.

Opportunities and solutions

Several opportunities exist to enable MSME energy efficiency finance and investment, including measures that build upon current initiatives for awareness raising, training and capacity building. Others can address the overall cost of finance for MSME energy efficiency upgradation, whilst support for innovative solutions and new business models, for example through energy service contracting, can enable greater uptake of energy efficiency solutions by MSMEs (Table 2.4).

Many previous efforts have addressed lack of awareness and capacity through cluster-level knowledge dissemination and technology demonstration workshops, although the reach and replicability of such initiatives remains a challenge. Awareness programmes are often constrained by short funding timeframes, such that the project reporting phase begins before all programme targets are achieved. A survey of MSMEs that participated in energy efficiency workshops reported that only around 50% of participants were satisfied with the frequency, practical training, and case studies used in these workshops (Biswas, Sharma and Ganesan, 2018[9]). Further, such awareness programmes and workshops tend to be carried out in silos, despite the potential to achieve greater scale by pooling resources.

Table 2.4. Barriers to MSME energy efficiency financing addressed by past or existing measures

Actor	Project cycle stage	Barriers addressed	Past / Existing measures
MSME	Technology upgradation	Lack of incentive to seek energy efficiency	• GEF-UNIDO-EESL Promoting market transformation for energy efficiency in MSMEs
		Lack of awareness on energy efficient technologies and support schemes	• *National Programme on Energy Efficiency and Technology Upgradation of MSMEs (BEE SME Programme)* • *Promoting Energy Efficiency and Renewable Energy in Selected MSME Clusters in India* • *Financing Energy Efficiency in MSME Programme (FEEMP)*
MSME	Project implementation	Lack of credible local technology / service provider	• GEF-UNIDO-EESL Promoting market transformation for energy efficiency in MSMEs • *JICA Energy Saving Equipment List* • *BEE Grading of Energy Efficiency Projects (under 4E Programme)* • *Promoting Energy Efficiency and Renewable Energy in Selected MSME Clusters in India*
		Lack of market confidence in local ESCOs and performance-based contracting	• GEF-UNIDO-EESL Promoting market transformation for energy efficiency in MSMEs
MSME	Accessing finance	Lack of capacity to conduct energy audit and project preparation	• End-to-End Efficiency (4E) Programme • *National Programme on Energy Efficiency and Technology Upgradation of MSMEs (BEE SME Programme)* • *Promoting Energy Efficiency and Renewable Energy in Selected MSME Clusters in India* • *Financing Energy Efficiency in MSME Programme (FEEMP)*
		Lack of requisite collateral / guarantees to apply for project finance	• World Bank – SIDBI Partial Risk Sharing Facility (PRSF) • Credit Guarantee Fund Trust for MSMEs (CGTMSE)

			• Credit-Linked Capital Subsidy Scheme (CLCSS) • *Technology & Quality Upgradation Support for MSMEs (TEQUP)*
		Inability to afford high cost of available finance and / or credit guarantees	• *MSME Interest Subvention Scheme*
Financial institution	Project evaluation	Lack of data on energy and asset performance at the unit / cluster level	• TERI Small and Medium Enterprises Energy Efficiency Knowledge Sharing (SAMEEKSHA) • *JICA Energy Saving Equipment List* • BEE Energy Efficiency Financing Platform (EEFP)
		Lack of capacity to evaluate / grade projects on case-by-case basis	• *BEE Grading of Energy Efficiency Projects (under 4E Programme)* • GEF-UNIDO-EESL Promoting market transformation for energy efficiency in MSMEs • *Financing Energy Efficiency in MSME Programme (FEEMP)*
Financial institution	Supplying finance	High perception of MSME default risk	• World Bank - SIDBI Partial Risk Sharing Facility
		Due diligence costs passed on to borrowers as processing fees	• GEF-UNIDO-EESL Promoting market transformation for energy efficiency in MSMEs
		Hedging costs make international lenders' rates uncompetitive	

Note: The list of existing measures and potential measures to address risks is not exhaustive. Measures in italics indicate past programmes; non-italics indicate existing ones. Details of past and existing measures mentioned in this table are given in Table 2.2, Table 2.3, Table 2.4.

BEE signed a Memorandum of Understanding with Office of Development Commissioner of the Ministry of MSMEs (DC-MSME) in 2019 for joint implementation of a programme for “Promoting Energy Security of the MSME sector” addressing awareness and technical capacity building. The programme, still awaiting implementation, will be a step in the direction of greater co-ordination across government authorities. It also is an opportunity to build upon the experience and lessons learned from BEE and DC-MSME initiatives, which can help to improve continuity and replicability of programme outcomes in the future.

Policy can also include financial or regulatory incentives and demand aggregation measures. Targets and policies, such as state-level energy efficiency obligations, green product standards for export, or higher minimum energy performance standards (MEPS) for widely used equipment (e.g. electric motors) can be effective in promoting MSME uptake of energy efficiency. Further, multilateral funding sources can be availed of to develop and deploy customised energy-efficient technology solutions for key MSME segments (see Annex B). BEE is likewise considering the expansion of the PAT scheme to certain MSME clusters, as originally proposed under ROSHANEE, to further incentivise energy efficiency investments. Revised versions of past MSME schemes providing credit subsidies for technology upgradation, like CLCS-TUS and TEQUP, likewise could explicitly include energy efficiency as a criterion for eligibility or preferential financing terms..

On the financial institution side of the equation, Roadmap stakeholders noted that modifying certain RBI regulations could potentially increase commercial lending to MSME energy efficiency. Examples include declaring energy efficiency as a requirement under priority sector lending (PSL) rule or making the 90-day default window flexible to accommodate MSME's variable cash flows. Concessional financing terms to nodal financial institutions under upcoming technology upgradation schemes could similarly induce them to prioritise energy efficiency lending.

Several opportunities exist as well to improve the availability of MSME data and boost lender confidence in MSME energy efficiency projects. Initiatives have been undertaken by various ministries and independent agencies to collect data and develop knowledge products required by MSMEs and financial institutions to finance energy efficiency, but these remain widely dispersed and difficult to access. Consolidating this data and information would greatly improve transparency and serve as a foundation on which further data collection efforts can be based. Additional proposals from stakeholders include measures to appropriately classify existing data on lending to MSMEs for energy efficiency (e.g., by defining simplified criteria for tagging energy efficiency loans among technology upgradation loans) and to centralise and consolidate unit-level and cluster-level data (e.g., by incentivising MSMEs to file energy returns, digitising existing data from past projects and support schemes, improving digitalisation, and strengthening the monitoring, reporting & verification process on future support schemes).

BEE's new digital platform under the EEFP has the potential to serve as a centralised data and information repository. This project aims to develop a digital matchmaking platform, where MSMEs can register interest or propose energy efficiency projects by providing basic details, which will then automatically be screened and passed on to BEE and empanelled financial institutions for further evaluation. Currently, only two financial institutions (YES Bank and the Indian Renewable Energy Development Agency) are empanelled with the EEFP, and there is a need to engage more local commercial banks and NBFCs with existing banking relationships with MSMEs to facilitate wider reach.

Further, there is scope for the platform to integrate additional features, such as an up-to-date dashboard of indicators on financing activities (e.g. projects financed and total investments made by enterprise type), a monitoring, reporting & verification functionality (e.g. project-level savings achieved, debt service obligations, cost of equity, etc.), as well as a resource centre providing technical and financial advisory services on energy efficiency projects. Although the platform does not specifically cater to MSMEs, it could serve as a medium to consolidate key informational tools, such as lists of energy-efficient technologies (such as BEE's list released in September 2022), credible service providers and certified energy auditors, as well as simplified technical manuals (see Box 2.1 on an international example). These can help to address awareness gaps and ensure that matchmaking benefits are accessible to MSMEs.

Box 2.1. The Energy Efficient SME Platform for European Union countries

The Energy Efficient SME Platform (https://www.energyefficientsme.eu/) was developed with European Union Horizon 2020 funding on behalf of a consortium of knowledge institutes, non-profit organisations, and energy service suppliers from Austria, Germany, Italy, the Netherlands, Romania, and Sweden. The platform consolidates and publishes open-access information and resources to help SME clusters become more efficient and establish energy collectives with their local trusted partners.

Resources on this digital platform are organised into four key pillars:

- Explore – provides a Handbook with detailed information on the energy collective approach.
- Implement – provides practical guidelines, training materials and tools on a variety of topics, such as identifying relevant stakeholders, contracting energy service suppliers, identifying attractive energy efficiency technologies, self-evaluating energy consumption data and energy-related key performance indicators.
- Get Inspired – provides examples and best practices from other successful energy collectives.
- Interact – provides access to a community of energy collective developers to connect and exchange with

Source: www.energyefficientsme.eu/about/.

Previous initiatives by government agencies and international partners to create bankable and investor-ready projects have included capacity building elements for MSMEs (e.g., technical assistance for project preparation or financial support for investment-grade energy audits) as well as financial institutions (e.g., financial and technical support for energy efficiency project grading under BEE's pilot Grading of Energy Efficiency programme). For instance, Further efforts are needed to build trust, for instance, by involving and building capacity of local actors (e.g., state designated authorities, MSME cluster associations, local financial institutions) dealing directly with MSMEs.

Capacity and confidence-building are also necessary to support the development of ESCO markets in India. ESCOs serve as intermediaries in the energy efficiency financing value chain, delivering projects that are financed through resulting energy cost savings (IEA, 2021[25]). With the ESCO model, MSMEs can avoid large upfront capital investments by entering into energy saving contracts with ESCOs and paying in instalments with savings on their monthly energy bills. At the same time, ESCOs can offer an aggregated pipeline of projects for financial institutions, thus making them less exposed to individual MSME risks.

Despite the success of bulk procurement programmes run by the super-ESCO Energy Efficiency Services Limited (EESL) for energy-efficient street lighting and super-efficient air conditioners, the ESCO market in India is still at a nascent stage. In particular, there is a shortage of local-level ESCOs with the capacity to service the MSME sector. For example, EESL runs the National Motor Replacement Programme (NMRP), through which it aims to sell 40 000 IE3 motors to industry clients, but more targeted and localised efforts are required to reach MSMEs and achieve full energy savings potential (U4E, 2020[26]). Further capacity building programmes should thus focus on training and incentivising to local ESCOs to provide the full range of services needed by MSMEs clusters, from developing or procuring custom technology solutions to installing, operating and maintaining them.

Market confidence in energy performance contracting and the ESCO model can be strengthened by developing energy savings insurance, an innovative financial product that covers projected paybacks from capital-intensive energy-efficient technology investments. With such an insurance product, ESCOs can back their contractual guarantees for the performance of their products and MSME clients can be assured of compensation in case projected energy savings are not realised. Several components need to be designed and strengthened simultaneously to establish an energy savings insurance (ESI) model in India, including standardised energy performance contracting, third-party technical validation procedures and an ESCO financing structure (CFL, 2015[27]). International partners have previously supported the successful implementation of ESI models in Colombia and Mexico, as well as numerous pilot projects in other Latin American countries, and interest to develop these elsewhere is expanding (Box 2.2).

Box 2.2. Energy Savings Insurance Program in Colombia

Project objective

The Energy Savings Insurance (ESI) pilot program in Colombia was launched in 2016 under the leadership of Bancóldex, the Colombian national development bank, with financial and technical support from the Inter-American Development Bank (IDB) and the Climate Investment Facility's (CIF) Clean Technology Fund (CTF). The program offered a de-risking package consisting of both financial and non-financial elements designed to build investor confidence and drive investments in energy efficiency projects. The program was expected to support 104 firms to reduce about 13,977 tonnes of CO2 emissions annually through energy efficiency upgrades.

Barriers to investment

Energy-efficient technologies require higher upfront capital investments than conventional technologies, and returns are obtained over time in the form of energy savings and reduced energy bills. A key barrier to such investments is thus the lack of trust among investing firms that energy efficiency upgrades will deliver promised energy savings. Local financial institutions also lack the capacity to accurately evaluate creditworthiness of projects where eventual savings can be used to repay debt obligations, which further hinders firms' access to long-term financing at competitive rates for such projects.

Financing strategy

The ESI model combines medium- and long-term credit lines with three risk mitigation instruments that support the identification and structuring of technically robust and bankable projects: a standard contract, technical validation, and the energy savings insurance.

The standard contract establishes the responsibilities of the supplier (supply and installation of equipment, guarantees, and expected energy savings) as well as the customer (timely payments, access to facilities, and adequate maintenance of the equipment).

The technical validation is carried out by an independent validator who evaluates and confirms the project's technical potential to achieve the promised savings and verifies on site that the project has been built according to specifications. The validator also acts as an arbitrator in case of disagreements between customer and supplier in terms of actual savings generated by the project.

The energy savings insurance is activated upon technical validation of the project. It is a performance warranty provided by the supplier to the customer for the committed savings over the contract duration. If at any point in time, the project does not achieve the pledged savings, the insurance will financially compensate the client.

Insured projects are provided credit lines at special conditions, including preferential rates, grace periods and extended tenure. Additional incentives are also provided to investors and technology providers, including free technical validation, specialised technical support, access to capacity building services, expedited credit evaluation, and preparation and dissemination of success cases in events and electronic platforms.

Source: Inter-American Development Bank's website

Targeted risk mitigation and payment security mechanisms are equally required to reduce the cost of financing and to unlock greater private capital for MSME energy efficiency. Particularly in the context of ESCO development, payment security mechanisms to financial institutions can help build confidence in the nascent ESCO market. Currently, payment security for MSME energy efficiency projects is available through existing government guarantees under the PRSF and CGTMSE schemes. International development finance institutions also offer risk mitigation products (e.g. the UNLOCK credit guarantee and ARIZ risk sharing mechanism by AFD, the Sustainable Renewables Risk Mitigation Initiative by the Energy Sector Management Assistance Programme, etc.) but their applicability to small-scale MSME energy efficiency projects remains challenging.

Roadmap stakeholders noted that design improvements are needed to make existing schemes like the PRSF and CGTMSE more flexible, more accessible and more effective. For instance, current procedures to avail of credit guarantees under these schemes involve extensive paperwork and significant delays in fund transfers in case of invocation, thus reducing the utility of the guarantee for lenders. Moreover, the cost of availing of these guarantees (with guarantee and service fees accounting for up to 2% of project costs) is often passed on to MSME borrowers, thus limiting the efficacy of such schemes. Proposed measures to reduce guarantee costs include risk adjustments (e.g. reducing the default risk coverage to reduce exposure or implementing a portfolio risk-adjusted guarantee fee structure for financial institutions) and concessional finance (e.g. charging a reduced uniform guarantee fee for lending to MSMEs or offsetting guarantee costs with government or international finance) (RBI, 2010[28]).

Further measures to reduce the cost of finance include building upon existing initiatives, for example through cluster mapping and technology demonstrations, to reduce transaction costs and to ensure sufficient pipelines of energy efficiency data and demand. It is also important to ensure that general programme costs (i.e. administrative or “handholding” costs) of financial support schemes are not passed on to MSME borrowers and do not raise the eventual cost of finance.

Opportunities exist equally to address currency risks faced by international partners financing policy programmes targeting MSME energy efficiency or extending credit lines to MSME borrowers through local financial institutions. International lenders have more experience financing MSME energy efficiency projects and thus a lower risk perception, but currency hedging costs make their eventual costs of finance uncompetitive with local lenders. Such risks can be addressed by extracting lessons from foreign exchange hedging facilities, such as the Currency Exchange Fund (TCX) or MFX Currency Risk Solutions, which hedge impact investment projects through forward contracts and currency swaps. Tailoring such solutions, including addressing eventual regulatory barriers (e.g. limiting hedging by entities that do not hold the underlying asset) would help address costs.

Investment needs and financial support for energy efficiency

Estimated energy saving measures in the industry sector (including MSMEs and large industries) will require total investments of more than INR 5-6 lakh crore (USD 62-73 billion) to 2031 (BEE, 2019[4]). This represents roughly 45% of the total estimated potential investments of more than 10-13 lakh crore in energy savings measures in the overall economy across sectors to 2031. By comparison, over 1995-2018, only around USD 241 million (INR 1 900 crore) had been provided as financial support (including budgetary support, lines of credit, and grants) to roughly 8 000 MSMEs to implement energy efficiency measures (Biswas, Sharma and Ganesan, 2018[9]).

NRDC and the OECD assessed over 16 500 projects supported by the CLCSS and TEQUP schemes between 2016-21, where the estimated project capital expenditure (CAPEX) amount, based on the eligible amount of subsidy, typically fell between INR 0.2-0.6 crore (roughly USD 25-65 thousand). Additional data from MSME loan schemes offered by state banks and NBFCs showed that collateral requirements could often be in the range of 20-40%, suggesting that actual borrowed amounts (i.e. loans after the applied capital subsidy and collateral requirements) were in the typical range of INR 0.1-0.35 crore (roughly USD 13-45 thousand). Interest rates varied from as little as 6.75% to 27%, over tenures of 1.5 to 10 years (the average being around 5). Processing fees were as much as 1-3% (absolute) of those interest rates.

While these data are not necessarily a full picture of MSME financing, and while energy efficiency may not represent full project CAPEX, the spread gives a sense of magnitude and eventual implications for the cost of finance. For instance, reducing a five-year INR 0.2 crore loan by 1% or 2% (absolute) would reduce the overall borrowed cost to MSMEs by around INR 0.6-1.1 lakhs (around USD 800-1 500). Given current volumes under the CLCSS (around 8 500 projects are subsidised each year), a 1-2% interest rate reduction would thus represent as much as INR 350-800 crore (roughly USD 45-105 million) in eventual savings to borrowers. When considered within the context of scaling up MSME energy efficiency upgradation, for example if 2% of the roughly 10 million SMEs in India were to perform efficiency measures each year, savings from such improvements in the cost of financing could easily be in the INR 100-450 lakh crore (USD 1.5-6 billion) range over the next decade. Identifying and implementing measures to address the cost of finance, alongside other actions (e.g., training and capacity building to encourage energy efficiency adoption by MSMEs) will consequently play a critical role in unlocking those investment opportunities.

Roadmap to 2030

Meeting India’s NDC commitments and energy efficiency target by 2030 will require targeted action and tailored solutions through co-ordinated efforts across stakeholders, from energy efficiency stakeholders and MSME associations to state and central governments, financial players, local banks and NBFCs and international partners. Working together can bring forward solutions to address bottlenecks and enable the finance needed to unlock MSME energy efficiency potential.

Recommendations

The Roadmap proposes seven key recommendations to de-risk MSME energy efficiency investment and to enable the flow of finance to those projects. Proposed interventions are set forth across two key pillars: targeted enabling tools and specific financial support to address critical barriers in the MSME energy efficiency financing value chain. It should be noted that several of the following recommendations can be applied as well to promote energy efficiency across sectors beyond MSMEs.

Enabling tools

1. **BEE and MoMSME should jointly strengthen incentives for MSMEs and financial institutions to seek energy efficiency measures through use of policy “carrots” and “sticks”.**

   Enabling the flow of capital to MSME energy efficiency projects requires an established and trusted pipeline of projects for banks and NBFCs to finance. MSMEs often lack the incentive to take up energy efficiency measures and technologies, as these tend to be capital-intensive investments with long payback periods and potentially uncertain returns. Creating and strengthening incentives, for example through policy and regulatory tools, can help to overcome shortage of demand.

   - Financial “carrots” can incentivise MSMEs to invest in energy efficiency, for example, by offering preferential financing terms for energy-efficient technology upgradation under schemes such as CLCSS or TEQUP. Similarly, financial institutions can be encouraged to lend to MSME energy efficiency projects, for instance, through government schemes offering concessional financing (e.g. via on-lending) to target energy efficiency loans.
   - Regulatory “sticks” can facilitate energy efficiency uptake whilst discouraging the use of inefficient technologies, for example, by setting stringent minimum energy performance standards (e.g., for electric motors) and by making inefficient technologies ineligible for technology upgradation

subsidies. Obligations, for instance through state-level energy efficiency targets or by expanding the PAT scheme to medium enterprises or large SME clusters (appropriately targeted to avoid burdening struggling SME units) could also drive demand for energy efficiency.

2. **International partners should support the development of BEE's new facilitation centre to enable a one-stop shop for energy efficiency data and resources.**

   Raising awareness among MSMEs and financial institutions to ensure adequate demand for energy efficiency projects requires a clear evidence base to increase confidence in those investments. This includes making sure sufficient data and informational tools are readily accessible to stakeholders. BEE's new EEFP, with the right support from partners, can become a central hub for co-ordinating efforts to ensure future initiatives build upon previous successes and unlock opportunities for MSME energy efficiency financing.

   - The EEFP facilitation centre should work with domestic and international partners (e.g. MoMSME, TERI, JICA, etc.) to ensure the digital platform consolidates existing informational tools, such as sector-specific manuals on energy-efficient technologies, best operating practices, case studies and success stories, alongside information on available support schemes, lists of energy-efficient technologies and names of empanelled service providers.
   - The platform should consolidate existing project-level and cluster-level data on MSME energy performance (e.g., from past efforts by BEE, MoMSME and partners on energy mapping, energy auditing, detailed project preparation, standardised project documentation, and project evaluation and grading).
   - Building on SIDBI's existing Knowledge Repository, EEFP could incorporate an interactive community feature, where MSMEs can access a network of practitioners and experts to share insights, experiences and best practices.
   - International partners specifically can provide financial and technical support to consolidate existing data and resources that can be built upon in the future (e.g., by tagging of energy efficiency loans sanctioned through the platform and by regular updates of performance data, support manuals and lists of credible local service providers).

3. **International development partners with relevant Indian ministries should scale up, co-ordinate and pool training and capacity building efforts.**

   India's rich experience in awareness raising, training and capacity building along the entire MSME financing value chain underscores that these efforts are critical to enabling energy efficiency finance and investments. Given the scope and scale of MSME activities in India, it is essential that these efforts continue and are both scalable and replicable, so that initiatives do not result in one-off exercises.

   - BEE should continue to collaborate with other agencies (e.g. under the recent MoU between BEE and DC-MSME) to explore opportunities to pool resources and increase capacity building activities, for instance under possible collaboration with SIDBI's Knowledge Centre for MSMEs and in continued activities with internal partners.
   - Local actors, such as state designated authorities, MSME cluster associations and local financial institutions, should be involved to the greatest extent possible in these interventions in order to build trust and achieve maximum reach.
   - Special efforts should be made to target local ESCO capacity, as these actors have enormous, untapped potential to develop, procure, install, operate and maintain customised energy-efficient technologies that are needed by MSME industries and clusters.
   - International partners should support BEE's facilitation centre to play a role in coordinating training and capacity building efforts, possibly through the creation of a revolving fund, particularly given the scale and scope of these activities and required resources to maintain them.

Financial support

4. **BEE can target new interest subsidy support for MSME technology upgradation with the objective of lowering cost of finance for energy efficiency measures.**

While past technology upgradation schemes like CLCS-TUS and TEQUP have offered credit subsidies to partner financial institutions, experience so far suggests that more effort is needed to translate these subsidies into lower borrowing costs for MSMEs and address high collateral requirements.

- BEE should build on lessons and experiences from other programmes through interagency collaboration (e.g. with MoMSME on CLCS-TUS and TEQUP) in designing a new interest subsidy mechanism for energy-efficient technology upgradation in MSMEs.
- This new interest subsidy mechanism should include a monitoring and verification component to track its impact on eventual interest rates offered to MSMEs by partner financial institutions.

5. **SIDBI should work with BEE and international partners to improve the flexibility, pricing, and efficacy of existing credit guarantee schemes.**

Credit guarantee schemes like PRSF and CGTMSE mitigate the high perception of default risk, but corresponding guarantee fees and service costs charged to participating financial institutions add to the final cost of finance for MSME borrowers (including ESCOs). Complicated paperwork to avail of guarantees is another current deterrent to financial institutions, and delays in reimbursements lead to an additional cost of provisioning in lenders' books. Such issues need to be addressed to increase lender confidence in these mechanisms and increase their impact.

- SIDBI can take advantage of improved data through BEE's EEFP to target risks in its guarantee schemes, increase flexibility in the PRSF and CGTMSE mechanisms, and reduce the need for extensive paperwork. For instance, loan performance data can be used to assess the first signs of debt distress to redesign the schemes so guarantee payment is automatically triggered (e.g. within 30-45 days of default).
- SIDBI should explore mechanisms to reduce the cost of availing guarantees for MSME clients, for example by reducing the default risk coverage ratio (e.g. from 75% to 50%) or by charging a concessional guarantee fee for lending to MSME energy efficiency loans. SIDBI can also work with international partners to apply blended finance to partially offset guarantee fees and service costs.

6. **BEE and international partners should work together to pilot an energy savings insurance scheme (ESI) in India, while encouraging local ESCO market development in India (see Annex C).**

ESCO market development in India remains a key, untapped opportunity to increase energy efficiency deployment through demand aggregation and project pipeline creation. A robust ESCO market can equally help to reduce transaction costs and improve MSME access to affordable finance. To unlock India's ESCO market potential, financial instruments such as ESI are needed to address risks and improve confidence in the energy performance contracting model.

- BEE should work with energy efficiency stakeholders, domestic and international financial actors (e.g. insurance companies), and regulatory agencies (e.g. the Insurance Regulatory and Development Authority or India) to pilot an ESI product, building upon experiences and lessons learned from international experience with such instruments.
- Multilateral development banks and international donors can support the development of this ESI model, not only through direct financial support but also to support various elements of the insurance product (e.g. preparation of standardised documentation and technical validation methodologies).
- The scope of the new UNIDO-EESL Promoting Market Transformation for Energy Efficiency can be expanded to increase participation of local ESCOs (potentially with training and capacity

building services, for instance by EESL) and improve their capacity to implement performance-based contracting with an ESCO financing model.

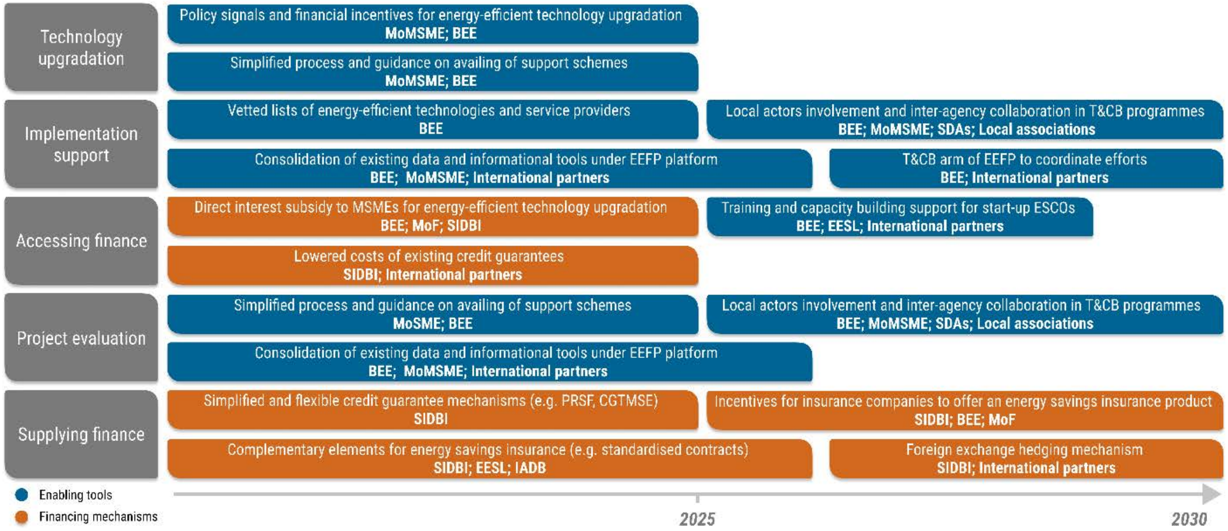
7. **SIDBI should work with MoF, MEA and international partners to establish a targeted foreign exchange hedging mechanism.**

Currency hedging costs can limit international lender support for domestic policy programmes and credit lines to support MSME energy efficiency investment. Establishing a targeted foreign exchange hedging mechanism with a suitable financial intermediary can help reduce these costs and enable greater international support for MSME energy efficiency measures.

- A foreign exchange hedging facility should be explored in earnest. A pilot programme, with support from international donors, can demonstrate the use of such a facility, ideally targeting financing for energy efficiency in the MSME sector. The said facility would be in-charge of channelling foreign currency loans, such that lending institutions are either able to avail of finance for further lending in INR or purchase currency swaps at a lower-than-market rate from the facility.
- This hedging facility could be housed within and managed by a suitable financial intermediary such as SIDBI or a public sector bank with foreign exchange capabilities (e.g. SBI), engaged with relevant ministries such as MoF, RBI and MEA.
- Blended concessional finance and grant support from international donors will be crucial to setting up the facility and make available low-cost currency swaps for early programme development.

Key actions and timeline

Figure 2.2. Overview of the main recommendations for Energy Efficiency of MSMEs until 2030



Note: T&CB: Training and Capacity Building; EE: Energy-efficient
Source: Authors

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Notes

[1] IE, or International Efficiency, is an international standard defined by IEC 60034-30-1, which stipulates the energy efficiency of low-voltage alternating current motors. There are four IE classes: IE1 represents standard efficiency; IE2 represents high efficiency, IE3 represents premium efficiency, and IE4 represents super-premium efficiency.

3 Offshore wind

This chapter explores the financing and investment pathway to achieve India's 2030 targets for offshore wind development. It summarises the key developments in the offshore wind sector to date, noting the results from several national and international initiatives. Furthermore, it highlights the barriers associated with offshore wind development at various stages of the project value chain as well as the policy opportunities to overcome them, acknowledging the expected impact of existing actions and strategies. It also provides an estimation of the investment needs for India's offshore wind goals, identifying levers to lower project costs and assessing their potential impact. Finally, this chapter sets forth seven recommendations on improving the enabling environment and financial support schemes to help mobilise finance and investments for offshore wind in India.

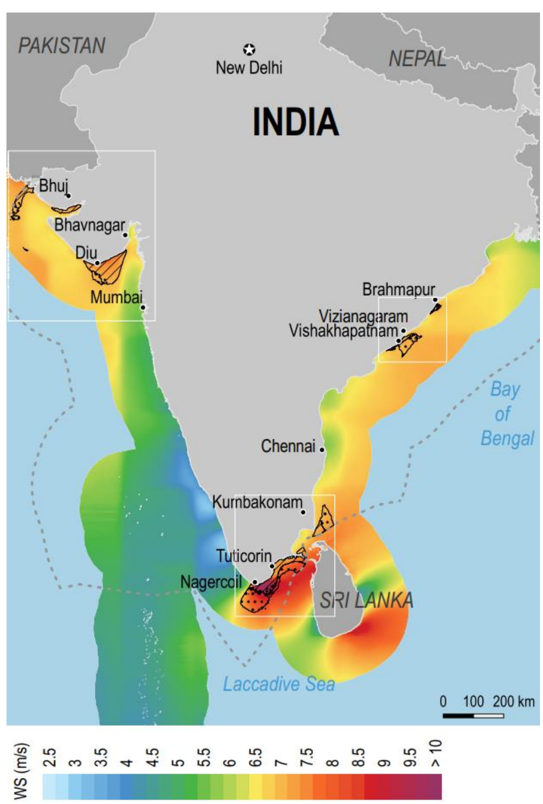
India's ambitions to achieve 500 GW of non-fossil fuel electricity generation capacity by 2030 requires substantial expansion of current clean energy development, which has been propelled to date by solar and onshore wind additions.[1] Unlocking the potential for new clean energy sources like offshore wind can help diversify India's electricity mix, with benefits from use of various sources of renewable electricity and their different production patterns, thereby ensuring a more consistent (i.e. less variable) energy supply to meet India's growing energy needs.

Offshore wind can also help to alleviate growing pressure from land competition for onshore wind developments. For example, changes in local land policies in the states of Gujarat and Tamil Nadu affected the cost and timelines for around 93% of onshore wind projects that were awarded through the central auctions in the two states (GWEC and MEC+, 2020[1]). Moreover, offshore wind typically has capacity utilisation factors of 40-45%, higher than onshore wind (30-35%) and solar power (20-25%), which can contribute to stabilising the power generation at state and country-level (Krishnan et al., 2022[2]).

India fortunately has a considerable coastline, with about 7 600 kilometres of relatively shallow waters near to shore (within 12 nautical miles) and an exclusive economic zone of over 2.3 million square kilometres (Kumar Dash, 2019[3]). The overall technical potential for offshore wind within 200 kilometres of India's coasts amounts to an estimated 174 GW[2] of power (Gulia and Jain, 2019[4]) (Figure 3.1).

The government has already identified early destinations for project development off the coasts of Gujarat and Tamil Nadu, amongst other possible sites such as the state of Maharashtra. Estimates by the National Institute of Wind Energy (NIWE) and by partners under the Facilitating Offshore Wind Energy in India (FOWIND) suggest that Gujarat and Tamil Nadu alone have more than 65 GW of combined potential offshore wind power potential in feasible zones.[3]

Figure 3.1.India's Offshore Wind Technical Potential



Note: The map displays the 100-meter height wind speed along the Indian coastline.
Source: (ESMAP, 2021[5])

Overview of offshore wind market developments and trends to date

The Ministry of New and Renewable Energy (MNRE) noted the important role that offshore wind will play in reaching India's renewable energy targets in its 2015 National Offshore Wind Policy,[4] which outlined several critical objectives to explore and promote offshore wind in India. It also identified NIWE as the nodal agency for development of offshore wind, including responsibilities to invite proposals for development of offshore projects, to co-ordinate resource assessments and to help developers to obtain approvals from various authorities, such as the Ministry of Environment, Forest and Climate Change (MoEFCC).

MNRE further clarified this policy framework through notices such as its 2018 Guidelines for Offshore Wind Power Assessment Studies and Surveys[5] and its 2022 Strategy Paper for Establishment of Offshore Wind Energy Projects.[6] NIWE also released a Wind Data Sharing Policy in 2019.[7] In addition, several notable initiatives, such as the FOWIND project, supported preparation of offshore wind development in India, for instance through technical reports, mapping and feasibility studies (Table 3.1). The Indo-Danish Centre of Excellence for Offshore Wind (COE-OSW) also organised several workshops in recent years to support planning and permitting, financial framework and auction design, grid and offshore wind supply chain infrastructure, technical standards and rules for innovation.[8]

Building upon these initiatives, MNRE announced its offshore wind energy targets in 2022, with ambitions to achieve annual capacity additions of 4 GW for three years from financial year 2022-2023, followed by 5 GW yearly till 2030, to reach a cumulative auction capacity of 37 GW in 2030 (MNRE, 2022[6]). Eight preliminary zones were identified in Gujarat, with a further eight zones identified off the coast of Tamil Nadu. Five and seven zones each, respectively, are expected to be available for exploitation, and NIWE carried out multiple studies for the first planned area in a 370 square kilometre zone (Zone 'B' near the port of Pipavav) in Gujarat. This included a two-year wind resource assessment through light detection and ranging (LiDaR) measurements. NIWE also prepared oceanographic, geophysical and geotechnical investigations for the zone, as well as a rapid environmental impact assessment.

NIWE issued an Expression of Interest in April of 2018 for 1 GW of capacity additions off the coast of Gujarat. Interest from developers counted 35 firms,[9] although projects did not proceed for a number of reasons, including high capital costs, infrastructure constraints and lack of a financial support scheme (GWEC, 2021[7]).

Further assessments, such as the project "Financial modelling of offshore wind farms in India" (FIMOI), as well as modelling and feasibility studies for Gujarat and Tamil Nadu, have since provided additional details on the expected levelised cost of energy (LCOE) for the first offshore wind projects and eventual support needed through the VGF (see Box 3.3). NIWE has conducted Geophysical and Geotechnical studies off Tamil Nadu coast, and NIWE is installing additional floating LiDaR to validate wind measurements. MNRE also noted that would invite developers to carry out detailed studies and surveys in other targeted zones, and that it was open to assessments for offshore wind project development within India's exclusive economic zone.

Table 3.1. Key assessments in support of offshore wind development in India

	Dates	Actors	Main Achievements	Link
Facilitating Offshore Wind Energy in India (FOWIND)	2013-19	GWEC-led consortium (C-Step, DNV GL, WISE and the GPCL), supported by the European Union	Identified 16 zones through offshore mapping and produced technical studies (e.g. on supply chain and port infrastructure) as well as pre-feasibility and feasibility reports for Gujarat and Tamil Nadu	https://gwec.net/members-area-market-intelligence/fowind/
First Offshore Wind Power project in India (FOWPI)	2016-19	COWI and WFMS, supported by the European Union	Provided technical assistance and produced studies (including surveys, environmental scoping, cost-benefit analysis, and conceptual design, etc.) leading to the pre-financial investment decision (pre-FID) for zone off the coast of Gujarat	https://www.cecp-eu.in/resource-center/post/fowpi-website/home
Financial modelling of offshore wind farms in India (FIMOI)	2019-22	COE-OSW, supported by the Government of Denmark	Produced LCOE estimates for the first offshore wind farm in India (February 2021) and updated cost assessments (April 2022), as well as a Technology Catalogue (February 2022) and LCOE and VGF tool (April 2022)	https://coe-osw.org/the-fimoi-report/

Notes: GWEC = Global Wind Energy Council; C-Step = Centre for Study of Science, Technology and Policy; WISE = World Institute of Sustainable Energy; GPCL = Gujarat Power Corporation Limited; WFMS = WinDForce Management Services Limited.

Offshore wind ambitions to 2030

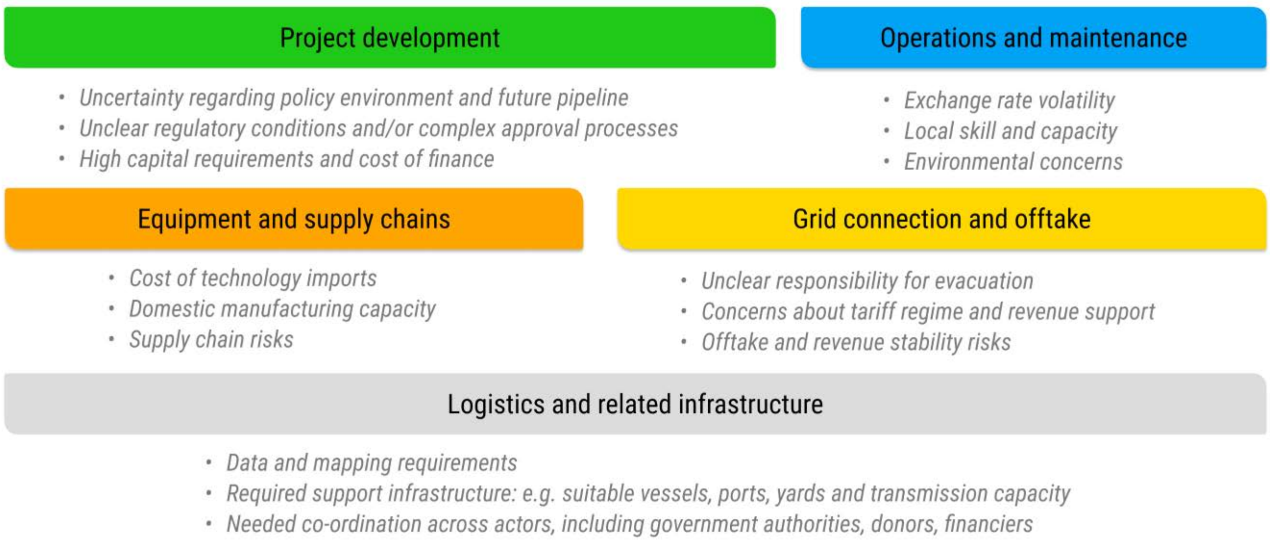
MNRE's emerging policy framework and initiatives such as the FOWPI and FIMOI studies are helping to bring together the various pieces needed to enable development of the first offshore wind projects in India. Continued collaboration with international partners, such as the joint collaboration between NIWE and the United Kingdom's Offshore Renewable Energy Catapult announced in May of 2022,[10] equally illustrates that there is strong interest to develop India's offshore wind market. This is reflected by similar announcements by developers and large industry players, like Tata Power and RWE Renewables, who signed a memorandum of understanding in February of 2022 to undertake technical and commercial assessments to facilitate offshore wind development (Frangoul, 2022[8]).

Nevertheless, unlocking the opportunity for offshore wind requires measures to build upon this momentum and address remaining gaps for finance and investment in project development. Targeted actions can deal with these barriers and ensure that the right policy clarity and market conditions are in place to make offshore wind projects in India an investable reality.

Barriers and challenges

Several key themes emerged from stakeholder consultations by the OECD and NRDC and in the first Roadmap workshop in March of 2022. These themes touched upon a number of potential barriers and challenges along the value chain for offshore wind development, which consequently affect finance and investment in projects (Figure 3.2).

Figure 3.2. Common risks highlighted by stakeholders in the value chain for offshore wind projects



Note: These illustrative examples of risks highlighted in stakeholder consultations are not exhaustive.

Stakeholders emphasised that precision also was needed within the regulatory framework on aspects such as technical standards, local content requirements, taxation, and elements like seabed rights and lease awarding criteria. The regulatory environment can also facilitate approvals across the multiple authorities[11] touching upon offshore wind development, where processes and timing for licensing and permit approvals under the 2018 Expression of Interest were an issue for some developers. Streamlining and centralising these approvals (e.g. through a "one-stop shop") would improve this process and leave developer risks as much as possible to the boundaries of actual construction.[12]

In addition, stakeholders consistently noted that policy and regulatory conditions needed to address core project risks, such as revenue stability. Clarity on who will bear these risks, for instance through precisions on offtake agreements and the sanctity of power purchase agreements, is critical in getting financial institutions and investors to sign off on projects. Eventual guarantees (e.g. using a payment security mechanism) would also help to mitigate these risks, as would clarity on expected incentives and support. For future additions, it will be important to highlight these conditions and/or intended cost-reduction strategies if the planned VGF will be phased out after the first capacity additions.

Data and mapping were likewise noted as critical elements for assessing risks, where developers noted a preference to collect detailed information themselves once given exclusivity to study specific zones. Needs for further assessments were also highlighted, for instance to reflect trends in plant load factor over time, which is challenging with only one or two years of data. This information is not only useful for developers but can also validate need for support (e.g. the proposed VGF), for example if average wind speeds are in a decreasing trend. Stakeholders noted they were looking for further clarity on who will bear the responsibility for these detailed studies and surveys in the future, and equally whether this information will be made publicly available.

Infrastructure development (e.g. ports, yards and transmission capacity) was stressed as well, as was the development of domestic manufacturing capacity and clear supply chains. These will ensure a functional ecosystem for offshore wind development, including one that is capable of meeting India's ambitious 2030 targets, and will play a key role in bringing down project costs. Importantly, stakeholders emphasised that logistics and value chain issues need to be treated in parallel to the first offshore wind projects, which realistically will rely on imported technology, in order to avoid major delays or hindered capacity additions. Ensuring sufficient market capacity (e.g. skilled labour) to deliver on 2030 ambitions likewise will help to lower offshore wind development costs.

Stakeholders indicated that there additionally may be potential environmental and/or social conflicts that require awareness raising and community outreach activities, where such issues have delayed or hindered projects in other countries (e.g. in fishing zones).

Lastly, stakeholders called attention to the high capital needs for offshore wind development and to the cost of finance as a critical factor in achieving offshore wind ambitions. Part of this cost of finance is due to project risks, which can be addressed through a clear policy environment and regulatory framework (e.g. through long-term power purchase agreements with off-takers with strong credit standing, or offtake guarantees to support weaker credits). Development costs can likewise be improved through support for a robust offshore wind ecosystem, for instance through support to enable domestic manufacturing capacity and supply chains. Yet even with these measures, stakeholders emphasised that meeting 2030 offshore wind ambitions will require solutions to raise sufficient scales of affordable capital (see section on investment needs below). Measures to encourage equity investors willing to bear early-market risks will help, but new sources of financing, including investment vehicles to pool different sources of finance, are needed to unlock a robust offshore wind market in India.

Opportunities and solutions

Targeted actions and tailored solutions can address these barriers and challenges to offshore wind development. This includes greater clarity on policy, which MNRE presented at the Roadmap workshops and in its updated strategy paper in July of 2022 (MNRE, 2022[6]) (Table 3.2).

The proposed VGF will apply to two tenders in 2023-24 and 2024-25, based on competitive bidding under a two-stage single bid process followed by a reverse auction,[13] and SECI will guarantee the offtake for these additions. Grid connectivity will be carried out through Powergrid and the Central Transmission Utility (CTU), where offshore transmission and evacuation infrastructure from the developer substation (metering point) to the onshore meeting/interconnection point will be socialised. Fixed 30-year floor (seabed) lease agreements, currently under preparation, will be signed with successful bidders and MNRE or a designated agency for an annual fee of INR 1 lakh (USD 1 300) per square metre for allocated blocks. However, in case the survey is conducted by a developer for blocks or sub-blocks allocated with exclusivity rights for a fixed period, the quoted lease fee would be paid up to the commissioning of the offshore wind project or a defined fixed period, whichever earlier. Awarded capacity will equally have up to four years for project development from the date of signing the concessionaire agreement.[14]

Table 3.2. Indicative auction trajectory for offshore wind developments, 2022-30

	Auction capacity under Model 1	Auction capacity under Model 2	Auction capacity under Model 3	Total auction trajectory (GW)	Cumulated auctioned capacity (GW)
2022-2023			4	4	4
2023-2024	1		3	4	8
2024-2025		2	2	4	12
2025-2026		4	1	5	17
2026-2027		4	1	5	22
2027-2028		4	1	5	27
2028-2029		5		5	32
2029-2030		5		5	37
Total	**1**	**24**	**12**	**37**	**37**

Notes: Model 1 corresponds to specific zones where MNRE or NIWE has conducted studies, and is eligible for VGF; Model 2 encompasses Model 2(A), where developers will carry out studies themselves, and where the winning bidder will benefit from VGF, whilst under Model 2(B) developers will carry out studies and secure bilateral power purchase agreements or captive consumption, without benefitting from VGF; Model 3 will apply to zones not covered in Model 1 and Model 2, where developers can be allocated exclusive rights to carry out surveys, develop projects and secure bilateral power purchase agreements or captive consumption, without availing of VGF.
Source: (MNRE, 2022[6])

Three potential models for capacity auctions

The "Model-1" approach may be extended to other zones where necessary studies and surveys have been carried out by NIWE. This model replicates the structure of comprehensive public-private partnerships, where the public sector bears risks that it is best placed to take on such as the transmission infrastructures, and the private sector is required to finance, build, and operate the generation units.

For other future tenders, MNRE indicated it would use a "Model-2" approach for other sites along India's coastline. Under this approach, developers will be able to select offshore sites to carry out necessary surveys and studies, subject to approval by NIWE. Project development can then happen either through bidding under Model 2(A), with offtake through SECI or a state distribution company (DISCOM), or through sale of power under the open access regime under Model 2(B) (i.e., a bilateral agreement).

The bidding mechanism in Model 2(A) would follow the same procedure as Model-1, whilst in the case of open access sale of power, developers will submit detailed project reports within five years of the date of consent issued by NIWE and will not have access to VGF. This period may be extended up to a maximum of six years on a case-by-case basis, after which point all clearances shall be withdrawn and developers shall submit their study and survey data with NIWE.

A "Model-3" approach, under which private companies will obtain exclusive rights to develop blocks for captive electricity consumption and will not avail of VGF, could also be rolled out (PIB, 2022[9]). This model requires limited support and intervention from MNRE, and a tender under Model-3 could be launched within a year, upon the notifications of lease rules.

In all three models, grid connectivity for projects to 2030 will be covered by CTU. Lease agreements likewise will be treated with MNRE or a designated authority. NIWE will facilitate all the stage I and II clearances under a single window for no objection certificates (NoCs). MNRE additionally clarified that support for projects beyond the first two tenders would include fiscal incentives, such as the waiving of transmission charges. It also noted and that renewable energy certificate (REC) multipliers would be explored as a possible developer incentive. However, some stakeholders highlighted that each model could be further improved to provide confidence, for instance by extending volumes benefitting from seabed exclusivity rights, which would facilitate the progress of development and feasibility studies.

Box 3.1. Experience from the Dutch model to de-risk offshore wind projects

The development of offshore wind farms is one of the pillars of the Dutch climate policy, who has set a target of 11.5 GW of installed capacity by 2030. The Dutch Government aimed to reduce pre-bid investment risks, especially by establishing the Netherlands Enterprise Agency as a one-stop-shop for the project developers. The approach of the Dutch policy was developed within an initiative to reduce the cost of offshore wind power generation by 40%.

The model was founded on several key principles, starting with the pre-selection of sites and the preparation of environmental impact assessment and studies, and collection of data under the coordination of the Ministry of Economic Affairs and Climate Policy and the Ministry of Infrastructure and Environment. The realisation of the grid connection is ensured by TenneT, the transmission system operator. Once all these preparatory steps are finalised, and after a public consultation, a Wind Farm Site Decision is issued, which provide the main technical requirement from construction until decommissioning, and the Netherlands Enterprise Agency starts coordinating the auction process. The Government grants the necessary permit to the winning project developer as soon as the result of the tender is confirmed.

With this model, the Dutch government considered the price as the key criteria to select the winner, as other matters were equal for all developer, by design of the tendering process. In addition, a price cap was set from the first auction in 2015, and gradually decreased over the next auctions. In 2018, Vattenfall was awarded with Hollandse Kust Zuid offshore wind farm project in a subsidy-free tender under this model.

Source: (PwC, 2020[10]), (Netherlands Enterprise Agency, 2022[11]), (BASF, 2022[12]), (EURACTIV, 2018[13])

Several initiatives can replicate successful experiences of other renewable sources

In addition, MNRE noted that the drafting of contractual documents (e.g. implementation, concessionaire and connectivity agreements) is being prepared. There equally are several on-going studies under bilateral and multilateral co-operations to assess port and logistic infrastructure, grid and transmission capacity needs, supply chain updates and marine spatial planning.

MNRE also is setting up a test facility to replicate the successful experience of test centres in the United Kingdom. The Indian site, on Rameshwaram Island, will allow for testing of equipment, providing important data to inform how to optimise technology. It will equally act as a research facility and training centre.

These announcements respond to several core barriers highlighted for offshore wind development. They also noted that further measures can accelerate opportunities for offshore wind projects. For example, MNRE could work with the Ministry of Power and the Central and/or State Electricity Regulatory Commissions to extend separate renewable purchase obligations (RPOs) for offshore wind, similar to what is already done for hydropower. This would boost demand for offshore wind capacity (notably beyond the first 3 GW of early additions) via DISCOMS' RPOs. Similarly, tenders could potentially bundle power, for instance to ensure round-the-clock power with offshore wind and other renewable energy sources. This approach worked well in the early days of solar in India, bundling it with cheaper thermal energy.

Replicating the solar approach to standardise contracting would likewise help to address project costs, as would eventual prequalification criteria for offshore wind projects. These can complement the single-window for stage I and II clearances under NIWE and facilitate the overall speed of project development.

Opportunities to address risks specific to the offshore wind industry

Production-linked incentive (PLI) schemes such as those offered by IREDA[15] can equally help to lower development costs, especially for scaling up capacity additions to 2030, by incentivising manufacturers to establish or expand production in India. Support by export credit agencies from other countries can similarly help to establish domestic supply chains for offshore wind development, as can other government-to-government or multilateral initiatives to address technology transfer, development and innovation.

Thorough risk studies can help to lower the cost of finance for projects, particularly as these provide additional comfort to investors, especially when paired with risk mitigation tools such as an offtake guarantee. Additional technical reports, such as on-going assessments looking at potential supply chain gaps and infrastructure needs will help developers and investors to assess expected project costs. Gains in project capital expenditure (CAPEX) will influence the overall need for financing, thereby addressing in part the cost of finance on offshore wind development.

Given the time between the beginning of project development and operations for offshore wind projects (typically between 5 and 7 years) and that the first offshore wind projects therefore will not be operational before subsequent auctions in the mid-2020s, stakeholders noted that the planned VGF may need to cover further rounds of project development (or by other support mechanisms). Using assessments like the FIMOI LCOE tool, MNRE could work with partners and international donors to close the eventual gap in expected VGF requirements beyond the first 3 GW. Lessons from the international experiences can also help identify suitable solutions for future capacity additions. For example, the contract for difference (CfD) model like that used in the United Kingdom could address risks for offshore wind projects beyond the planned VGF. Other market instruments (e.g. forwards, future, spreads and options) are also commonly used as hedging strategies against electricity price risks (Mbistrova and Nghiem, 2017[14]). Not only can these help to lower debt costs, but they can also help to increase debt capacity.

India can benefit from other international experiences in addressing offtake risk (both volume and price) and execution risks (e.g. operation and maintenance costs and resource uncertainty) (Krishnan et al., 2022[2]). For instance, global expertise in structuring PPAs to enable can help in financing of future offshore wind pipelines (Box 3.2). Similarly, lessons can be extracted from experiences in India with onshore solar and wind developments (e.g. the Madhya Pradesh solar park).

Lastly, greater co-ordination (not only government agencies but equally across developers, international partners and support such as development assistance) can help to avoid distortions in the market and ensure needs of the overall value chain for offshore wind (e.g. ports and transmission) are met. While bilateral initiatives can bring quick results, co-ordination across partners can deliver long-term benefits. For instance, a working group or country platform could help to co-ordinate public interventions, bilateral partnerships and international climate and/or development finance. Similar co-ordination already happens with industry and developers through initiatives such as the Indian chapter of the Global Wind Energy Council (GWEC).

Box 3.2. Denmark's offshore wind tender model

Denmark is a worldwide leader in the development of offshore wind, with 2.3 GW total installed capacity in more than ten wind farms, among which the first large-scale projects commissioned in 2002-2003 (WindEurope, 2022[15]). In 2020, the Danish Energy Agency has released a model for tendering offshore wind farms, building upon the country's experience in such projects. It highlights a range of risk mitigation measures implemented for upcoming tendering processes.

Preliminary studies co-ordinated by the power grid Transmission System Operator (TSO) will provide critical data on site resources, soil conditions, environmental impact on fauna and flora, as well as on traditional uses of the ocean, such as fisheries. This will provide crucial information for project developers, and the winning bidder will have to carry out additional studies in order to obtain permits and license to operate. In order to bring clarity on the licensing process, the tender material includes drafts prepared by the Danish Energy Agency.

The Danish Energy Agency initiated a negotiated procedure with prior call for competition, enabling the tenderers to discuss the conditions of the tender, and to propose modifications eventually leading to more competitive prices.

Given that the project lifetime will influence the return on investment, and therefore the bid price, the license duration has been extended to 30 years to correspond to the technical lifetime of the turbines, with an option to benefit from a further 5-year extension.

In parallel of the state tenders, Denmark has implemented an "open door" process, allowing project developers to apply to establish an offshore wind farm at the location of their choice. Subsequently, the Danish Energy Agency studies their proposal and grant the project developer the permission to undertake preliminary studies. This process can enable to speed up the deployment of renewable energy capacity.

Source: (Danish Energy Agency, 2020[16])

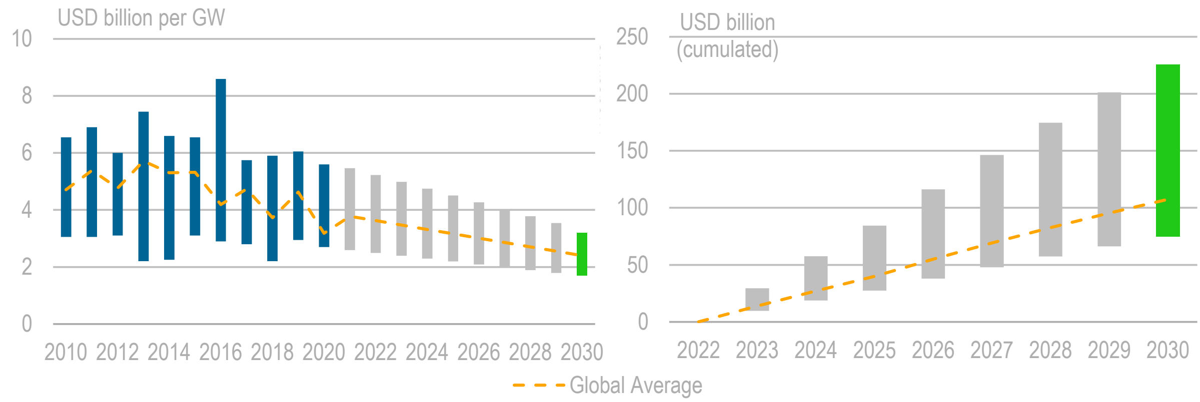
Investment needs and financial support for offshore wind

Exact costs for offshore wind project development depend on a multitude of factors, from location and technology choice (e.g. bottom-fixed or floating turbines) to import costs and relevant taxes. Operational conditions (e.g. plant load factor) and maintenance costs in turn influence developer expectations on LCOE, as do considerations for project risks such as payment delays or failures.

Globally, offshore wind costs continue to decline, from an average LCOE of around USD 0.162 (INR 7.41) per kilowatt-hour (kWh) in 2010 to USD 0.084 (INR 6.22) per kWh in 2020 (IRENA, 2021[17]). In terms of total installed costs, this represented a global average of around USD 3.2 billion (INR 0.24 lakh crore) per GW in 2020, although the range in CAPEX across projects varied considerably and reached more than USD 5.5 billion (INR 0.4 lakh crore) per GW.

Presuming India would benefit from international experiences and continued technology learning curves, CAPEX needs for 37 GW of offshore wind capacity over the next decade may be in the order of USD 75-150 billion (INR 5.7-11.5 lakh crores) (Figure 3.3). This follows a global average installed cost declining from around USD 3.7 billion (INR 0.28 lakh crore) per GW in 2021 to around USD 2.4 billion (INR 0.18 lakh crore) per GW in 2030, where this range is in line with suggested potential costs of USD 2-4 billion per GW as indicated by stakeholders during the Roadmap process.

Figure 3.3. Illustrative trajectory of installed costs and investment needs for offshore wind in India



Note: Given the performance achieved by India in other clean energy sectors, with total installed costs lower than the global average for solar and wind power (IRENA, 2022[18]), the likely target for India would be between the lower bound of the bars and the dotted line highlighting the global average.
Source: Adapted from (IRENA, 2021[17]) and using 2030 cost estimates from (IRENA, 2019[19]).

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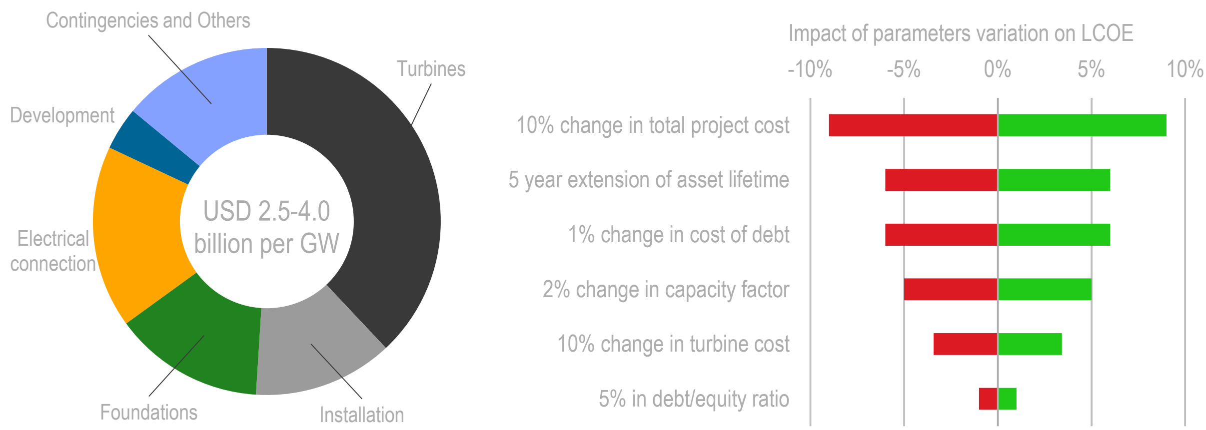
On a per unit basis, stakeholder estimates suggested that LCOEs for offshore wind projects in Tamil Nadu and Gujarat could be in the range of INR 7 to 9 (roughly USD 0.10-0.12) per kWh, potentially reaching INR 11 or 12 (USD 0.15-0.16) or higher per kWh for the first projects. A 2022 FIMOI study on cost estimates for the first offshore wind farms in India estimated that LCOEs for Tamil Nadu with Final Investment Decision (FID) in 2025 would be INR 7.4 (USD 0,09) per kWh and Gujarat would be INR 12.2 (USD 0.15) per kWh (COE-OSW, 2022[20]). Import duties, particularly for the first projects, and local content requirements would further increase these development costs.

Identifying levers to lower project costs will have substantial influence on the competitiveness of offshore wind solutions, where, for example, onshore wind tariffs in 2020 were around INR 2.8-2.9 per kWh (Bhatti, 2021[21]). Roadmap stakeholders highlighted that comparison to onshore wind and solar prices does not reflect the system benefits brought by offshore wind development in India and that it would make more sense to compare offshore wind to thermal power installations using natural gas, whose LCOE ranges from around INR 3.7 to 6.7 (USD 0.05-0.09)[16] per kWh (IEA, 2021[22]). Overall, there was strong agreement that offshore wind prices can come down substantially through a combination of measures that address project risks, alongside tools that address technology costs and the overall cost of finance.

The OECD and NRDC assessed the potential impact of various measures to address the cost of offshore wind development using the FIMOI LCOE tool developed by COE-OSW.[17] Technology costs, such as lower turbine costs, can substantially influence offshore wind LCOE (Figure 3.4). It is perhaps early to assess future operational opportunities, but extended asset lifetimes would also help to improve LCOE.

The cost of finance, with a typical lending interest rate of 9.5% in 2019 (Esser, Gadre and Jaiswal, 2021[23]), will equally play a critical role in achieving deployment targets to 2030 at more competitive LCOE. For example, lowering the cost of debt by 1% (over a base of 10%) for offshore wind projects could lower LCOE by as much as 5%. This represents a return of roughly USD 100 million for each GW installed, presuming a reference CAPEX of around USD 3 billion per GW.

Figure 3.4. Illustrative impact from the variation of parameters on offshore wind LCOE



Note: Illustrative sensitivity calculation based on USD 3 billion per GW at 45% capacity factor, 65/35 debt/equity ratio, 10% cost of debt and debt tenure of 10 years. Variation of the main parameters are based on typical standard deviations across projects.
Sources: Values and breakdown on the left chart based on (IRENA, 2021[24]), (IRENA, 2022[18]), (Lazard, 2021[25]). OECD analysis using COE-OSW FIMOI LCOE tool (COE-OSW, 2022[20]).

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Stakeholders noted that these solutions to lower development costs will require combinations of public and private capital, including possible blended finance from international donors, to address project risks and to support market development (e.g. to ensure training and capacity of local market actors). For instance, offtake guarantees and VGF will help to lower the cost of finance by directly addressing revenue stability and security, which are critical concerns for lenders and investors (Box 3.3). Stakeholders highlighted that these types of risk mitigation tools are more likely to affect the cost of finance relative to other options. For example, expanding Priority Sector Lending (PSL) rules to target offshore wind may help to increase overall lending to projects, and achieving lower rates for PSL loans compared with regular loans would reduce the cost of finance.[18]

Public financial institutions and international partners (e.g. export credit agencies) can also help to address the underlying cost of finance, for instance by providing combinations of equity and long-tenure loans (i.e. 15-20 years). Multilateral agencies and development finance institutions can likewise contribute by extending credit lines, by proposing partial credit guarantees or first-loss provisions, or by offering credit wrapping. They can also finance projects as co-participants or through other forms of blended finance to help close the viability gap of early projects to reduce the risks for private capital.

In addition to risk mitigation tools, public financial institutions such as IREDA can help to provide finance at more attractive rates. In fact, a parliamentary committee on energy recommended in early 2022 that IREDA should be given a special window for borrowing at repo rate (raised to 4.9% in June of 2022[19]) to ensure availability of low-cost funding for renewable energy projects, in line with the government's 500 GW target (FE Bureau, 2022[26]). The panel also recommended that MNRE should explore the possibility of exempting state-run lenders like IREDA, PFC and REC Limited from payment of guarantee fees (up to 1.2% per annum) for raising funds from multilateral agencies.

Box 3.3. Estimating the cost of VGF to unlock investment in offshore wind in India

The Indian Ministry of New and Renewable Energy (MNRE), the National Institute of Wind Energy (NIWE) and the Danish Energy Agency (DEA) have created a knowledge hub called the Centre of Excellence for Offshore Wind and Renewable Energy (CoE) in 2021. The CoE has launched the FIMOI tool in 2022, proposing a detailed economic assessment of the LCOE and dimensioning of a VGF to achieve a target price for offshore wind.

FIMOI estimates a rapid decrease of the LCOE between 2020 and 2030 in Tamil Nadu and Gujarat, respectively from INR 10.3 to 5.2 (USD 0.26 to 0.07) per kWh, and from INR 14.4 to 7.8 (USD 0.181 to 0.10) per kWh. Considering a target price of INR 3.5/kWh, which could enable offshore wind to be competitive on the Indian power market, an investment subsidy under the VGF scheme could amount to INR 0.5-0.6 lakh crores (USD 6.6-7.3 billion) for the initial eligible capacity of 3 GW.

The FIMOI analysis considers a full scope, although MNRE has informed that the transmission of power from the offshore substation to onshore transmission will be provided free of cost until 2030. By excluding this item, the dimensioning of the VGF could be reduced by close to one third for the first 12 GW. This would enable to reach a potential leveraging factor slightly above 1 to 1.

The FIMOI report highlights that the tool could be further developed and improved in the future by incorporating additional elements, for instance on taxes, other economic incentives beyond VGF, or the financing structure of the projects.

Source: (Centre of Excellence for Offshore Wind and Renewable Energy, 2022[27])

Stakeholders insisted that these types of support instruments, while taking different forms, should seek to address specific barriers to offshore wind development, notably taking on risks that are hindering private capital or that add to the cost of capital for projects. Additionally, stakeholders noted that the scale and complexity of offshore wind projects, including financing needed across the entire offshore wind value chain, means that support likely needs be multifaceted, potentially requiring multiple financial solutions and risk mitigation tools from a range of partners to enable an effective and robust ecosystem.

Moreover, there will remain substantial investment needs for offshore wind development to 2030 and beyond, even with early market support to address risks and achieve cost improvements. Stakeholders noted that no single bank or investor will be able to meet such intensive capital requirements. For example, domestic lenders, who play a key role in financing onshore wind and solar, already face power sector lending limits, and the overall magnitude of funds required for offshore wind (e.g. USD 2-5 billion per GW) will require them to tap into other financial pools, such as secondary markets. Private players, including big industry, will also need to guarantee a certain return on capital employed as overall investment levels increase, meaning they will require financial leverage.

Experience with offshore wind development in other countries illustrates that raising these scales of capital is possible through multiple sources of finance, such as a consortium of investors, like those used for offshore wind projects in the North Sea (Box 3.4). This pool of investors helps to address individual risks and could be supported through existing platforms in India, such as the National Infrastructure Investment Fund (NIIF), possibly with support from multilateral agencies that have experience with syndication and related guarantees. Infrastructure Investment Trusts (InvITs) can likewise provide a platform for investors to access renewable energy projects (Srivastava, 2021[28]). For example, Virescent Renewable Energy Trust (VRET), one of India's first "pure-play" renewable energy InvITs, raised INR 460 crores (USD 62 million) in September of 2021 with both foreign and domestic investors (Tisheva, 2021[29]). These types of structures can also be used as a tool to recycle capital by selling shares in operating units and use the proceeds to develop new renewable energy projects.

Box 3.4. Trends and lessons from financing offshore wind development in Europe

Europe invested EUR 16.6 billion (INR 1.4 lakh crore) in offshore wind projects in 2021, with an average CAPEX of EUR 3.5 million (INR 29 crores) per installed MW. The projects that have reached final investment decision are located in the United Kingdom, Germany, France and Denmark. Around two-thirds of the overall investment in offshore wind projects have been financed via project finance, for an amount of EUR 11.9 billion (INR 2.0 lakh crores), and one-third via corporate finance. The average debt-equity ratio of offshore wind projects using project finance has reached 78:22, with a total of 96 active lenders in 2021, including commercial banks, multilateral development banks and development finance institutions.

Thanks to a better understanding of the risks of offshore wind and the growing experience of the wind energy financing ecosystem in Europe, project finance has become the preferred structure for new projects. The percentage of debt financing has increased by around fifteen points over the past decade, and the spread between interest rates for offshore wind projects and the basis rate have decreased. Therefore, the cost of finance has decreased, and in turn the cost of production of electricity from offshore wind farms became more competitive.

Several initiatives are ongoing to better integrate offshore wind in larger energy ecosystems and to diversify the sources of finance to further mitigate the risks associated with capital-intensive projects, and eventually develop projects without relying on government funding. For instance, the pension funds Pension Danmark and PFA Pension partnered with the energy company SEAS-NVE to develop up to 10 GW offshore wind, electricity storage and power-to-X projects. Energinet, Gasunie and TenneT, three power Transmission System Operators (TSOs) in Northern Europe, have founded the North Sea Wind Power Hub (NSWPH) in 2017. The NSWPH promotes a “Hub-and-Spoke concept” to integrate offshore wind capacity with several national power grids and with future green hydrogen pipelines.

As the deployment of offshore wind capacities will require a significant investment, recycling capital can be critical to develop new projects. The construction of a wind farm typically lasts three to four years, and the debt providers take into account execution risks, such as the risk to delay the project, which drives up the interest rates. Once the wind farm is operational and generates revenues, the risks are lower, thus there is an opportunity to refinance the project at better interest rates. Project developers can also decide to sell shares of commissioned projects and use the proceeds to develop new projects.

Sources: (PwC, 2020[10]), (offshoreWind.biz, 2020[30]), (North Sea Wind Power Hub, 2021[31]), (WindEurope, 2022[32])

Capital-market solutions, such as green bonds and sustainability-linked bonds, can equally raise money for offshore wind projects. More than USD 10 billion in green bonds for clean energy projects were issued in India between 2016 and 2021 (Srivastava, 2022[33]), and sustainability-linked instruments and Masala bonds, such as those issued by PFC and IREDA,[20] are likewise helping to mobilise capital. While there is considerable appetite for Indian issuances for renewable energy projects in the international capital markets, the domestic market has seen limited issuances. Indian institutional investors prefer investing in AA and above rated securities and few utility-scale renewable energy projects have met this rating threshold (Singh, Dutt and Sidhu, 2020[34]). Support of first issuances for offshore wind in India, for example through the government’s plans to issue green, could raise awareness for these projects and provide improved insight (e.g. on asset performance) to investors. This could equally be done through collaboration across multiple actors to support issuance at high credit ratings, as was previously done for infrastructure projects in India. For example, the Asian Development Bank (ADB) supported a first-of-a-kind facility with the India Infrastructure Finance Company Limited (IIFCL) and domestic financial institutions in 2012 to provide partial guarantees on INR-denominated bonds issued by Indian companies for infrastructure projects. ADB took on part of the guarantee risk, helping projects to achieve A or AA credit ratings (Aravamuthan, Ruete and Dominguez, 2015[35]).

Other forms of support may be required to unlock finance and investment at suitable scales via global capital markets. For instance, accessing large capital volumes through international markets may require hedging to treat foreign exchange (Fx) and other offshore wind investment risks. This could be to support early market technology imports (e.g. via export credit agencies) as well as to facilitate investment by international firms in establishing or expanding manufacturing capacity in India. Such examples also exist via tools through private banks. For example, Siemens Gamesa Renewable Energy arranged EUR 174 million in Fx hedging contracts for sustainable transactions in a deal arranged by BNP Paribas in 2019. This helped the group to mitigate Fx exposure for selling offshore wind turbines in Chinese Taipei (Menendez, 2019[36]).

Lessons could be extracted from these experiences for the Indian market, as well as from other international experiences in hedging risks. For instance, use of sophisticated and competitive hedging is common in the United Kingdom to address risks for offshore wind projects. This broadened participation beyond commercial banks (e.g. to investment banks) and has driven down hedging prices, including for cross-currency swaps (Lancaster, 2019[37]).

Roadmap stakeholders also noted that one way to help direct finance to clean energy development, including through capital markets, is through a sustainable finance framework. Development of a national green taxonomy in India, possibly based on existing ones, such as those in Europe and Singapore, would provide a clear set of rules and mitigate perceived risk of ‘green washing’. Investor and company disclosure requirements would likewise help drive investment in clean energy projects like offshore wind, particularly as the pool of investors seeking ESG performance continues to grow in India and globally.

Roadmap to 2030

Meeting India’s offshore wind ambitions to 2030 and beyond will require a number of targeted actions and tailored solutions through co-ordinated efforts across stakeholders, from developers and investors to state and central governments and international partners. Working together can bring forward solutions to address bottlenecks to project development and enable the finance needed to unlock a robust offshore wind market.

Recommendations

The Roadmap proposes seven key recommendations to de-risk offshore wind investment and to enable the flow of finance to those projects. Proposed interventions are set forth across two key pillars, notably targeted enabling tools and specific financial support to address critical barriers across the offshore wind value chain, bridge the current economic gap and create an enabling environment for investment.

Enabling tools

1. **MNRE should provide improved clarity on the policy framework and regulatory conditions for projects to 2030, complementing the 2022 Strategy Paper for Establishment of Offshore Wind Energy Projects.**

Well-established offshore wind markets require clear policies with long-term targets and transparent regulatory conditions, which facilitate investment decisions, especially as these projects are capital intensive. Recent announcements (e.g. on auction schedules, offtake, evacuation infrastructure and seabed leasing) are important steps forward, but ensuring these details are spelled out clearly within policy and regulations will help developers and investors to assess opportunities and risks.

- A policy update should clarify the volumes that will fall under Model 2(A) to thus be eligible for VGF and other revenue support beyond 2024, and it should clarify other developer obligations (e.g. local content requirements) and incentives (e.g. import duty reductions or tax benefits).
- In preparation of the first offshore wind auctions in 2022-24, the update can also specify expected (or else potential) future market demand mechanisms, for example using bundled/hybrid auctions, RPOs and weighted RECs; which will help to establish bilateral contracts and address offtake risk (with lesser risk for SECI). Given that anticipated offshore wind tariffs are unlikely to be competitive with onshore wind, solar and conventional energy, RPOs would be an important policy tool to create demand certainty for investors.
- The updated framework can serve as a template for Tamil Nadu, Gujarat and other states to update their own offshore wind policies and regulations, which will help to ensure consistency in the overall operational environment for developers.
- Ideally, all these policy and regulatory elements will be included and where possible streamlined under the proposed single-window by NIWE, ensuring a “one-stop shop” for offshore wind projects.

2. **The Ministry of Commerce and Industry (MoCI), supported by MNRE, should begin work with industry to jump start domestic offshore wind supply chains and manufacturing capacity as soon as possible, especially to ensure these are in place in time for capacity additions beyond the first projects.**

   In addition to a clear policy and regulatory environment, achieving 2030 deployment targets will require an efficient administrative process to deliver 37 GW of capacity additions in a relatively short window of time, whilst equally enabling opportunities to lower technology and project development costs.

- Support can include a PLI scheme and expanded PSL, as has been done for the solar industry. Caution is recommended in applying any local content requirements, specifically for components not currently produced in India, as the offshore wind market develops in the coming years. Strict requirements risk increasing development costs and project lead times, where more gradual application of local content requirements (e.g. as done in the United Kingdom and Denmark) has supported development of robust offshore wind industries and lower projects costs.
- International partners can support market development via technology transfer support for joint ventures and co-operative activities (e.g. under industry agreements), as well as through support for training and capacity building, for instance for skilled labour creation in the domestic manufacturing industry.

3. **MNRE and the relevant authorities (e.g. Powergrid, CTU and state transmission authorities, and the port authorities in Tamil Nadu and Gujarat) should plan and co-ordinate necessary infrastructure development in support of offshore wind capacity additions.**

   To avoid unwanted delays or additional expenses in future offshore wind additions, relevant infrastructure like ports, yards and transmission capacity needs to be developed in time to accommodate offshore wind capacity additions to 2030 and beyond.

- For initial offshore wind projects up to 2030, the dedicated evacuation infrastructure will be provided by CTU.

- The needs for other potential infrastructural developments, such as roads and bridges to accommodate transport of larger blades, must be assessed. Planning and co-ordination can likewise look to cluster supply and manufacturing capacities, for instance close to ports.
- Assessments and plans can also look at the development of green energy corridors, with eventual infrastructure developments such as transmission, distribution, conversion and storage capacities to use offshore wind to produce green hydrogen for use in local industries.

Financial support

4. **MNRE should work with partners to co-ordinate finance and investment moving forward, for instance through a financing platform that brings together donors, investors and other relevant development players for the development of a blended finance facility for offshore wind (see Annex D).**

   The complexity of establishing a vibrant offshore wind market, including related infrastructure development, manufacturing and supply chain investments, means that stakeholder co-ordination and co-operation will play a key role in ensuring timely, sufficient and affordable finance and investment for the entire offshore wind value chain.

- This type of co-ordination has worked well to identify critical challenges and key opportunities to enable offshore wind development, for example through industry initiatives like the India chapter of the Global Wind Energy Council (GWEC). A similar platform for financial actors, development assistance and climate finance can help to ensure relevant support and suitable financing vehicles are in place to deliver on offshore wind ambitions.
- The platform, hosted and managed by a specially designed unit in an existing agency like IREDA, would help to ensure specific risks and challenges are addressed, whilst avoiding duplication of efforts and ensuring the overall value chain of needs to unlock the potential for offshore wind is sufficiently supported. It can equally facilitate investor dialogues.
- The platform could coordinate interventions by donors to support project de-risking that can be delivered via a blended finance facility, to which donors can contribute capital, and that could be managed by an agency such as IREDA. The facility would be intended to mobilise private capital through de-risking, focussing on one single and well-defined area.
- The blended finance facility for offshore wind could include a number of different mechanisms. For example, multilateral development banks could serve as co-investors or provide sub-ordinated debt and equity to help unlock commercial capital. They can equally help through more traditional concessional finance, for example providing suitable loan tenures for offshore wind (e.g. above 15 years after commissioning date).

5. **MNRE should assess suitable financial instruments, including potential sources of funding for such mechanisms, to provide needed risk assurance for offshore wind project development in the coming years.** These tools can also help to lower the cost of finance for project development and possibly be integrated in the blended finance facility.

   Expected costs for early offshore wind projects, in addition to development risks for the first capacity additions, means support like the proposed VGF is needed to address higher LCOE and offtake risks. Continued support equally may be necessary beyond the first planned capacity additions and as the market develops, given the scope and scale of achieving 37 GW of capacity additions by 2030.

- This includes work with relevant Indian counterparts like Ministry of Finance, development partners and multilateral agencies to raise sufficient funds for VGF to cover early capacity additions.
- International partners can support MNRE in assessing and developing other financial instruments such as CfD auctions and hedging instruments that offer safeguards to developers against volatile

prices. This could be through a consortium of development and climate finance, working with Indian institutions like IREDA.

- MNRE and IREDA, working with relevant authorities like SECI, should assess solutions to address payment risks via financial instruments like payment security or credit enhancement mechanisms. While RPOs and weighted RECs will help to address offtake risks, risk of late payments or non-payments by DISCOMs may still be a major concern for developers and can be mitigated by such mechanisms, which could equally be supported by development and/or climate finance.

6. **In addition to pursuing financial incentives such as PLI for manufacturing, MNRE should work with domestic and international partners to channel finance and investment for the offshore wind ecosystem, including relevant financial support mechanisms to unlock private capital for these developments.**

   Unlocking finance and investment in offshore wind development will require additional financial support for development of domestic supply chains and manufacturing capacity as well as infrastructural needs. This could be integrated in the blended finance facility if these parts of the value chain are selected with international partners as a focus area.

- SIDBI, IREDA and other relevant financial institutions can provide required capital and relevant risk mitigation for domestic manufacturing capacity and supply chain development, for instance using targeted financial instruments like low-interest loans (or subsidised interest rates, for instance with partner banks and NFBCs), guarantees and grants (where applicable).
- International partners, such as export credit agencies, can support development of supply chains and manufacturing capacities through financial instruments such as concessional loans, loan guarantees, current swaps or hedging products, and even first-loss equity. Technical Assistance Programmes may also be conducted by multilateral agencies to reduce the developmental risk.
- The National Infrastructure Pipeline (NIP) and NIIF can channel investment in large infrastructure additions such as ports and transmission lines. Development finance and multilateral funds can support this through injection of capital, including credit enhancement and risk mitigation support, such as first-loss guarantees, to address risks.
- The Government of India can also use sovereign green bonds, or serve as a co-investor for such instruments, to support large infrastructure additions. Support could equally include waiver of guarantee fees or credit enhancement for issuance by other entities, such as public investment funds.

7. **Domestic partners such as IREDA, the Ministry of Finance and RBI should support MNRE to assess opportunities, challenges and limitations in use of financial instruments to access capital markets in India and internationally.**

   Achieving offshore wind ambitions to 2030 and beyond will require capital market instruments to unlock the quantum of finance and investment needed to meet these targets. Access to capital markets can help to address limitations in lending for domestic banks and NBFCs, particularly given the scale of capital required for 37 GW of capacity additions. Capital market instruments equally can help to lower the cost of finance, as has been illustrated in bond issuances for renewable energy projects in recent years.

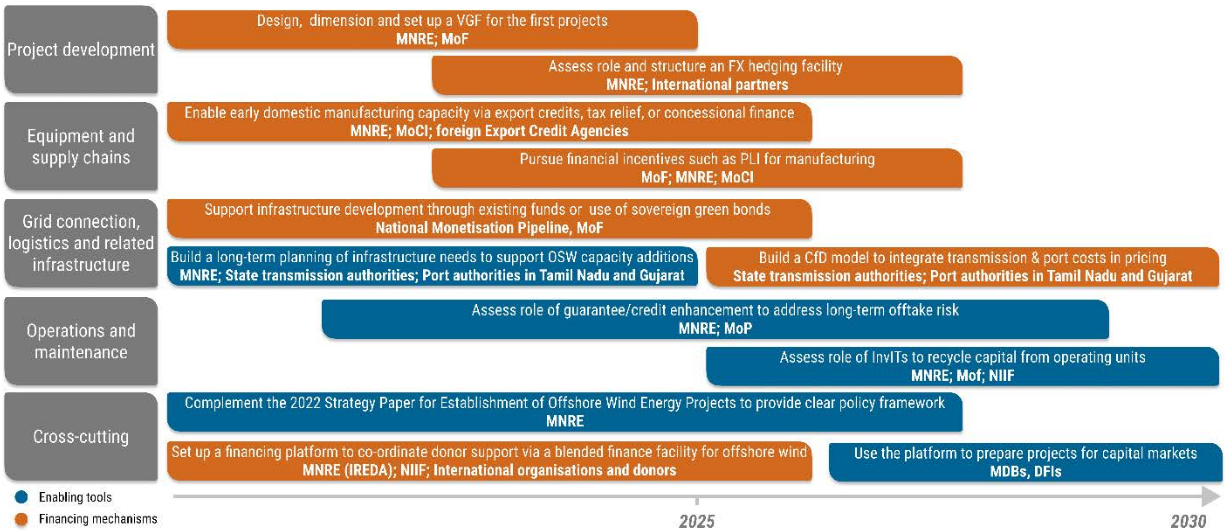
- Efforts include assessing the impact of related costs, such as government guarantees, as well as the role of other support mechanisms (e.g. credit enhancement or first-loss provisions) that can enable debt capital market solutions like green bonds for offshore wind projects at affordable costs.
- Measures can include support for development of refinancing vehicles, such as asset-backed securities, to recycle existing capital for new projects. Specifically, use of such vehicles for existing onshore solar and wind debt can attract institutional investors, such as insurance and pension funds, who have shown a preference for operating assets.[21] Given the complexity in preparing these deals, specialised bodies such as InvITs or an Alternative Investment Fund (AIF) could be

used (at least in the near term) to address structural concerns and deploy investment strategies on behalf of investors. This could be prepared by IREDA with help of international partners.

- MNRE and IREDA, alongside other relevant energy authorities, should work closely with the Ministry of Finance as it prepares a sustainable finance framework for India, to ensure that renewable energy is clearly reflected in rules and definitions (e.g. under a sustainable finance taxonomy). This will help to direct financial flows to offshore wind and other clean energy projects, whilst mitigating perceived risk of ‘green washing’ for investors.

Key actions and timeline

Figure 3.5. Overview of the main recommendations for Offshore Wind until 2030



Source: Authors

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Notes

[1] Physical progress on installed renewable energy capacity, as of end-April 2022, consisted of 40.5 GW of onshore wind power, 55.3 GW of solar power, 10.2 GW of biomass co-generation, 4.6 GW of small hydro power and around 0.5 GW of waste to power and energy sources. Large hydro capacity accounted for another 46.7 GW. For more information on renewable energy additions and total installed power generation capacity, visit: https://mnre.gov.in/the-ministry/physical-progress and https://powermin.gov.in/en/content/power-sector-glance-all-india.

[2] For more information on technical offshore wind potential estimates by the World Bank Energy Sector Management Assistance Program (ESMAP), visit: https://esmap.org/esmap_offshorewind_techpotential_analysis_maps.

[3] Information on the Facilitating Offshore Wind in India (FOWIND) studies are available on the MNRE offshore wind portal: https://mnre.gov.in/wind/offshore-wind/.

[4] For more information on the 2015 National Offshore Wind Energy Policy, see: https://mnre.gov.in/img/documents/uploads/3debfe9158b643d8a3e06a7a007f2ef9.pdf.

[5] For further information on the 2018 Guidelines for Offshore Wind Power Assessment Studies and Surveys, see: https://mnre.gov.in/img/documents/uploads/a341c6e68bce413392b0383f18a647ef.pdf.

[6] For further information on the 2022 Strategy Paper for Establishment of Offshore Wind Energy Projects, see: https://mnre.gov.in/img/documents/uploads/file_f-1657882722533.pdf

[7] For more information on the NIWE Wind Data Sharing Policy, see: https://mnre.gov.in/img/documents/uploads/345c9baad1734e928162142391O7292d.pdf.

[8] For more information on COE-OSW events and analysis, visit: https://coe-osw.org/.

[9] The list of participants under the 2018 Expression of Interest includes: www.eqmagpro.com/wp-content/uploads/2018/06/EOI_Participants_list.pdf.

[10] For more information, see: https://ore.catapult.org.uk/press-releases/ore-catapult-and-niwe-announce-uk-india-offshore-wind-collaboration/.

[11] See Annex A of the 2015 National Offshore Wind Energy Policy: https://mnre.gov.in/img/documents/uploads/dd5f781d18d34b9ca796f5364f7325bb.pdf.

[12] The 2022 Strategy Paper for Establishment of Offshore Wind Energy Projects states that NIWE will facilitate as single window for clearances.

[13] A reverse auction is a type of auction in which potential sellers bid for the prices at which they are willing to sell their goods and services to one buyer. Sellers then place bids for the amount they are willing to be paid for the good or service, and at the end of the auction the seller with the lowest amount wins.

[14] For further information as presented by MNRE at the *Roadmap* workshops, visit: www.oecd.org/cefim/india/roadmap/.

[15] For more information on IREDA's PLI schemes, see: https://www.ireda.in/pli-scheme-documents.

[16] LCOE is for combined-cycle gas turbine (CCGT) power generation.

[17] For more information on the FIMOI LCOE tool, see: https://coe-osw.org/fimoi-lcoe-and-vgf-tool/.

[18] Capital subsidy schemes in India, for instance for MSME technology upgradation, have not explicitly addressed the cost of capital for borrowers. For more information, see Chapter 2 on MSME energy efficiency finance and investment.

[19] For more information, see: www.business-standard.com/article/finance/rbi-raises-repo-rate-by-50-bps-to-tame-prices-pegs-fy23-gdp-growth-at-7-2-122060900047_1.html#:~:text=The%20six%2Dmember%20Monetary%20Policy,to%20expectations%20of%20further%20monetary.

[20] For more information, see: www.climatebonds.net/2017/09/ireda-usd300m-green-masala-bond-launch-lse-climate-bonds-certified; https://economictimes.indiatimes.com/markets/bonds/how-pfc-get-record-5-demand-against-1-bn-offshore-bond-sale/articleshow/69746264.cms.

[21] Between 2009 and 2019, over 75% of renewable energy deals involving institutional investors were in operating assets (IRENA, 2020[38]).

4 Green hydrogen

This chapter delves into the financing and investment required to develop India's green hydrogen sector by 2030. It provides an overview of the current trends of the hydrogen market in India and summarises key announcements related to green hydrogen to date. It also highlights the barriers associated with green hydrogen development at various stages of the value chain and in order to scale up financing. This chapter then proposes seven recommendations on improving the enabling environment and financial support schemes to unlock required capital to meet 2030 targets.

Green hydrogen produced from clean energy sources like solar and wind power is an opportunity to reduce carbon emissions, contributing potentially to around 10% of global emissions reduction efforts needed by mid-century (IRENA, 2022[1]). It could substitute grey hydrogen, produced from fossil-fuels, for current applications mainly in refineries and fertiliser production plants, as well as replace coal and natural gas in various industries such as shipping and steelmaking.

India is fortunate to have high-quality, low-cost renewable energy resources that can produce green hydrogen. This can be used in different applications, either as direct use, for example in industry, or for eventual use and export of hydrogen carriers and products, such as green ammonia and fertilizers. These applications can also help to increase penetration of renewable energy in India's energy system, improving the reliability of domestic energy networks (ESMAP, 2020[2]).

The complexity of the hydrogen value chain requires approaching development from a systems perspective to encompass barriers and opportunities across the future entire value chain, including identification of where green hydrogen can bring benefits, given national circumstances and priorities. India has a favourable background for the development of green hydrogen production and use, but the current ecosystem is still at an early stage and will require considerable efforts to unlock this potential through achievement of large-scale projects (FTI Consulting, 2020[3]).

Overview of India's hydrogen market and trends to date

Several announcements in recent years have promised to deliver domestic electrolyser manufacturing capacity and green hydrogen production in India (Table 4.1). These announcements have been supported by initiatives looking to unlock the potential for green hydrogen production and use. For example, several global energy and industrial majors have announced strategies and investment initiative. Some of them came together to set up the India Hydrogen Alliance (IH2A) in March of 2021, focusing on measures to commercialise hydrogen technologies and systems in India and covering the entire value chain from production to transport and industrial use-cases (Box 4.1). In March of 2022, six companies from the renewable energy sector similarly created the Independent Green Hydrogen Association (IGHPA), which works as an advocacy group to provide inputs for the development of India's green hydrogen and ammonia policy framework.

The Ministry of Power released the Green Hydrogen Policy in February of 2022[1]. This policy addressed several salient risks and barriers to the development of green hydrogen and green ammonia with respect to the delivery of renewable power, including considerations for open access, banking and transmission costs. For example, the government will waive interstate transmission fees for 25 years for all projects commissioned before June 30, 2025. It also will allow 30 days of renewable energy banking for green hydrogen and green ammonia producers. These measures could decrease the transmission cost by a factor of four and reduce the cost of green hydrogen by as much as INR 60 (USD 0.8) per kg, or roughly a 20% decrease in expected green hydrogen production costs without this support (KPMG India, 2022[4]). The Green Hydrogen and Green Ammonia Policy also entails demand-side measures, such as qualifying the renewable energy purchased for green hydrogen and green ammonia production under RPOs. This measure has been confirmed in the Green Energy Open Access Rules notified by the Ministry of Power in July 2022 (PIB, 2022[5]). Additionally, MNRE will set up a single portal for all statutory clearances for the manufacturing, transport and storage of green hydrogen and green ammonia.

Table 4.1. Examples of announcements on the field of green hydrogen in India

Companies	Date	Type	Description
Reliance Industries Limited Stiesdal	12 October 2021	Partnership	Co-operation agreement on technology development and manufacturing of electrolysers in India, based on the HydroGen technology developed by Stiesdal.
Ohmium	24 November 2021	Electrolyser delivery	The Indian subsidiary of Ohmium has shipped its first unit of electrolyser to the United States. It has been produced in its Bengaluru plant, which has a manufacturing capacity of 500 MW per annum.
Larsen & Toubro HydrogenPro	27 January 2022	Manufacturing capacity	Memorandum of Understanding to set up a joint venture in India for Gigawatt-scale manufacturing of Alkaline Water Electrolysers based on HydrogenPro technology for the Indian market.
Indian Oil Corporation	22 February 2022	Electrolyser installation	Plans to set up green hydrogen plants at its Mathura (40 MW electrolyser) and Panipat (15 MW electrolyser) refineries by 2024 to replace carbon-emitting units
Greenko John Cockerill	12 April 2022	Manufacturing capacity	Partnership to develop a manufacturing capacity of 2 GW per annum and jointly develop large-scale green hydrogen projects
Ayana Renewable Power Greenstat	2 May 2022	Partnership	Joint Development Agreement for development of green hydrogen projects powered by renewable energy The initial pilot project will be launched in Karnataka.
Adani New Industries TotalEnergies	14 June 2022	Acquisition	TotalEnergies has acquired a 25% stake in Adani New Industries, planning to build capacity to produce a million tonnes of green H2 annually by 2030. Its first project will be a 2 GW electrolyser powered by 4 GW of wind and solar.
Jindal Stainless (Hisar) Ltd Hygenco India	10 August 2022	Partnership	The companies have announced a partnership to install a Green Hydrogen Plant. that will enable to reduce the stainless steel company's CO2 emissions by nearly 2 700 metric tonnes per annum.
Ohmium	8 September 2022	Electrolyser delivery	Ohmium has signed an agreement to provide 343 megawatts of Proton Exchange Membrane (PEM) electrolysers to Tarafert, that is developing a large-scale urea fertilizer and green ammonia production facility in Mexico. The electrolyser will be manufactured in India, and the first 69 MW are to be delivered in 2025.

Note: This table is a non-exhaustive list and just aims to highlight the momentum of announcements during the preparation of this Roadmap.
Sources: (Stiesdal and Reliance, 2021[6]), (SolarQuarter, 2021[7]), (Larsen & Toubro, 2022[8]), (H2WorldNews, 2022[9]), (pv magazine India, 2022[10]), (The Economic Times, 2022[11]), (Recharge, 2022[12]), (JSHL, 2022[13]), (Ohmium, 2022[14]).

State governments are also taking action to bolster the policy environment set forth by the Ministry of Power. For example, the government of Tamil Nadu announced in April of 2022 the preparation of a Green Hydrogen Policy (The Indian Express, 2022[15]). The state of Kerala similarly aims to develop hydrogen-fuelled vehicles, focusing on heavy duty vehicles such as buses and trucks, and it announced a pilot project with ten buses supported by a viability gap funding of INR 10 million (USD 128 000) from the state's government budget. Furthermore, Kerala is investigating industrial usages in refineries and is planning to develop hydrogen valleys inspired by international experience (Jyothilal, 2022[16]).

Box 4.1. India Hydrogen Alliance activities

Global energy and industrial majors have launched the IH2A in March of 2021 to support public policy and private sector actions in support of a domestic hydrogen supply chain in India.

A Steering Group comprised of Chart Industries, Reliance Industries Limited (RIL) and JSW Steel leads the coalition, supported by the work of six working groups covering the value chain, including:

- Hydrogen production and electrolyser/fuel-cell manufacturing
- Storage and transport
- Hydrogen valleys
- Steel and cement
- Refineries and fertilisers
- Heavy-duty vehicles

In March of 2022, IH2A proposed seven steps to commercialise green hydrogen in India, emphasising in particular the benefits to create a pipeline of green hydrogen hubs for GW-scale projects. This would be supported by public-private consortiums. The proposal highlighted opportunities to collaborate with multilateral development banks and government agencies to de-risk early market development. Capital-intensive funding required for large-scale projects could additionally rely on corporate and sovereign green bonds, global climate finance commitments, or a USD 1 billion (INR 0.75 lakh crore) Hydrogen Economy Development Fund, as proposed by IH2A in January of 2022.

In addition, IH2A proposed to lead a public-private H2Bharat Taskforce to identify and shortlist five GW-scale national green hydrogen hubs by mid-2023, bringing together all relevant stakeholders from the government, funding agencies and the industry.

Source: https://ih2a.com/.

Green hydrogen ambitions to 2030

India has taken initial steps to explore hydrogen as a source of energy. MNRE released a first roadmap for hydrogen fuel in 2006 (MNRE, 2006[17]), and hydrogen discussions resurfaced in recent years, for instance when Prime Minister Shri Narendra Modi announced plans for a National Hydrogen Energy Mission at the third Global Renewable Energy Investment Meeting and Expo in November of 2020.[2] The Mission was then launched at India's 75th Independence Day in August of 2021. The Ministry of New and Renewable Energy has accordingly prepared a draft Mission document. The draft Mission proposes a framework inter-alia for a phased implementation approach, demand creation, a basket of measures to support production and utilization of green hydrogen, support for indigenous manufacturing, Research & Development, pilot projects, enabling policies and regulations, and infrastructure development (PIB, 2022[18]). It includes plans to build upon expected growth in India's hydrogen demand, for example in the fertilizer and refinery industries, which could increase from around 7 million tonnes in 2021 to nearly 12 million tonnes by 2030 (H2WorldNews, 2021[19]), and a target to produce 5 million tonnes of green hydrogen by 2030 (EQ International, 2022[20]). Analysis estimate that it would require a dedicated renewable generation capacity in a range from 25 to 100 GW by 2030, depending on the mix of renewable energy sources, which will influence the capacity factor of the electrolysers (IH2A, 2022[21]), (IHS Markit, 2022[22]); (EY and SED Fund, 2022[23]).

Policies providing a stable, long-term view and a uniform set of standards are key enablers to provide confidence for investors and industrial actors to invest in green hydrogen (ESMAP, 2020[2]). For instance, the lack of an agreed definition of green finance in India has been highlighted as a major barrier to attract investments (Prakash Jena and Purkayastha, 2020[24]). A green hydrogen definition within a taxonomy, national green finance framework or ESG criteria would strengthen the confidence of investors in green hydrogen projects, given increasing pressure to disclose the share of portfolios that meet such criteria. Engagement with international organisations to build consensus on the definition of green hydrogen, including building a sound certification and tracking of green hydrogen, will ensure that it leads to emissions reduction and best use of renewable energy sources, and will also help to remove barriers to global trade. This would help to mobilise needed finance, as green hydrogen technologies are capital-intensive.

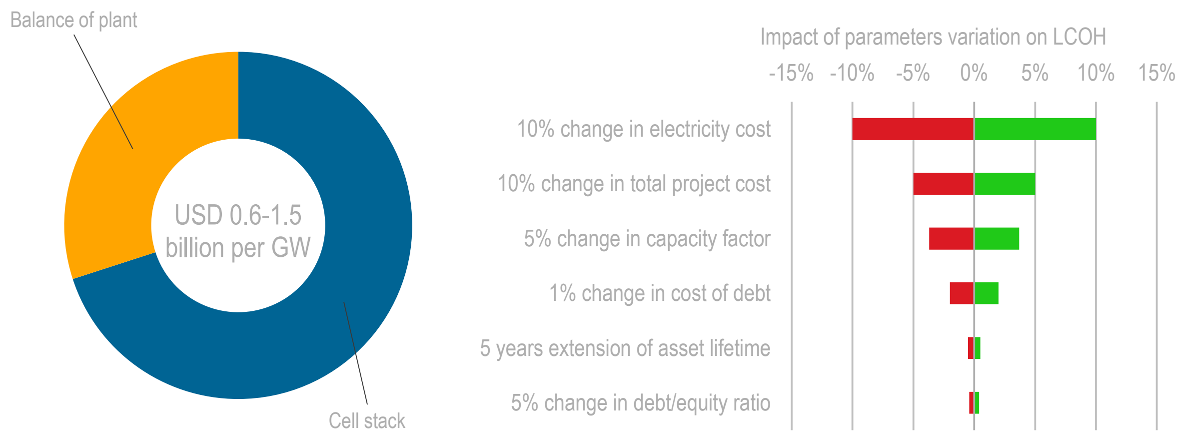
Barriers and challenges

The cost of producing green hydrogen generally is higher than traditional hydrogen produced from steam methane reforming (SMR) or coal gasification. In 2020, costs of hydrogen from electrolysis were at around INR 400 (USD 5.1) per kg versus INR 140–180 (USD 1.8-2.3) per kg from SMR (Hall et al., 2020[25]).[3]

Producing green hydrogen at competitive costs is a major challenge, which depends on several key factors within the hydrogen value chain, including needs to reduce costs of electrolyser technologies and their manufacturing as well as the costs of renewable electricity inputs, and to increase the load factor of electrolysers (Hall et al., 2020[25]). Achieving a significant drop in the capital cost of electrolysers, for instance through technological learning and scale, alongside improvements in the efficiency of electrolysers and further reductions in the costs of renewable power, will influence long-term competitiveness of green hydrogen production as well as cost improvements for things like storage and transport of hydrogen (Hydrogen Council and McKinsey & Company, 2021[26]). At a global scale, the electrolyser costs could see a 40% cost reduction by 2030 and 80% by 2050 (IRENA, 2020[27]).

These parameters affect the overall levelised cost of hydrogen (LCOH) (Figure 4.1). For instance, a 10% change in the price of electricity can drastically impact the cost of hydrogen.[4] Project costs, mainly driven by the CAPEX of electrolysers, and capacity factor equally influence the LCOH, as does the cost of finance, particularly give the overall levels of capital needed to implement hydrogen projects.

Figure 4.1. Illustrative cost breakdown and impact of influencing parameters on the cost of hydrogen



Notes: 1) The breakdown represents a ballpark figure for either alkaline or Proton Exchange Membrane (PEM) electrolysers. Illustrative sensitivity calculation based on 800 kUSD/MW, 60% capacity factor, 65/35 debt/equity ratio, 10% cost of debt, and debt tenure of 10 years. The percentage of variation of the main parameters are based on typical standard deviations across projects.
Source: Left chart is adapted from (Patonia and Poudineh, 2022[28]); for electrolysers in the range 10-100MW.

StatLink https://stat.link/cqn2t9

Lowering the costs of electricity inputs is a decisive factor to bring down costs of green hydrogen. Solar, wind and pumped hydro power purchase agreements at fixed prices below the average price of the green electricity day-ahead market can contribute to improving the electricity costs. Off-Grid solutions may also be encouraged after carrying out locational analysis of the power system, based on the size of the targeted green hydrogen output, as this would eliminate grid congestion and transmission issues.

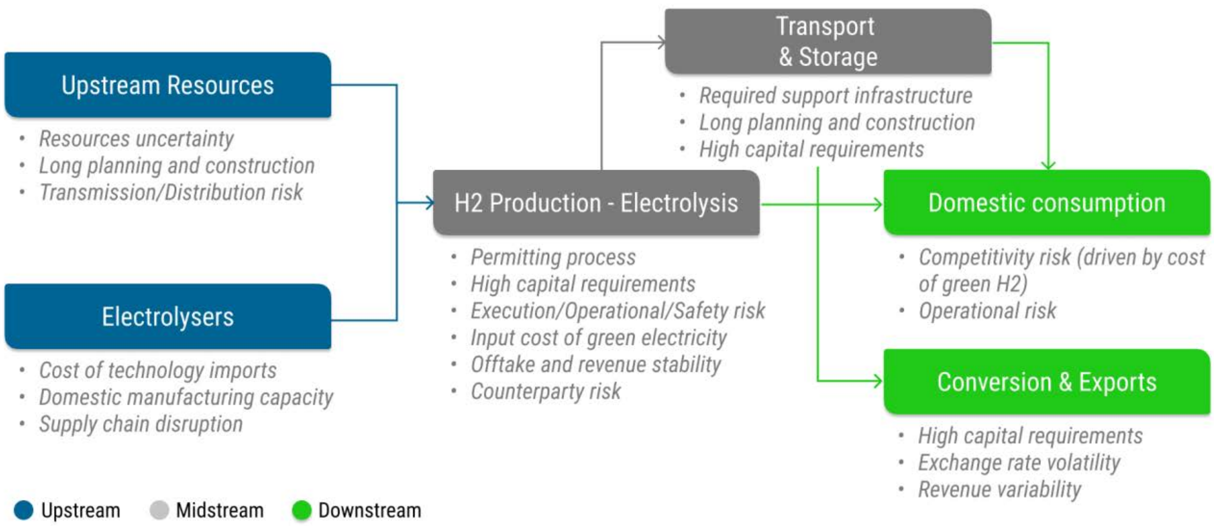
Reducing the cost of electrolyser technologies, for instance through development of local manufacturing capacities, can help to achieve cost-competitive LCOH in India, lowering prices to around INR 122-173 (USD 1.7-2.4) per kg of hydrogen in 2030 (NITI Aayog and RMI, 2022[29]). Yet, enabling some of these cost improvements will be challenging, at least in the short-term, as a domestic hydrogen value chain is established. For example, developers will likely need to import electrolysers for the first projects, given the time required to build large-scale manufacturing capabilities. This will influence technology costs, for instance due to foreign currency swaps and other potential factors such as import duties.

A robust value chain that lowers the cost of green hydrogen will be influenced by other elements within the hydrogen ecosystem, such as related infrastructure needs and supply chains for manufacturers. The challenge for green hydrogen projects is therefore to structure an acceptable risk profile for financing by allocating risks to those best able to take them, whether this be sponsors, insurers, financiers or ultimately in some cases, the government (Green Hydrogen Organisation, 2022[30]). Risks, for example from unclear policy and regulatory frameworks, and challenges in accessing finance will impact development of project pipelines (Figure 4.2). Many components, from manufacturing and supply of equipment to clear offtake for green hydrogen, will influence investment in projects, as well as the cost of finance for project development.

Roadmap stakeholders highlighted the so-called "chicken and egg" problem between supply and demand of hydrogen. Green hydrogen producers highlighted the need to incentivise demand creation to reduce the offtake risk, whilst potential consumers like the fertilizer industry underscored that increasing demand would rely on green hydrogen availability at scale and at a competitive price. Offtake risk is even more significant in the absence of guarantees, which increases risk of non-payment.

Stakeholders equally noted that uncertainties on electricity prices for green hydrogen production could weaken the competitiveness of industrial consumers. Industries with high exposure to the international market may have competitors that are not exposed to green hydrogen costs. Thus, the market price fluctuations of their products could move independently of green hydrogen production cost, which may lead to a volatility of the cost margins.

Figure 4.2. Common risks highlighted by stakeholders in the green hydrogen value chain



Note: These are illustrative examples of risks highlighted in stakeholder consultations and are not exhaustive.

Lack of infrastructure for green hydrogen transport and storage could also create vulnerabilities for future hydrogen projects. Several stakeholders noted that grey hydrogen today is produced and consumed at the same location, whereas achieving economies of scale for large green hydrogen projects (e.g. a GW scale) would require building shared infrastructures and grouping demand of end-consumers. As the transport of hydrogen over 5000 km in large-scale pipelines can remain below INR 80 (USD 1.0) per kg of hydrogen, building dedicated pipelines or repurposing part of the current natural gas network could provide benefits to connect areas where low-cost hydrogen can be produced to consumption centres (IRENA, 2022[31]). Long planning, development and construction phases for these support infrastructures may expose projects to delays.

Roadmap stakeholders emphasised that while many actors have identified green hydrogen as a strategic area of interest, the lack of a pipeline of projects with viable business cases is affecting the design of financing solutions. This makes it difficult to raise capital early in the project cycle. The absence of policy clarity to identify the priority sectors or hubs for green hydrogen would add an offtake uncertainty, on top of the technical risks on execution and operation. As green hydrogen projects are still perceived as high-risk investments, and in addition are typically large ticket sizes, solutions are needed to address risks and the impact these have on the cost of finance.

Other potential issues to finance can hamper investment flows. For instance, restricted access to finance for some developers may deter project developers and financial institutions to invest in green hydrogen projects. Long-term, low-cost debt is often not available and access to international private capital can help lowering the cost of finance.

Opportunities and solutions

Roadmap stakeholders stressed that green hydrogen is a "must-go" area to meet India's clean energy ambitions, equally confirming their expectation that projects can become concrete over next 2-3 years with the right conditions. Achieving this enabling environment requires measures to address barriers and risks across the green hydrogen value chain, including several solutions already outlined in the Green Hydrogen Policy released in February of 2022 (Table 4.2). Covering partially or fully the hurdles through policies, de-risking instruments and financial support will help companies and financial institutions to accelerate investments in green hydrogen.

Table 4.2. Risks addressed in the Green Hydrogen and Green Ammonia Policy

Value Chain	Barriers / risks addressed	Description	Measure
Upstream Resources	Long planning and construction phases	• Long planning, development and construction phases expose projects to a high degree of political and policy risk. • This makes it difficult to raise capital early in the project cycle.	• Priority for the connectivity to the Interstate power transmission system
	Transmission/Distribution risk	• Securing access to a stable source of renewable electricity enables to increase the capacity factor of the electrolyser, thereby reducing the LCOH	• Open access for sourcing Renewable Energy for Green Hydrogen plants within 15 days of receipt of application • 30 days banking for RE used for making Green Hydrogen / Green Ammonia
H2 production	Permitting process	• Setting up a green hydrogen project require obtaining multiple permits (e.g., environmental, social, right-to-operate, etc.) from various institutions. • This may delay projects, increase development costs, and dissuade project developers.	• Land in RE Parks can be allotted for the manufacture of Green Hydrogen / Green Ammonia. • Plan to set up Manufacturing Zones. • Single portal for all statutory clearances and permission required for manufacture, transportation, storage and distribution
	Input cost of green electricity	• Securing access to a low-cost source of renewable electricity and minimising transport and distribution costs reduces electricity enables to reduce the LCOH.	• Waiver of inter-state transmission charges for a period of 25 years for Green Hydrogen projects commissioned before 30th June 2025.
	Offtake risk	• A reduced customer base or the exposure to fluctuating demand can lead to reduce production of green hydrogen.	• MNRE may aggregate demand from different sectors and have consolidated bids conducted for procurement of Green Hydrogen/Green Ammonia
Transport and Storage	Lack of infrastructures	• The absence of sufficient capacities to transport and store green hydrogen and its derivative may require postponing projects or run at a reduced pace, thus affecting the profitability of the project.	• Allow to set up bunkers near Ports for storage of Green Ammonia for export/use by shipping

Notes: 1) The table identifies the risks that are addressed by the current Green Hydrogen and Green Ammonia Policy, based on a sub-selection of the risks identified in Figure 4.2. The policy includes additional measures, such as allowing companies to meet their RPOs via the purchase of green hydrogen. 2) Some risks are only partially covered by the measures in the table. For instance, other elements than power transmission lines will affect the long planning and construction phases of green hydrogen projects.

Future policies are expected to cover the entire value chain for hydrogen use, from demand creation through green hydrogen targets to supply support (e.g. with incentives for domestic equipment and green hydrogen production) and market enablers, such as infrastructure and supply chain developments. An integrated approach of the green hydrogen production increase with renewable electricity capacity development, water access policy and land use should also be considered. For instance, 115 GW of renewable power is needed to meet the 5 million production target of green hydrogen by 2030 (EY and SED Fund, 2022[23]). Aligning these volumes with the national renewable target of 450 GW by the same date must be considered, in particular to ensure that renewable capacity developed for green hydrogen does not hamper the development of direct electrification.

MNRE also indicated that it would provide support for research and development (R&D) for green hydrogen technologies. Encouraging deep research and creating suitable testing facilities will be key to bring down costs in the long run and to enhance the efficiency, safety and reliability of relevant systems and processes across the value chain. In addition, a working group has been set up to prepare a proposal for a framework of regulations and standards.

Stakeholders identified additional solutions for risks not covered yet by government policies and regulations. For instance, PLI schemes can be used to incentivise electrolyser manufacturers to establish capacity in India, which should lower equipment costs, particularly for scaling up development. The schemes could be time-bound and incentivise actors in the early phase of market development.

On the demand side, encouraging early market applications can help to boost demand with limited impact on final prices to consumers. Such applications will likely need complementary signals, such as the planned fertilizer and refinery industry obligations for green hydrogen use. Green hydrogen mandates for these sectors offers large opportunities to drive demand through domestic production, especially as ammonia and fertilisers are net imports in India today. Measures to develop demand from other hard-to-abate industries such as steel should be considered in by 2030, as their potential consumption could help accelerating the green hydrogen transition.

Stakeholders also underscored that a multi-year outlook of consolidated government tenders based on aggregated demand would facilitate green hydrogen market creation. This needs to be complemented with a set of instruments to lower risks for green hydrogen production. For example, a VGF mechanism could be applied for green electrolyser producers in early projects. A CfD model or double auction could similarly be applied for the first green hydrogen tender, allowing producers of green hydrogen to offer their lowest price against the highest bid price of industrial buyers. Auction winners would be producers with the lowest prices and buyers with the highest, and the difference between the two bids would be paid out by the government (or CfD facility) to winning bidders for the contract period.

International experience on the effectiveness of these schemes remains limited, as most countries are still in the definition phase of their support to large-scale hydrogen projects. For example, an assessment of support mechanisms to build a Low Carbon Hydrogen Business Model in the United Kingdom has been carried out via a public consultation led by the Department for Business, Energy & Industrial Strategy (Box 4.2) (BEIS, 2022[32]).

Related infrastructures could be supported by relevant funds, for instance under the National Infrastructure Pipeline. NIIF could likewise co-ordinate and channel investment in green hydrogen pipelines and storage facilities, as well as other related infrastructure like ports, which are crucial to develop green hydrogen hubs and/or exports.

Box 4.2. Consultation on Low Carbon Hydrogen Business Models in the United Kingdom

The United Kingdom's Department for Business, Energy & Industrial Strategy has highlighted various options for the establishment of a viable green hydrogen business model using different support mechanisms, including:

- Contractual payments to producers (e.g. CfDs), where producers receive a subsidy to cover the incremental cost of low-carbon hydrogen above the carbon-intensive alternative fuel.
- Regulated returns, which allow hydrogen producers to earn a return on costs (e.g. using a Regulated Asset Base).
- Obligations on suppliers, imposed on parties outside the hydrogen production sector (e.g. fuel suppliers or end users) to supply or consume a certain quantity of low-carbon hydrogen.
- End user subsidies, applying a technology-neutral subsidy for carbon abatement.

A preference has been noted for contractual payments to producers and regulated returns, as these models transfer better the risk away from investors and reduce the risk of policy changes.

The consultation also has highlighted mechanisms to managing downside demand risk, through:

- Backstop payments, where producers are paid regardless of demand levels, although this could lead to inefficient over-production and high per-unit support costs for taxpayers/consumers.
- Split payments, in which separate support payments would be given to cover fixed and capital costs regardless of demand, but where variable costs are only covered when low-carbon hydrogen is being produced. The split payment approach has a key advantage as it avoids over-incentivisation for producers.

Additionally, revenue stabilisation is preferred, given its practicality and simplicity for deployment. The Department for Business, Energy & Industrial Strategy expresses a balanced view on the use of fixed support vs. indexed support (e.g. on natural gas or electricity). The latter may be particularly helpful if a revenue stabilisation approach is taken to avoid placing excessive input cost risk on investors.

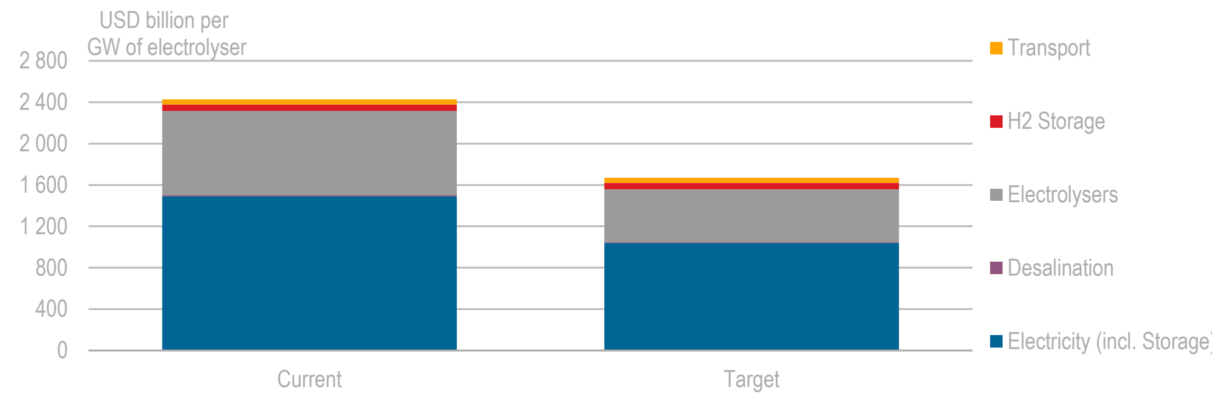
Source: (BEIS, 2021[33])

Investment needs and financial support for green hydrogen

The investment need for green hydrogen projects will depend on project boundaries. An electrolysis project vertically integrated with dedicated renewables would require significant CAPEX, but the operating costs would be limited. It is worth noting that the cost for renewable electricity can be as low as INR 47 000 (USD 590) per kW for solar energy in India, whereas the global weighted average cost for offshore wind[5] is close to INR 240 000 (USD 3000) per kW in 2021 (IRENA, 2022[34]). Conversely, an electrolysis project purchasing green electricity on the power exchange would require less upfront CAPEX (given the upstream accounting for the power generation CAPEX), but it would likely be exposed to higher levels and price fluctuations of its variable costs.

In both cases, the project would include CAPEX for electrolysers, which typically ranges from INR 27 000 (USD 350) per kW to INR 125 000 (USD 1 600) per kW for alkaline electrolysers (IRENA, 2022[35]). Due to the potential various configurations, a case-by-case analysis is required to assess investment needs at the project level, in particular if electricity and hydrogen infrastructures required for transport and storage are included (Figure 4.3). Should projects not be co-located with renewable energy, or if demand centres are not near the hydrogen production, the cost of hydrogen storage and transportation would increase greatly.

Figure 4.3. Illustrative CAPEX for a 1 GW electrolyser project with co-located renewable energy



Notes: Assumptions based on 50% onshore wind and solar power, with respective target price of USD 800 (INR 64 000) per kW and USD 400 (INR 32 000) per kW, and a target electrolyser price of USD 550 (INR 44 000) per kW. The final system cost to develop 25 GW electrolyser may vary greatly depending on (i) the type of renewable electricity sources; (ii) the connection to projects to the grid or the development of off-grid projects; (iii) the availability of existing natural gas pipelines for retrofitting or the installation of new pipelines; (iv) the possibility to store hydrogen in geological formation or the need to use line pack storage or steel tanks.

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IH2A estimates that as much as USD 25 billion (INR 2 lakh crores) in public and private funding is needed to set up 25 GW of electrolyser capacity by 2030 and produce 5 million tonnes of green hydrogen (IH2A, 2022[21]). Another analysis considers that 1 million tonnes of green hydrogen corresponds to around 11-13 GW of electrolyser capacity, which would result in 55-65 GW of electrolysers to achieve this 2030 green hydrogen production target (NITI Aayog and RMI, 2022[29]). Other studies estimates that achieving this production would require at least 40 GW of electrolysers and 100 GW in renewable generation capacity by 2030, and slightly more than USD 100 billion (INR 8 lakh crores) of investment (IHS Markit, 2022[22]); (EY and SED Fund, 2022[23]).

Multiple sources of finance will be needed to achieve these levels of green hydrogen production, especially given the ticket size for large-scale projects, which is likely a major barrier for a single actor to bear, particularly given associated risks. Solutions to lower the development costs for green hydrogen and achieve required investment levels will thus require public funding, notably to reduce the risks of first-of-a-kind projects in India and specifically to leverage private investments in early market development. Multilateral Development Banks (MDBs) and Development Finance Institutions (DFIs) can also support development, for example through blended finance solutions addressing early project risks to support both the market creation and the market growth phases.

In addition, further development of capital markets for clean energy projects in India will be required to enable project developers to tap into different financial instruments and capital sources. This can be supported by development of a national green or sustainable finance taxonomy (possibly based on existing ones, such as those in Europe and Singapore) to provide a clear set of rules. Company disclosure requirements can likewise help investors to monitor the quality of portfolios, particular as the pool of investors seeking ESG performance continues to grow in India and globally. These actions can be a first step before evaluating the possibility to extend Priority Sector Lending (PSL) to the green hydrogen value chain.

Roadmap stakeholders highlighted that a typical financing structure of 20-30% equity and 70-80% debt should be targeted for green hydrogen projects by the end of the decade. Considering current (and targeted) costs of electrolysers with ambitions for 25-40 GW capacity by 2030, as much as INR 0.8 lakhs crore (USD 9.5 billion) in equity and INR 1.8 lakhs crore (USD 22.0 billion) in debt would need to be raised over the next decade (for electrolysers only).[6] To help achieve these ratios and leverage the overall capital needed, early green hydrogen projects will thus likely require grants or subsidies to address risks, attract investors and lower the overall upfront equity required.

International support (e.g. via export credits and development finance) can also build upon on-going technical co-operation, joint ventures and technology collaborations to facilitate market development. On the financing side, donor co-ordination can avoid duplicating efforts, as donors can have different requirements, eligibility criteria and due diligence procedures.

As the market develops and matures, the overall magnitude of public contributions and blended finance should naturally decline, helping to achieve commercial sustainability (OECD, 2018[36]). Indicators to support decisions on exiting blended finance interventions should be defined, for example after reaching scale (in GW of electrolysers), cost (in INR/kW for electrolysers, in INR/kWh for electricity), penetration rate (in % of green hydrogen in total hydrogen consumption), revenue (in INR/kg of hydrogen), and/or by observed project replication without support (e.g., when actors no longer use auctions to agree on a price).

These types of pre-set indicators can also help to evolve the level of public and donor support as the market developers. For instance, progress in market development, based on indicators such as those noted above, could trigger the switch from VGF or a CfD approach to a credit enhancement mechanism, such as a first loss facility. This could help to limit the cost of public contribution whilst maintaining a certain support to de-risk continued project development. Evolution of support, with emphasis on risk mitigation, would likely ensure lower cost of finance for project developers.

Roadmap to 2030

Meeting India's green hydrogen ambitions to 2030 and beyond will require a number of targeted actions and tailored solutions through co-ordinated efforts across stakeholders, from developers and investors to state and central governments and international partners. Working together can bring forward solutions to address bottlenecks to project development and enable the finance needed to unlock a robust green hydrogen market.

Recommendations

The Roadmap proposes seven key recommendations to de-risk investment in green hydrogen development and to enable the flow of finance to those projects. Proposed interventions are set forth across two key pillars, notably targeted enabling tools and specific financial support to address critical barriers across the green hydrogen value chain, bridge the current economic gap and create an enabling environment for investment.

Enabling tools

1. **MNRE should design for demand-side or double auction process for hydrogen to achieve faster economies of scale.**

- It is likely that the first applications of green hydrogen in India will be in natural gas network, fertilisers and ammonia, where green hydrogen can replace a small share of other fuels. While individual users may have limited green hydrogen needs, aggregating demand-side volume can help reach a critical mass.
- MNRE could make use of auctions, for instance through SECI, to aggregate volumes for green hydrogen supply and demand. Organising hydrogen auctions to aggregate demand will enable to warrant investment for centralised production and justify building common user infrastructure. This model can help to increase scale and intensify competition, thus improving the LCOH.

- The design of auctions can be tailored to allow the first large scale users, such as hard-to-abate industries, to pay a price enabling them to remain competitive in their subsector. This would provide better clarity for the government to couple the auction process with other support mechanism such as Contract for Difference (CfD) and ensure an efficient allocation of public money.
- For this purpose, MNRE could set up sectoral tables where (a) Offtakers from the same sector can come together, aggregate their demand and learn from each other; (b) Suppliers can gather to network and find an offtaker. This model could be implemented by replicating the approach of the European Clean Hydrogen Alliance (European Commission, 2022[37]).
- The demand-side hydrogen auctions could be complemented by renewable energy auctions dedicated to Green Hydrogen and Green Ammonia producers. Organising such auctions through SECI could enable to monitor the evolution of the winning bids, thus helping to ensure the competitiveness of green hydrogen production, and possibly help to better estimate the potential needs for other support instruments such as CfD.
    - Such auctions would help in the mid-term to combine solar, onshore wind, offshore wind and pumped hydro capacity for hybrid auctions earmarked for green hydrogen production, in order to support all these sectors simultaneously, ensure additionality, and optimise the power supply portfolio and costs of green hydrogen producers. Given the risk of limited land and water access, such scheme could explore the benefits of producing green hydrogen from offshore wind plants and floating marine solar plants.
    - Moreover, refineries, ammonia producers and other bulk users have indicated interest in setting up their own Green Hydrogen production facilities. The government may consider organising renewable energy auctions to supply the quantum and profile of renewable energy for such process. Such auctions would also ensure additionality, and possibly support a faster deployment of renewable electricity capacity.

2. **A Public-Private Taskforce should provide a framework to build a pipeline of GW-scale green hydrogen hubs.**

- The concept of hydrogen valleys or hydrogen hubs has emerged to overcome the limitations of individual projects by covering multiple steps of the hydrogen value chain and more than one end-use sector in large-scale projects in a given geographical area. Combining various uses within the same area (e.g., an industrial cluster, a port or a city) can create synergies and help achieve economies of scale, optimise costs and reduce variation of demand. Given the GW-scale target, the hubs would need to be matched with large supply projects. MNRE may issue a consultation framework to identify and support potential hubs.
- For this pipeline of projects, a broader range of aspects need to be looked at (e.g. other decarbonisation strategies like direct electrification) to deploy hydrogen when it is the solution that makes most sense.
- The way it is phrased, it seems to be demand, which will not happen without GW-scale supply.
- IH2A is promoting the approach to develop “Bharat Hubs” for green hydrogen, and has proposed on 30 June, 2022 to develop twenty-five green hydrogen projects and five national hydrogen hubs by 2025 through public-private partnerships (pv India, 2022[38]).

3. **MNRE should engage in the international dialogue to converge on a common definition of green hydrogen and implement certification and safety standards.**

- India can exploit its low-cost renewable electricity sources to decarbonise its economy, and to become a global exporter of green hydrogen and its derivatives. Engagement with international organisations to build international consensus on the definition of green hydrogen and building a sound certification and tracking scheme for green hydrogen will help guaranteeing that the production and use of green hydrogen leads to CO2 emissions reduction. In the future, this could help to remove barriers to international trade.

- Although the industry has consumed hydrogen for decades as a feedstock, the production and consumption are mainly occurring on-site, in a strictly controlled environment. Scaling up the production leads to building huge storage facilities and infrastructure, and the increasing role of transportation and distribution will expose more users. Building a safety culture through global collaboration and implementation of global safety standards and best practices will be very important, as an accident can undermine the green hydrogen momentum. Existing initiatives, such as the Center of Excellence in Hydrogen, can be used as platforms to facilitate capacity building, training and R&D development in this area (CoE-H, 2022[39]).
- MoF could build on a national sustainable finance taxonomy in order to bring confidence to domestic and international finance institutions. A growing number of countries have released green or sustainable finance taxonomies. They are becoming increasingly recognised, with companies set to begin reporting based on these standards, and investors targeting to increase the share of their portfolio that is aligned with the taxonomies. India can build on international experiences of existing taxonomies and make the eligibility criteria compatible with its net-zero and intermediate targets. It would help align the domestic and international financial flows with the country's objectives, and could as well avoid duplication of efforts, as several organisations are following internal mechanisms to classify their projects as green or sustainable.

Financial support

4. **IREDA should take the lead to co-ordinate donor support for green hydrogen production via a financing platform and the creation of a blended finance facility for green hydrogen (see Annex D)**

- The platform could be designed with a partner MDB to bring together investors and donors (both domestically and internationally), under the guidance of MoF and MNRE.
- The platform could coordinate interventions by donors and develop a blended finance facility, to de-risk and mobilise capital and that could be managed by an agency such as IREDA.
- The high-ticket size for green hydrogen project, the high risk associated with early markets, and the lack of maturity of the finance community in that subsector can deter investors from green hydrogen projects. The platform could bring together project developers and public and private finance institutions to identify the most suitable sources of financing for green hydrogen projects.
- The platform could be structured to cover several areas of the value chain, or projects of hydrogen valleys. The scope definition could notably be carved out with MDBs, which can provide a wide array of blended finance instruments to support the entire value chain, from renewable electricity to ports infrastructures: donor coordination could enable to target their intervention where they will have the highest impact. It should also be the preferred platform to propose project development assistance, with a focus on developing blended finance solutions.

5. **MNRE should define and confirm financial support to reduce perceived risks for first-of-a-kind capital investments**

- In the short-term, confirm the modalities of the VGF proposed for an initial capacity of 3 GW. For vertically integrated renewables and electrolysers projects, as CAPEX and fixed costs constitute the majority of costs, this would probably help unlocking private capital. In the mid-term, clarifying how the eligibility rules to VGF will be re-evaluated beyond the first 3 GW would provide additional certainty to project developers to engage on site surveys.
- The amount allocated to the VGF could be affected by the implementation of other instruments and parameters influencing the market competitiveness of green hydrogen, such as:
  - The mechanism to reduce and stabilise RE price for Green Hydrogen production.
  - The gap between the achieved green hydrogen price and grey hydrogen price to enable price stability for consumers.

  - The revenue guarantee mechanism.
- In the mid-term, other credit enhancement mechanisms should be explored in order to increase the efficiency of the public finance. Indeed, while it is expected that the scale-up of the green hydrogen market will bring down the CAPEX costs, the cost of finance or offtake risks may linger on. In that case, providing partial credit guarantees or establishing a first-loss provision fund could improve the creditworthiness of investments while achieving a better financial leverage than a VGF.

6. **MNRE should design a mechanism to reduce offtake and revenue risks for first-of-a-kind green hydrogen producers**

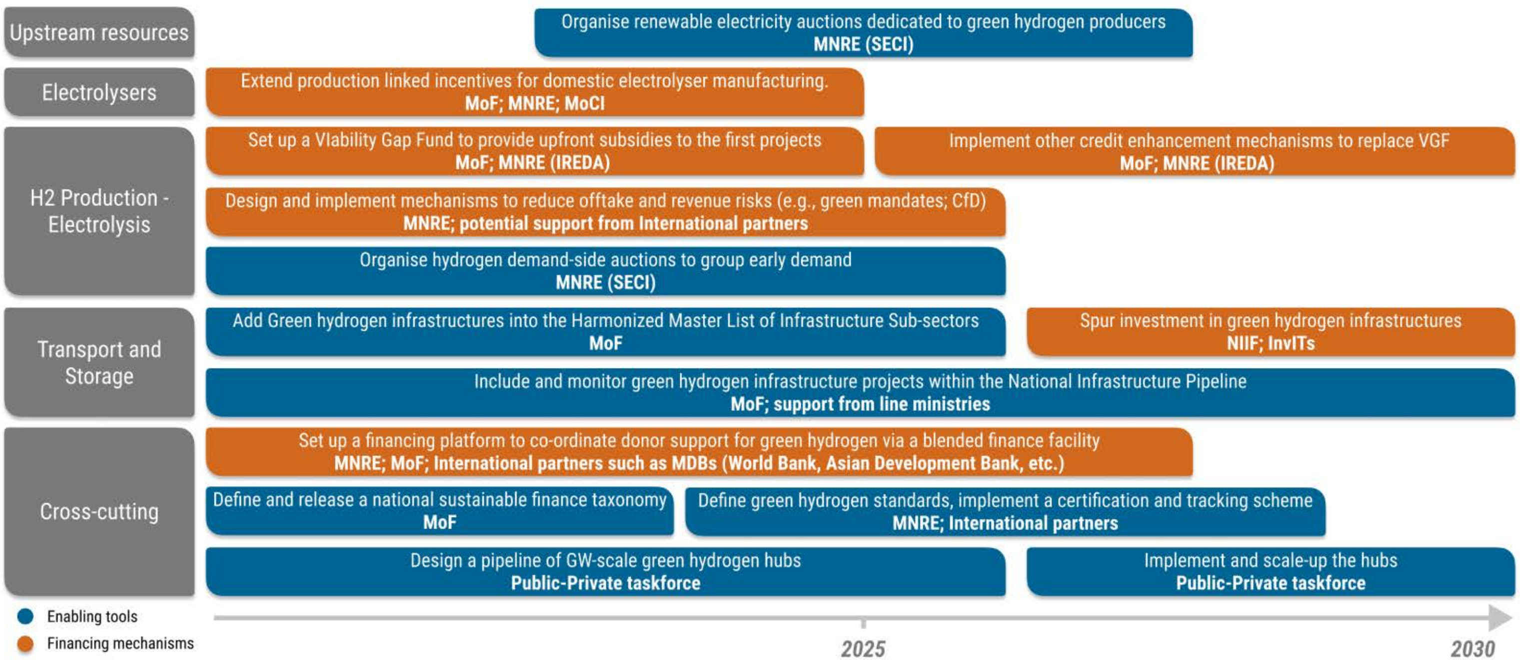
- International partners, such the UK, the European Union or Japan, could share their experience or provide assistance to set up such a scheme.
- On demand side, green hydrogen demand mandates for existing consumers (fertilisers' producers and refineries) or early market applications (e.g., blending with natural gas) could help build up sufficient volumes to enable large scale electrolysis projects. Sustainable public procurement could also support the green hydrogen demand, for instance by committing to emission thresholds for steel used in public infrastructures, which would encourage steelmakers to switch their process.
- On pricing side, auctions and revenue guarantee may provide an additional risk mitigation:
  - Grouping demand would help to mitigate offtake risk and to optimise use / mutualise costs to build infrastructures for the first projects, especially valid if it applies to an identified hub/cluster. It could also help benefit from scale effect.
  - If the price of electricity remains too high, providing support to green hydrogen producers with a CfD indexed on electricity price would substantially reduce risks. This needs to be considered in parallel with the VGF to ensure that there is no double-subsidization of projects.
  - A compensation of price difference between suppliers and customers in a double auction process could as well promote a ramp-up of hydrogen demand at large scale (H2Global, 2022[40]).

7. **MNRE should reinforce incentives to develop a domestic manufacturing capacity for electrolysers.**

- Initial projects are likely to involve substantial import of components. As several partnerships have been announced between Indian and foreign companies, export credit agencies could play a central role both in equity and debt financing.
- Extending the production-linked incentives scheme or equivalent financial support for domestic manufacturing of electrolysers would help attract large investments from the private sector for the local manufacturing activities serving the green hydrogen value chain consistent with the "Make in India" strategy.
- MNRE could pursue a first analysis on the ability of Indian manufacturing ecosystems to select the most critical components of electrolysers that could be produced domestically.

Key actions and timeline

Figure 4.4. Overview of the main recommendations for Green Hydrogen until 2030



Source: Authors

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Notes

[1] The measures announced in the policy are matched with the risks identified during the Roadmap in Table 4.2.

[2] Information on the 3rd Global RE-INVEST Renewable Energy Investors Meet & Expo, organised by MNRE from 26 – 28 November 2020 on a Virtual Platform, can be found on: https://re-invest.in/.

[3] While natural gas prices have seen significant increase in the context of the global energy crisis that started in 2021, closing the gap between costs of hydrogen from electrolysis and from SMR, this could be short-lived, whereas investments are usually made on the basis of long-term price levels.

[4] In the case of green hydrogen, the electrolyser would likely rely on new capacity of renewable electricity generation. When considering the comprehensive project scope, the investment in renewable energy assets can represent the largest part of the total investment (Figure 4.3).

[5] India has no offshore wind capacity by the end of 2021.

[6] This would correspond to around 10% of the required funding to meet India's wind and solar 2030 capacity targets (BloombergNEF, 2022[41])

Conclusion

The CEFI Roadmap developed between June 2021 and September 2022 brought together the government, industry sector stakeholders and domestic and international finance institutions to address bottlenecks complicating or constraining finance and investment in India's clean energy sector. The Roadmap's Steering Committee selected three focus areas, energy efficiency upgradation with a focus on MSMEs, offshore wind and green hydrogen, which will play a prominent role to help India to meet the targets announced in its updated NDC submitted in August 2022.

The recommendations of the Roadmap have been tailored to address the key concerns raised during the stakeholder consultations and three series of workshops in March, May and August 2022, each of them gathering more than 50 domestic and international participants. Recent policy developments that occurred during the development of the roadmap cover – at least partially – several key takeaways from the first and second series of workshops. Taking this forward, the third workshop focused on "deep dives" into solutions leading to the concept notes in Annex C and Annex D. They can be used as starting points for practical design and implementation of solutions after the roadmap.

The Roadmap can provide a basis to implement instruments supporting the efforts of the Government of India to reach commitment for clean energy and decarbonisation initiatives. Some recommendations can also be taken up under India's G20 Presidency in 2023, exploring further how international dialogues can facilitate mobilisation of private capital by bringing together public and private capital providers together with governments to accelerate financing for clean energy transition.

Annex A. Roadmap process and timeline

The *Roadmap* process was launched in June of 2021 in discussions with the Government of India. Subsequent meetings with the Steering Committee and Technical Working Groups led to the three Roadmap Workshops & review process.

Table A A.1. Roadmap timeline of events

July – August 2021	Steering Committee and Technical Working Group meetings
	Early stakeholder consultations to gather input on priority needs and focus areas
September 2021 – January 2022	Steering Committee meeting to set *Roadmap* topical focus
	Stakeholder consultations to assess critical barriers, challenges and needs
March 2022	Workshop I (*online*) to deliberate critical issues and priority areas for action
March – April 2022	Technical Working Group and Steering Committee follow-on to Workshop I discussions
	Stakeholder consultations on financing and investment vehicles
May 2022	Workshop II (*hybrid event*) on investment needs and solutions to unlock capital
June – July 2022	*Roadmap* draft and stakeholder review
August 2022	Workshop III (*online*) to deliberate recommendations and discuss actions forward
October & November 2022	Investor dialogue as part of OECD Forum on Green Finance and Investment (Paris)
	Roadmap launch in India

Annex B. Available multilateral funding for new energy-efficient technologies

Table A B.1. Available multilateral funding for new energy-efficient technologies

Name	Year created	Donors	Mission	Eligibility	Focus areas	Corpus	Type of assistance	Key outcomes
Clean Technology Fund	2008	Australia, Canada, France, Germany, Japan, Spain, Sweden, United Kingdom, United States	To promote scaled-up financing for demonstration, deployment and transfer of low-carbon technologies with significant potential for long-term greenhouse gas emissions savings.	ODA eligible countries under OECD-DAC list	Renewable energy; Energy efficiency in power, transport, industry, buildings and agriculture	USD 5.4 billion	Blend of instruments: Grants, contingent grants, concessional loans, equity and guarantees. Grant element at least 25%.	USD 4.8 billion used by 2021; 5392 GWh annual energy savings from 19 projects
Global Environment Facility	1991	40 donor countries, both developed and developing	To address the most pressing environmental issues, including by supporting technology transfers	Developing countries and economies in transition	Biodiversity loss, Chemicals and waste, Climate change, International waters, and Land degradation	USD 5.3 billion for 2022-26	Grants, blended finance	USD 22 billion provided till date
Green Climate Fund	2010	Annex 1 countries under the Paris Agreement	To support low-emission, climate-resilient development pathways, including investing in new technologies.	Non-Annex 1 countries under the Paris Agreement	Adaptation; Mitigation	USD 10 billion	Flexible combination of grant, concessional debt, guarantees or equity instruments.	USD 2.9 billion used in 32 projects by 2021;
Special Climate Change Fund	2001	Belgium, Canada, Denmark, Finland, Germany, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, United States	To support adaptation and transfer of climate-resilient technologies to developing countries	Non-Annex 1 countries under the Paris Agreement	Adaptation; Transfer of technologies	USD 375 million	Grants	USD 355 million invested in 87 projects

Note: OECD-DAC list of ODA eligible countries can be found on OECD website. Annex 1 and Non-Annex 1 countries under the Paris Agreement are listed on UNFCCC website.
Source: Funds' and Facilities' websites.

Annex C. Concept note: Energy Savings Insurance

Conceptual framework of the ESI model

The Energy Savings Insurance (ESI) model was first developed-by the Inter-American Development Bank (IDB) in 2014, with the support of Basel Agency for Sustainable Energy (BASE), to drive investments in energy efficiency projects. It has since been implemented in eight Latin American countries targeting small and medium enterprises (SMEs) among several sectors, notably healthcare, tourism, hospitality, and agriculture.

The ESI model is a de-risking package consisting of both financial and non-financial elements designed to build investor confidence in energy efficiency projects. It has four building blocks that support the identification and structuring of technically robust and bankable projects: standard contract, technical validation, energy savings insurance, and concessional financing.

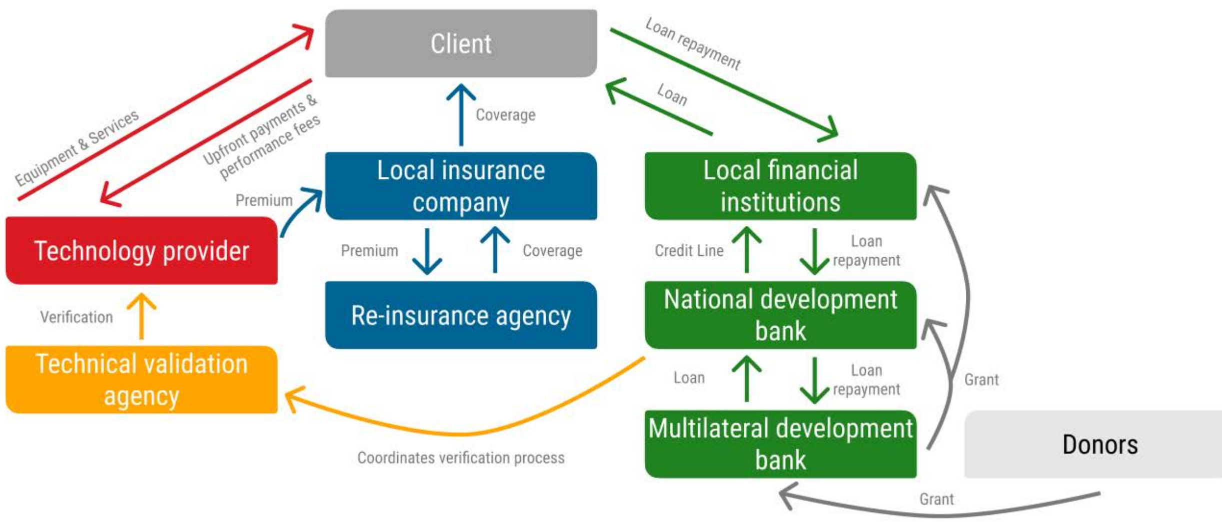
(a) The **standard contract** establishes the responsibilities of the supplier in terms of supply and installation of equipment, corresponding guarantees, and the promised energy savings relative to a benchmark (established by the supplier using standardised methodologies). It also commits the customer to timely payments, access to facilities, and adequate maintenance of the equipment.

(b) The **technical validation** is carried out by an independent agency who evaluates and confirms the project's technical potential to achieve the promised savings and verifies on site that the project has been built according to specifications approved in the initial evaluation. This actor also determines which party is entitled to compensation in case of disagreements on the achieved performance and actual savings generated by the project. The validator's roles are defined in the standard contract and its decisions are binding for both parties.

(c) The **energy savings insurance** is a performance warranty provided by the supplier to the customer for the committed savings in a period of time previously agreed between the two parties. If at any point in time, the project does not achieve the pledged savings, the insurance agency will financially compensate the client. The energy savings insurance is activated upon technical validation of the project, and is further backed by a reinsurance agency.

(d) Insured projects are financed with **concessional credit lines** usually set up by donor agencies and multilateral development banks. Lenders provide preferential terms under these credit lines, including preferential interest rates, grace periods and extended tenures.

Figure A C.1. Conceptual design of ESI



Source: (Micale, Stadelmann and Boni, 2015[1])

Notes: 1) In addition to the actors directly participating in the ESI model, regulatory agencies can play a role to oversee the various mechanisms involved; 2) In India, national development banks are also eligible to lend directly to clients.

Key barriers and potential solutions

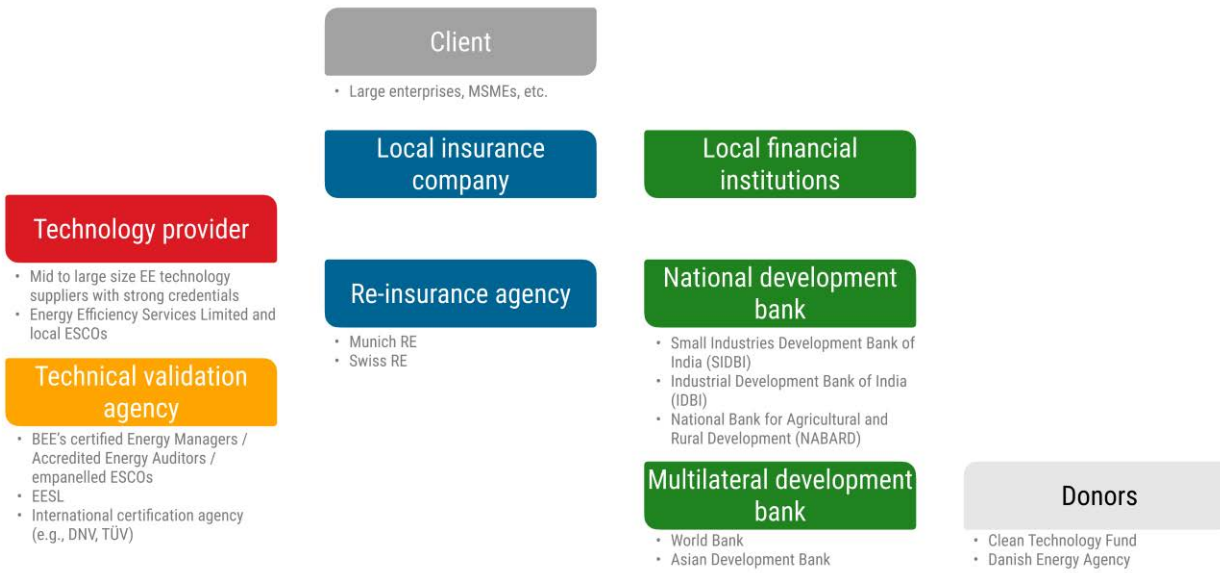
Table A C.1. Four key barriers to the implementation of the ESI model in the Indian context

Key barrier	Experience from Latin America	Challenge for India	Potential solution(s) for India
High transaction costs for small projects	Transaction costs are relatively low (1.5%-2.5% of the project value on average).	The cost of insurance and the cost of validation services, which are to be paid by the client, can account for very high shares of project costs of MSMEs (typically around USD 5 000 – 300 000 in value)	• Provide third-party validation services free of cost • Offset the cost of insurance with donor funds
Insurance cost depends on credibility of technology provider	Insurance costs are ~1% of project value on average. Not a single claim has been made so far under ESI programs in any Latin American country.	The ability of an insurance company to offer a reasonably-priced energy savings insurance depends on its confidence in the technology provider's product quality and its ability to pay any eventual warranty claims. Start-up or MSME technology provide without strong credit profiles or proven track records are thus unable to participate in the ESI model.	• Engage a reputed technical validation entity (e.g., BEE's certified Energy Managers / Accredited Energy Auditors / empanelled ESCOs) to freely certify technologies provided by MSME suppliers • Engage credible energy service companies (ESCOs) with good credit profiles and track records (e.g. Energy Efficiency Services Limited) to act as intermediaries between MSME suppliers and clients.
Surety bonds not available in Indian market	The energy savings insurance product is structured as a surety bond i.e. tripartite legal contracts promising predefined compensation from a bank/insurance agency for clients in case suppliers break the contract.	Although surety bonds are well-established and widely used in other markets (particularly in public construction projects), they are not yet offered in India.	• Pilot surety bond issuances, in line with 2022 regulation from the Insurance Regulatory and Development Authority of India (IRDAI), and build capacity of local financial institutions to offer them • Explore potential alternative products that the market is already familiar with, such as conventional bank guarantees (unsuitable for start-up or MSME providers with poor credit profiles).
Difficulty validating energy efficiency performance	The standard performance contracts developed under Latin American ESI programs formulate performance guarantees in the form of energy savings parameters (e.g. guaranteed energy savings of 15-20% relative to an established or pre-defined baseline).	It can be challenging for the third-party technical validation agency to validate that the savings target has been achieved, particularly when there is a change in operating conditions (e.g. duration of equipment operation, electricity prices, etc.).	• Transfer methodologies and learnings from international experience to validate energy efficiency performance • Consider guaranteeing energy efficiency ratings rather than savings parameters

Implementation design and potential role of actors in India

The ESI model involves coordination between multiple actors and agencies. Potential roles for different actors in India are proposed as follows.

Figure A C.2. Potential actors to engage to set up a pilot ESI programme in India



- ***Clients***: The ESI program can be availed by both MSMEs and large industries. However, since MSME clients face higher transaction costs due to their typically smaller project sizes, some elements of the program may need to be subsidised for them (see Table AC1). Donor funding will play a critical role in subsidising these costs and ensuring that MSME clients can access the ESI program.
- ***Insurance agencies***: Both local and international insurance agencies can be involved in the ESI program. Local insurance agencies can be engaged to provide ESI coverage to clients, given their familiarity with the market and possibly pre-existing client relationships. Re-insurance to the local insurance agencies can be provided by international agencies, such as Munich RE or Swiss RE, which have experience in this area.
- ***Technical agencies***: Credible and well-established technology providers and technical validation agencies are necessary to build trust and keep insurance costs low. BEE's certified or accredited energy auditors, managers, ESCOs (including EESL) or international certification agencies are good examples of potential technical validation agencies that can boost the credibility of energy-efficient technology providers, particularly in the case of start-ups or MSME technology providers.
- ***Financial institutions***: Concessional credit lines under an ESI program run from donor agency to multilateral development banks (MDBs) to national development banks (NDBs) and eventually reach local financial institutions (LFIs), which in turn are best placed to lend to local clients. Appropriate NDBs and LFIs must be identified and empaneled in the ESI program in India, depending on the priority sectors to be targeted in the pilot phase (e.g. NABARD is well-placed to lend to clients in the agriculture sector, SIDBI for MSME sector, etc.).

- ***Donor agencies:*** Domestic and international donor agencies can support the implementation of the ESI model in India by providing funds for concessional credit lines, technical validation services, grants to offset insurance costs for targeted clients (e.g. MSMEs), or developing a standard contract contextualised for India. Interest of partners who have supported ESI schemes in other countries, such as the Climate Investment Facility's Clean Technology Fund or the Danish Energy Agency, will need to be explored.
- ***Regulatory agencies:*** In addition to actors directly participating in the ESI model, regulatory agencies can play a role to oversee the various mechanisms involved. For example, IRDAI can regulate insurance companies in the provision and structuration of the ESI product (e.g. use of surety bonds vs bank guarantees) while BEE can supervise the technical agencies and monitor if energy efficiency objectives are being met.
- ***International partners:*** Learnings from international experience piloting the ESI model in Latin American and European countries can be transferred to ensure successful implementation in India. Organisations such as IDB and BASE can share knowledge and best practices, as well as resources developed for other countries (e.g. formats for standard contracts, guidance for technical validation, etc.) which can be built upon for the Indian context.

The following agencies can have an overarching role in the potential ESI program in India:

- ***Bureau of Energy Efficiency (BEE)****:* As the statutory body for energy efficiency implementation in India, BEE could be involved in several technical and regulatory aspects of the ESI model. This would include coordinating regulatory approvals from IRDAI and seeking buy-in from local financial institutions regarding the use of specific insurance products (surety bonds, bank guarantees, etc.). BEE could also collaborate with international partners (e.g. IDB, BASE) to build on existing formats for standard performance contracts used in the ESI model and contextualise them for India. Further, BEE could utilise its latest energy-efficient technologies list (BEE, 2022[2]) to guide the third-party technical validation agencies within the ESI model.
- ***Energy Efficiency Services Limited (EESL):*** Given the barriers faced by MSMEs in accessing the ESI model, both as clients and as technology providers, EESL could leverage its position as India's super-ESCO to bring down transaction costs. For instance, EESL could play the role of an intermediary between MSME clients and technology providers, such that its credibility can lower the costs of technical validation and insurance for both parties. Further, EESL can help scale-up this approach by training local ESCOs and building their capacity to perform similar functions. EESL has expressed interest in providing support to test or pilot the ESI model in India, potentially under the "Promoting market transformation for energy efficiency in MSMEs" scheme.

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Annex D. Concept note: Blended Finance Facilities for Offshore Wind & Green Hydrogen

Purpose of Blended Finance Facilities for Offshore Wind & Green Hydrogen

Blended finance has mobilized approximately $171 billion in capital towards sustainable development in developing countries to-date (Convergence, 2021[1]). In accordance with OECD definitions,[1] blended finance structures can involve concessional funding from public or philanthropic sources mobilising private capital for projects that cannot raise commercial finance on their own,[2] primarily because perceived and real risk are too high for private investors. Governments (including development co-operation agencies) represent close to 69% of the total capital in blended finance funds and facilities, and MDBs are the second largest source of capital (Dembele et al., 2022[2]).

Establishing sectoral blended finance facilities for (a) offshore wind and (b) green hydrogen in India could allow various organisations to invest alongside each other while achieving their own objectives. In particular, these facilities could be integrated in development strategies and sector investment plans of the Government of India, with the ultimate goal to lower the levelized cost of clean energy and develop self-sustaining private investment market.

The blended finance facilities should provide a limited window of concessionality to serve the first few gigawatts until a target cost of energy is achieved, with the objective of lowering risks and the cost of capital to build self-sustaining private investment markets. To this end, the facilities would channel funds from domestic and international donors and financial institutions. Blended Finance facilities can be supported by broader activities, such as the identification of projects (e.g. through the National Infrastructure Pipeline), or the development of knowledge and training resources for offshore wind and green hydrogen.

While detailed needs assessment must be undertaken, this concept note outlines the key elements to address in the process of designing and setting up such facilities.[3]

Process to design and implement blended finance facilities for (a) offshore wind and (b) green hydrogen in India

Table A D.1. Key steps to design and implement blended finance facilities for (a) offshore wind and (b) green hydrogen in India

Steps	Main actions and remarks for future detailed assessment needs	Key Actors
1. Define the development objectives	N/A - the main development targets for Offshore Wind and Green Hydrogen have already been announced by the Government of India.	MNRE
1. Identify the sector-specific market failures, risks, and other barriers to investment	As several report already identify the main barriers to investment, this step would consist in proposing steps of the value chain that should be prioritised for the blended finance vehicle.	MNRE, International Organisations1), Think Tanks

2. Choose financial instruments while minimising concessionality	After having selected potential steps of the value chain for both proposed blended finance facilities, a detailed assessment of the value at stake to achieve the development objectives should be carried out, including detailed investment assumptions. The potential impact of the potential instruments, e.g. based on Figure A D.1, should be assessed in the financial model against key parameters, such as the required amount to reach development objectives, and/or their impact on LCOE and LCOH.	MNRE, partner MDBs and DFIs
3. Determine target mobilisation	The financial model or needs assessment methodology used in step 3 could be used to estimate the amount of commercial finance that the selected instruments may mobilise.	MNRE, partner MDBs and DFIs
4. Co-ordinate the intervention with the ecosystem	The selection of a blended finance structure needs to be decided based on the detailed needs and impact assessment carried out in steps 3 and 4. In addition, the facilities may be designed at a national level, or be integrated in global blended finance facilities. In both cases, co-ordination at international level will be required, as both offshore wind and green hydrogen are likely to rely on regional or global supply chains.	MNRE, partner MDBs and DFIs, International Organisations
6.a. Monitor and evaluate development impact	N/A – while a monitoring methodology needs to be defined, this will come after the detailed assessment needs to confirm the interest of blended finance vehicles for offshore wind and green hydrogen in India.	MNRE, partner MDBs and DFIs
6.b. Exit once commercial markets are functioning	N/A – while indicators can be defined to analyse the establishment of pure commercial markets for offshore wind and green hydrogen (e.g., the installed capacity in GW of offshore wind turbine or electrolysers, or the LCOE and LCOH achieved in auctions, respectively compared to other power generation sources and grey hydrogen), this will come after the detailed assessment needs to confirm the interest of blended finance vehicles for offshore wind and green hydrogen in India.	MNRE, partner MDBs and DFIs, other lenders and donors

Note: Including CEFI Roadmap core team
Source: Authors, based on (OECD, 2022[3])

Key questions to prepare a detailed needs assessment

Which steps of the value chain should be prioritised for the blended finance facility?

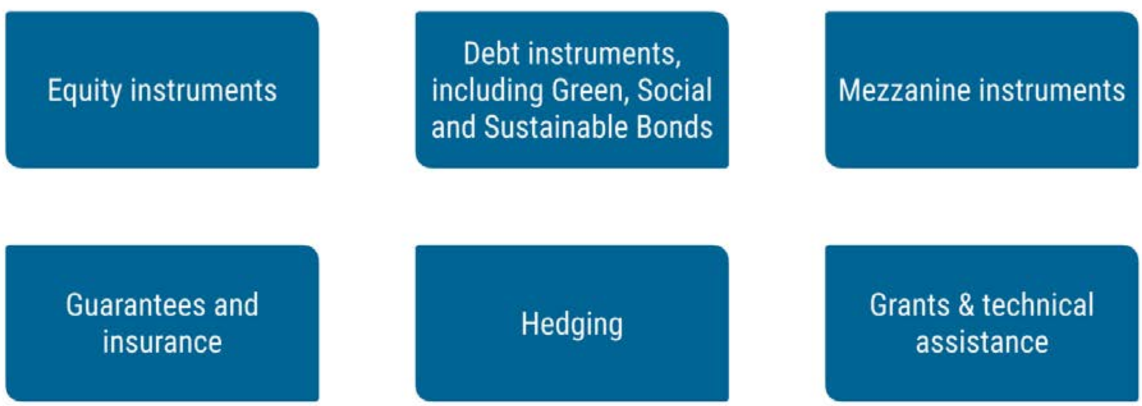
In the context of over-stretched public finances post the COVID-19 pandemic, the facility should target high impact for every rupee of public finances spent, which is key for highly capital-intensive sectors like offshore wind and green hydrogen, where around USD 100 billion investments would be needed to build 37 GW of offshore wind, and a similar amount to develop 5 million tonnes of green hydrogen, as per the targets announced by the Government of India.

Salient risk areas of offshore wind and green hydrogen could be addressed through the blended finance facility. While such a facility would be capable of channeling finance for all parts of the value chain, it would be particularly impactful and would facilitate co-ordination between donors if it focusses on one single and well-defined area. Both for an offshore wind blended finance facility and for a green hydrogen facility, financing infrastructure upgrades could have a large impact. Indeed, transmission system upgrades typically represent 15-20% of the offshore wind project CAPEX. Similarly, developing green hydrogen projects also involves building storage, transport and distribution infrastructure, which can be optimised by investing in hydrogen hubs, for instance by building common user infrastructures. Improving these costs can bring down cost of energy through lower tariffs and build a robust business case for further investments. In India, it has already been announced that transmission network connections for the initial stage of offshore wind project development will be provided by the government.

What degree of concessionality would be required in order to attract commercial investment?

Given the scale of capital required to finance investments in offshore wind and green hydrogen, the development finance funds of the blended finance facility should be used wisely. In these circumstances, the need for concessionality should be assessed in ad hoc business and financial models, to ensure that de-risking, e.g. through guarantees, is prioritised to mobilise capital from private sources. Blended finance can use a wide array of instruments (see Figure A D.1), with various levels of concessionality. As blended finance interventions should focus on where the business case for development is close to commercial maturity, this assessment could confirm the selection of the steps of the value chain where the blended finance facility would have the highest impact for offshore wind and green hydrogen.

Figure A D.1. Instruments to mobilise private capital

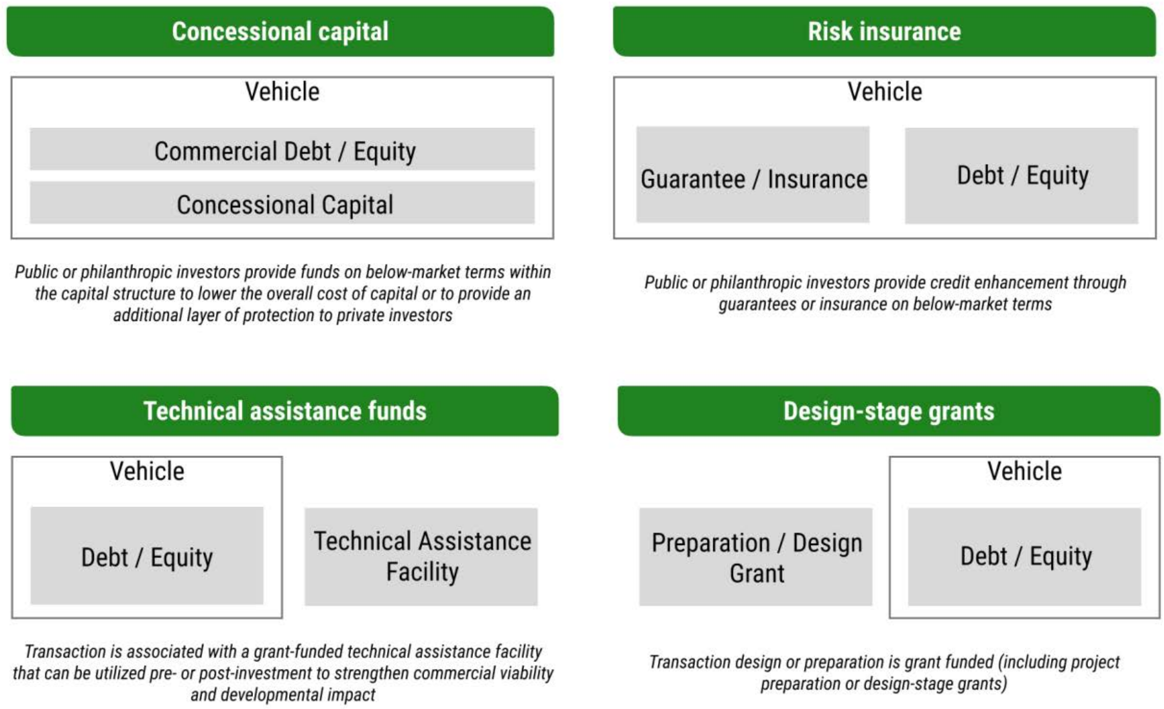


Source: (Dembele et al., 2022[2])

What are the pros and cons of establishing a national vehicle, or to rely on an international fund or facility?

There exist several common structures for blended finance vehicles (see Figure A D.2). The selection of one of these archetypes, or the design of a different structure, will depend on the market failures that must be addressed. The four archetypes are not mutually exclusive and a combination of these could be warranted.

Figure A D.2. Four archetypes of blended finance structures



Source: (Convergence, 2021[1])

While establishing the facility specifically for India, would provide certain advantages, there is scope to explore synergies with a global blended finance facility for offshore wind currently being developed by the World Bank, or similar funds that could be developed for green hydrogen.

Establishing a national facility could lead to a faster and more flexible implementation, as the Government of India – possibly through its agencies – would hold ownership of the process. As India is an attractive market for foreign investors and was the largest recipient of investment in blended finance in 2020, it could be possible to reach sufficient scale even with a national facility. Yet, an international facility would allow climate finance to be more easily and widely accessible, possibly through an existing fund to keep transaction costs low and could be more attractive for MDBs, as it would enable them to use a single vehicle covering several countries.

In the case of a national facility, the blended finance facility in India could be built on the concept of the Green Window that was proposed by IREDA in 2019 (PIB, 2019[4]) but was put on hold due to the pandemic related priorities.[4] Public concessional funding for the facility could be channeled by various state or finance ministries to designated implementing agencies such as NIIF and IREDA.

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Notes

[1] Blended finance is the strategic use of development finance for the mobilisation of additional finance towards sustainable development in developing countries.

[2] Blended Finance can also cover grants for project preparation and project structuring

[3] A comprehensive generic guidance on blended finance can be found on: https://www.oecd.org/dac/financing-sustainable-development/blended-finance-principles/.

[4] For more information on the Green Window concept, see: www.nrdc.org/sites/default/files/growing-clean-energy-green-windows-202001.pdf.

Green Finance and Investment

Clean Energy Finance and Investment Roadmap of India

OPPORTUNITIES TO UNLOCK FINANCE AND SCALE UP CAPITAL

India has achieved major progress in its energy sector over the last two decades. Still, investment needs to scale up considerably to meet the government's ambitions to achieve 500 GW of renewable energy capacity and energy-intensity reductions of 45% by 2030. Targeted application of public funds, alongside international climate and development finance, can crowd in investors and channel private capital to meet India's clean energy goals. The *Clean Energy Finance and Investment Roadmap of India* highlights key actions needed to accelerate the development of energy efficiency measures in micro, small and medium enterprises, offshore wind and green hydrogen production. The report provides a comprehensive overview of the initiatives to date and challenges to scale up investments. It also provides a number of tailored recommendations for the Government of India, development partners and the private sector.

PRINT ISBN 978-92-64-46554-1
PDF ISBN 978-92-64-65657-4

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