Policy Brief

Potential Areas of Climate, Energy and Development Partnerships of India with Germany, EU and G7

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Credits

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1. Introduction

The new German government has identified climate, energy and development partnerships as a particularly relevant instrument of German foreign climate policy for the implementation and achievement of the goals of the Paris Climate Agreement and the SDGs. Following the example of the recently announced South Africa Just Energy Transition Partnership, other Just Energy Transition Partnerships (JETP) can be set up individually with selected countries. These can cover areas of cooperation with respect to the partner country's interests –beyond the energy sector and including areas like development and resilience building.

This policy brief outlines possible thematic focus areas for partnerships as well as their potential architecture in India. These partnerships with India could be designed bilaterally with Germany or multilaterally between India and the European Union (EU) or the G7. Any such partnership would build upon existing cooperation, such as the partnership for green and sustainable development, signed recently by India and Germany on 2nd May, 2022. Through this partnership both countries committed to timely realisation of the Sustainable Development Goals and the goals under the UNFCCC and the Paris Agreement.[1] While sustainable development remains high on agenda, other promising facets are renewable energy, energy efficiency and the transport sector where India has set ambitious national targets. Engaging in Indo-German/EU/G7 climate, energy and sustainable development including SDG partnerships holds enormous economic and social advantages for India.

Ever since the announcement made at the UNFCCC COP 26 by the government of South Africa and the International Partners Group (IPG) on JETP, countries in pursuit of JET have been paying close attention to its implementation model. Ongoing negotiations for JETP around the globe will count on the inclusivity and equitability rendered in the South African Just Energy Transition Investment Plan (JET-IP).[2] Similarly, the G20 platform could play an equally pivotal role in contextualizing JET for developing (large) economies, especially after India assumes its presidency by the end of this year. One of the sought-after outcomes during its presidency could be a conclusion on the JETP negotiations.

[1] "Joint Declaration of Intent between The Republic of India and The ...." https://india.diplo.de/blob/2524930/6a4f226c3e696417d110e0651ea26d77/igc-joint-declaration-2022-data.pdf.

[2] "Six-Month Update on Progress in Advancing the Just Energy ...." 21 Jun. 2022, https://ukcop26.org/six-month-update-on-progress-in-advancing-the-just-energy-transition-partnership-jetp/.

2. Areas of Cooperation within a Partnership

While there is clear scientific consensus on the need to move rapidly towards a decarbonized world, no one country can hope to achieve this alone. Given the sheer scope, diverse needs, and myriad approaches necessary to address climate change, countries must work together and learn from one another. These efforts to foster partnership will bring increased access to information, knowledge sharing, expertise, financial resources and technical tools. This will increase efficiency, solidarity, increased visibility of issues, sharing of good practices, among other benefits.

It is in this direction that the Partnership for Green and Sustainable Development has been signed by India and Germany on 2nd May, 2022. In their pursuit to achieve the SDGs and the associated climate targets, focus will be laid, inter alia, energy transition, sustainable urban development, green mobility, climate change mitigation, resilience and adaptation, agro-ecological transformation, marine litter, and circular economy.

While the areas of cooperation within GSDP remains not limited to the above-mentioned ones, the predominant ones are discussed in this paper.

2.1 Climate Finance

The impact of the energy transition will be hardest on developing economies like India because the majority of its employment, GDP, and the physical capital stock is dependent on hard to abate sectors. To circumvent this, assistance via easy financing options is one of the key pillars for enabling a quicker and just energy transition.

The need for finance in developing countries has long been a cornerstone of the global negotiations. However, the previous fund flows and commitments under the Paris Agreement ($100 Billion by 2020, now pushed to 2023) have been subpar on account of scale, scope, and speed. COP26 at Glasgow, explicitly recognized this void and has urged developed countries to fast-track climate finance and meet the annual USD 100 billion commitment to developing nations. However, conservative estimates by Bhattacharya (2021)[3], McKinsey Global Institute (2022)[4] & Ahluwalia (2022)[5] suggest that the combined climate financial need for mitigation and adaptation efforts is around 1 trillion per annum for developing countries (excluding China).

To date, India's progress in the climate mitigation and adaptation space was largely funded from domestic sources with a higher share from the private sector. Going forward, the recent announcement of 500 GW of non-fossil fuel share will further ramp up the financial requirements for the country that will require major share to come from the foreign financial flows. Under the Partnership for Green and Sustainable Development, 10 billion Euros are pledged for the next ten years, and additional commitments can be expected under this partnership.

[3] Bhattacharya, A. & Stern, N. (2021). Beyond the $100 billion: Financing a Sustainable and Resilient Future. Grantham Research Institute at LSE, London, UK.

[4] McKinsey Global Institute (2022). The Net-zero Transition: What it would cost, what it could bring. January 2022. McKinsey & Co.

[5] Ahluwalia, M. S., & Patel, U. (2022). Climate Change Policy for Developing Countries (CSEP Working Paper 23). New Delhi: Centre for Social and Economic Progress.

The Government of India[6] (GoI) has estimated that India would need USD 2.14 trillion[7] from 2015 to 2030, or roughly INR USD 145 billion per year for climate action[8]. Out of this, it is estimated that India would need an annual investment of USD 20-26 billion[9] or a total of USD 0.2 trillion just for the renewable energy capacity additions for meeting India's long-term commitments as seen in Table 1. However, the financial flows for RE related capacity additions for the last few years have been posing a dismal picture in the range of USD 10 billion per year[10].

Technology Type	Capacity expected by 2030 (MW)	Cost per MW (Million USD)	Total Investment (Million USD)
Solar	2,40,000	0.43	103,200
Wind	1,00,000	0.72	72,000
Transmission	3,40,000	0.079	26,860
Pumped Hydro	10,000	0.66	6,600
Battery (without Balance of System)	1,08,000 (MWh)	148 (USD per kWH)	16
Total			**208,676**

While low adaptation-related finance remains unaltered, current financing challenges related to investments in the energy sector are also considerable. The large gap between required levels of investment highlights the extent of gap in this area. India's international climate partnerships could help bridge this gap and deploy concerted efforts to mobilize funds. While the national efforts are indispensable, the need and possibility for international funds should not be ignored.

2.2 Technology Cooperation

Indo-German technology cooperation is longstanding. For over sixty years, GIZ has been working with the Indian counterparts across the energy sector to jointly-develop technology solutions to meet local needs and achieve sustainable and inclusive development. Some of the flagship initiatives has been the Indo-German Energy Programme (IGEN) including the Green Energy Corridors, Grid Integration, Energy Efficiency in Industries (PAT programme), Energy Conservation Building Code for Residential Building and Solar Rooftops. Other key partnerships include the IGEN-Access, Indo-German Solar Energy Partnership etc.

2.2.1 Green Hydrogen

GoI launched a green hydrogen policy to revitalize the sector in Feb 2022[11] that follows the earlier 2006 roadmap. The policy aims to produce 5 MMT (Million-Metric Tonne) of green hydrogen per year by 2030. In order to meet this ambitious target, large investments in production, transport, and storage infrastructure are required. The European Union (EU) has been working in the green hydrogen domain for the last decade. It has set a target of 10 MMT of Green Hydrogen by 2030 (about double India's target).[12] Collaboration and partnerships between the two countries is necessary towards realising such ambitious targets. A step forward in this direction is the setting up of the Indo-German Green Hydrogen Task Force. The task force seeks to strengthen mutual cooperation in production,

6 India NDC to UNFCCC
7 We have used a conversion rate of 1 USD = 76 INR throughout the paper.
8 https://www.climatepolicyinitiative.org/wp-content/uploads/2020/09/Landscape-of-Green-Finance-in-India-1-2.pdf
9 Standing committee on Energy, Financial constraints in the RE sector.
10 Ibid., 6
11 https://powermin.gov.in/sites/default/files/webform/notices/Green_Hydrogen_Policy.pdf
12 https://www.spglobal.com/commodity-insights/en/market-insights/latest-news/electric-power/082321-feature-hydrogen-targets-in-eu-2030-climate-package-will-need-huge-renewable-power

utilization, storage and distribution of Green Hydrogen through enabling frameworks for projects, developing regulations and standards, conducting trade and joint research and development (R&D).

India is already producing 6 MMT hydrogen from fossil fuels.[13] For this to become a sustainable hydrogen production method on a path to net-zero emissions, the existing facilities will need to incorporate carbon capture and storage technology. The EU aims to have 10% of hydrogen from fossil fuels that will feature carbon capture and storage by 2030.[14] However, hydrogen production via water splitting through electrolysis holds the key. To date, the EU has an electrolyzer capacity of around 1 GW and aims to achieve 40 GW capacity by 2030.[15] In India, similar efforts to ramp-up electrolyser manufacturing capacities are underway. This is critical from the standpoint of achieving green hydrogen produced solely by renewable energy sources in the long run.

Hydrogen transportation is another aspect of interest. As the capital cost for building new hydrogen related transmission pipelines is steep, an onshore retrofit to address hydrogen embrittlement of existing natural gas pipelines surfaces is the more cost-effective option. Notably, the EU has conducted a thorough examination of pipeline agreements as well as existing natural gas pipeline material and age; capacity building of Indian stakeholders around the same can be looked into. As per the EU analysis, around 70% of existing oil and natural gas pipelines can be directly reused as hydrogen pipelines.[16] Another cheaper and interim way of transporting hydrogen by pipeline is through blending into the existing natural gas pipeline infrastructure. However, this again will require an assessment to identify the upper limit of hydrogen blending before pipeline embrittlement. Moreover, leakages of hydrogen throughout the value chain could be counterproductive.[17] [18]

Hydrogen carriers like ammonia and methanol are other potential hydrogen storage and transport methods. These carriers have the potential to be used in fuel cells directly thus requiring no energy for dehydrogenation. However, they present a significant health hazard to humans if not handled properly. Further, research and development is needed before its implementation.

2.2.2 Renewable Energy

Renewable Energy (RE) technologies present us with an opportunity to decarbonize the energy and other carbon-intensive sectors of economies and set them on the path to net-zero. Moreover, shifting from fossil fuels to RE technologies is important for reduced dependence on imported fossil fuels, lower energy import bills, and attainment of long-term energy security which is highly desirable given the geopolitical uncertainties.

a) Solar PV

In order to meet the 280 GW target capacity by 2030, around 30 GW of solar PV installation must be ensured every year. There is a need to expand the 4 GW of solar cells and 16 GW of solar PV module manufacturing capacity in India[19] to escape its import dependence. Further, the majority of installations in India revolve around crystalline solar PV technologies and limited focus has been on the next-generation technologies like perovskite, tandem cell, Bio-solar and others. Thus,

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13 https://www.teriin.org/sites/default/files/2021-07/Report_on_The_Potential_Role_of_%20Hydrogen_in_India.pdf
14 https://www.fch.europa.eu/sites/default/files/Hydrogen%20Roadmap%20Europe_Report.pdf
15 https://www.wfw.com/articles/the-european-hydrogen-strategy/
16 Carbon Limits AS and DNV AS, "Re-Stream - Study on the reuse of oil and gas infrastructure for hydrogen and CCS in Europe," Oct. 2021.
17 Hydrogen is also considered to have a 100-year global warming potential of 5.8
18 R. Derwent *et al.*, "Global Environmental Impacts of the Hydrogen Economy," 2006.
19 https://jmkresearch.com/13-75-gw-of-new-module-and-6-9-gw-of-new-cell-production-capacity-likely-to-be-added-in-india-in-next-18-months/

collaborations with the research and development institutes in the EU like Fraunhofer Institute for Solar Energy Systems ISE, Germany is vital.

Moreover, with increased capacity addition the end-of-life management of solar PV modules will become a critical facet in the near future. The PV waste volume in India is estimated to grow to 200 thousand tonnes by 2030 and around 1.8 million tonnes by 2050. Here, the EU has shown leadership by incorporating Waste Electrical and Electronic Equipment (WEEE) directive in February 2014[20]. Sharing of learnings and technology with Indian stakeholders will keep intact solar PV's environmental friendliness.

b) Offshore wind

With a 7600-kilometer coastline and being surrounded on three sides by water, India has an immense opportunity of harnessing offshore wind energy[21]. GoI has set a target of 5 GW of offshore capacity by 2022 and 30 GW by 2030. However, there has been little progress in this regard.

The EU is the current leader in the offshore wind space. The total installed offshore wind capacity in Europe today stands at 25 GW. Of this, Germany had deployed 7.7 GW by 2020[22]. Moreover, it aims to install 30 GW of offshore wind power by 2030, followed by 40 GW in 2035 and 70 GW in 2045. The growth of the offshore wind industry can be attributed to the policy and incentives of the German government during the initial phase. There is a vast scope of collaboration that can provide impetus to the germinating offshore industry in India.

2.2.3 Grid Integration & Energy Storage

Cross-sector convergence and upscaling of RE necessitates the deployment of technological solutions to enhance the resilience of the power systems. As India steadily adds RE capacities, transmission bottlenecks have begun to emerge. Evacuation constraints are visible, and stakeholders already see under-utilization of new and planned transmission corridors. Left unaddressed, these issues can lead to harmful lock-ins and stranded investments along with high levels of RE curtailment, unless long-term planning and proactive measures are undertaken.

Along with this, energy storage deployments can further defer infrastructure upgrades for constraint corridors. However, there are multi-faceted dimensions that govern the commercial deployment of energy storage technologies; these include application, economics, policy push, incentives, subsidies, regulatory mandate, awareness, etc. Knowledge-sharing partnerships are critical to realizing low-carbon energy transition. Countries such as the United States of America (USA) have scaled and deployed technologies such as Pumped Hydroelectric Storage (PHS), Gravimetric Energy Storage, and more[23]. Access to such innovative energy storage technologies could be a significant boost to help India realize a just transition.

a) Transmission-side Reforms

Today, there are very few independent research efforts and policy dialogues that focus on transmission reforms that will allow high RE integration. It is thus important for stakeholders to discuss new perspectives to transmission planning, pricing, and allocation and to identify principles that can

[20] http://www.solarwaste.eu/wp-content/uploads/2013/06/Solar-Waste-WEEE-Directive-Information-sheet.pdf
[21] https://mnre.gov.in/wind/offshore-wind/
[22] https://www.csis.org/analysis/germanys-offshore-wind-industrial strategy#:~:text=The%20country%20plans%20to%20install,5%20percent%20from%20offshore%20wind.
[23] https://www.utilitydive.com/news/energy-storage-capacity-eia-2021-report/627028/

ensure investments in the right technologies, and cost-effective construction and operation of the transmission system.

b) Pumped Hydro Storage (PHS)

In India 2.6 GW of PHS is operational and 3.1 GW is under construction[24]. PHS plants with a total capacity of 96.5 GW have been identified at 63 locations[7]. PHS can be a long-term and sustainable solution because it can give valuable support in both deficit and surplus situations, as well as fast ramping up and ramping down capabilities.

With 57 GW PHS, Europe is the second-largest zone, representing almost 33% of the market.

Additionally, the United States with a rated power of 27 GW[25] pumped hydro storage, accounting for 92% of energy storage capacity available in the country, could significantly contribute learnings to aid India's PHS development.

c) Concrete Based Storage

Lifting and lowering composite bricks or "mobile masses" created from recycled and locally obtained materials to store and dispatch energy using basic concepts of gravity and kinetic energy is referred to as concrete-based energy storage.[26] The concept of using structures and buildings in this way could be revolutionary, because it would offer an alternative solution to the energy crisis, by providing a large volume of energy storage. In a world with an ever-growing need for sustainable building materials, adding an element of functionality to the most commonly used building material (concrete) has a significant value from a sustainability perspective. The concrete-based storage comes with multiple gains like the efficiency of around 80 to 90%, less response time, cost-effectiveness and higher life cycle.

In both the EU and India, concrete-based energy storage is in a very early stage. A research group at the Chalmers University of Technology, Sweden, has developed a world-first concept for a rechargeable cement-based battery. The GoI invited proposals looking beyond battery storage. Energy Vault, a Swiss manufacturer of gravity-based energy storage systems, has commercialized its technology, with Tata Power of India slated to be the first customer in India. The collaboration around this technology can get more pilots done to ramp up technology advancement in this domain.

2.3 Climate Resilience

Building global cooperation on climate resilience at government, industry and businesses as well as at community and individual level is needed to enhance the response to climate impacts. With current emissions trajectories, it is discernible that India will need significant financial, technical and capacity building support.

2.3.1 Extreme Weather Events

Extreme weather events have been on a rise in the recent decades. These events have a particularly devastating impact on developing countries like India, where early warning systems are still in nascent stages and/or not widely used.

[24] https://ieefa.org/wp-content/uploads/2019/03/IEEFA-India_Pumped-Hydro-Storage_Mar-2019.pdf
[25] https://css.umich.edu/factsheets/us-grid-energy-storage-factsheet#:~:text=Key%20EES%20technologies%20include%3A%20Pumped,Hydrogen%20Energy%20Storage%20(HES).
[26] https://www.chalmers.se/en/departments/ace/news/Pages/World-first-concept-for-rechargeable-cement-based-batteries.aspx

The Physical Science Basis Report of IPCC (2021) clearly indicates that the increase in temperature will pose a threat to Asia, in terms of delayed and weak monsoon circulation, droughts in semi-arid and arid areas, heatwaves, floods and glacier melting in the Hindu Kush Himalayan region.

As per the Global Climate Risk Index study[27], India ranks among the top 10 (ranking 7th) most affected countries in 2018. Further, a December 2020 study[28] mentions that more than 75% of Indian districts (home to over 638 million people) are extreme climate hotspots. The study also concludes that post-2005, at least 55 or more districts witnessed extreme flood events year-on-year, exposing 97.51 million people annually. With this, the frequency of associated flood events such as landslides, heavy rainfall, hailstorms, thunderstorms, and cloudbursts surged by over 20 times between 1970 and 2019. The rising sea-level is projected to cause direct damage to GDP by 2080 and increase in flooding in coastal cities will significantly impact the average annual economic losses between the years 2005-2050.

In an agrarian economy like India, with a long coastline, it is crucial to understand that not just extreme events, but anomalies (in patterns/frequency of extreme events) and slow-onset processes like sea-level rise as well as potential tipping points like the Indian summer monsoon are alarming. To reduce the impacts of these projected and most likely unavoidable extreme events, the forthcoming international collaborations must include the elements for better preparedness and to enhance the capacities of infrastructure, ecosystems and communities to bounce back.

2.3.2 Sustainable Urban Planning

World Urbanization Prospects (2018) suggests that, by 2050, over 50 percent of the Indian population would be residing in urban areas. Comparatively, the Census of India, 2011, recorded the total urban population as 377 million, which constituted 31% of the country's total population. The added stress on consumption of natural resources in urban ecosystems will adversely impact air, land and water, if not done heedfully. It is therefore important that the following aspects are effectuated in the urban ecosystems: a) demand-side management (optimization/efficiency improvement) for energy and water needs, b) incorporation of blue green factor across habitat/building development, c) decentralized waste management systems, d) transit-oriented landscape designing (for having the least dependence on private transport), and e) buffer zones for accommodating future space needs. Additionally, the severe impacts of Covid-19 pandemic have reinforced the necessity of increasing alertness and preparedness during epidemics/natural disasters.

As a result, it is essential that urban planning systems should consider the needs of diverse socio-economic and cultural backgrounds while developing strong safeguard mechanisms for climate-induced disasters. For this, international partnerships can guide and support India in building resilient infrastructure, urban transportation as a service for all, build adaptive capacity of urban poor and support urban emergency and heat plans.

[27] Global Climate Risk Index 2021. Eckstein D., Künzel V., Schäfer L. Germanwatch

[28] Mohanty, Abinash (2020). Preparing India for Extreme Climate Events: Mapping Hotspots and Response Mechanisms. New Delhi: Council on Energy, Environment and Water.

2.4 Other areas of cooperation

a) Just Transition

The transition of major sectors and key activities towards sustainable, low carbon pathways will lead to economic restructuring at all levels: global, regional, national and local. This in turn will significantly impact the current workforce, specially the ones that work in fossil fuel heavy industries, ICE Car manufacturers, automobile ancillary units, auto service industry amongst others (for example the 20 million workforce in India's fossil fuel and fossil fuel dependent industries)[29]. To ensure that the transition to emission mitigation is "just" in nature, it becomes crucial that appropriate reskilling and capacity building as well as the creation of quality jobs are an integral part of climate planning and execution.

As per Mlinda Trust and NRDC's estimation, every 1 GW replication of their mini-grid community model will create 619,000 to 1,134,000 direct and productive use jobs.[30] It is in this direction that the Skill Council for Green Jobs and Power Sector Council of India (under the National Skill Development Council) has been identifying sectoral requirements and have undertaken training of trainers through its 350 training centres across seven states.[31] This fora has immense scope in imbibing learnings from Germany/EU/G7 through partnerships for reskilling and upskilling the transitioning Indian workforce. In addition to that, while the labor force participation rate (LFPR) is picking up post the pandemic slump, the low female LFPR in India has resurfaced drawing in need for attention.[32] The renewable energy space, particularly the solar sector, has much to offer in bridging this gap.[33] Due to its sheer nature across its value chain, this sector offers ample scope to create employment opportunities for the otherwise untapped high-skilled female labor force in India.[34]

Initially just transition must lay emphasis on sectors that have high mitigation potential; however, moving forward, it will also be applicable across the board, especially for waste management workers, farmers, pastoral communities, and service sector, to name a few.

b) Circular Economy

Adopting a circular economy model will help nations to reduce its reliance on imported energy and materials, and strengthen the economy's resilience. The benefits that come with adoption of such a model transcends into the social, cultural, environmental, and economic spheres of a country. The circular economy strategies can bridge the emissions gap between current commitments and business-as-usual by about half.[35] In order to ensure that the circular economic models become viable to operate, countries will have to mobilize funds for developing infrastructure, strengthen regulations, restructure existing value chains, and enhance capacity of recovery and recycling centres.

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[29] "A cross-sectoral landscape of Just Transition in India - iFOREST." https://iforest.global/wp-content/uploads/2021/07/Five-Rs-Single.pdf.

[30] "How Solar Mini-Grids Are Making a Difference in Rural India - NRDC." https://www.nrdc.org/sites/default/files/solar-mini-grids-rural-india-cs.pdf.

[31] "Renewable Energy and Jobs – Annual Review 2020 - IRENA." 29 Sep. 2020, https://www.irena.org/-/media/files/IRENA/Agency/Publication/2020/Sep/IRENA_RE_Jobs_2020.pdf.

[32] "Labor force, female (% of total labor force) - India." https://data.worldbank.org/indicator/SL.TLF.TOTL.FE.ZS?locations=IN.

[33] https://www.nrdc.org/sites/default/files/solar-mini-grids-rural-india-cs.pdf.

[34] "Women working in the rooftop solar sector – Analysis - IEA." https://www.iea.org/reports/women-working-in-the-rooftop-solar-sector.

[35] "Implementing Circular Economy globally makes Paris targets ...." https://circulareconomy.europa.eu/platform/en/knowledge/implementing-circular-economy-globally-makes-paris-targets-achievable

c) *Marine Litter*

Poor waste management and unregulated sewage flows to oceans threatens marine life and has remained a growing cause of concern globally. Around 80% of the marine litter is assessed to be from land-based sources, and plastic is the common type of marine litter.[36] Having a long coastal line, India's actions on the issue of marine litter, will leave a far greater impact, beyond the frontiers of land-sea borders. Running circular economy models, and strengthening measures such as Extended Producer Responsibility (EPR), leveraging partnership platforms could be some of the instruments to address this issue.

d) *Agro-ecological Transformation*

Food security is another key area that requires transformation in order to sustain the food supply amidst the increasing global population. Agro-ecological transformation has become a necessity for enhancing crop protection and resilience. The domains for shaping agro-ecological transformation are: strengthening knowledge systems; working with markets; enhancing collaboration between food system actors; and creating an enabling policy environment.[37] This also entails wide scale dissemination of information on efficient water harvesting methods as well as techniques to improve harvest.

e) *Green Mobility*

Globally, the transport sector contributes 37% of CO2 emissions from end-use sectors in 2021.[38] The paradigm shift towards green mobility requires strong policies, and extensive investments to increase the efficiency of transport system, improve fuel efficiencies, and for transition towards use of zero-emissions vehicles.

Click here to see

the technology readiness assessment matrix

from the Annexure

[36] "5th PROGRESS REPORT - Marine Litter Solutions." https://www.marinelittersolutions.com/wp-content/uploads/2020/08/ACC_12376_2020-Marine-Litter-Solutions_V5_Pages_NoCropsBleeds.pdf

[37] "Food Systems Summit Brief Prepared by Research Partners of the ...." https://sc-fss2021.org/wp content/uploads/2021/06/FSS_Brief_Agroecology.pdf

[38] "Transport – Topics - IEA." https://www.iea.org/topics/transport.

3. India-Germany/EU/G7 Dialogue Architecture

3.1 New partnerships agreed and under negotiation

India is already in cooperation with both the EU as well as with individual European countries. Long-standing and large-scale Indo-German cooperation exists around the areas of energy, sustainable urban development and environmental protection and resource conservation. So far, this cooperation has clearly focused on Energy supply measures, such as the GIZ-led Indo-German Energy Programme (IGEN-Access), the Green Energy Corridors, the Indo-German Solar Energy Partnership (IGSP) aimed at enhancing capacity of rooftop PV systems, or the cooperation to expand solar energy in India, which has been in place since 2015. One such partnership signed between India and Germany on 2nd May, 2022, for green and sustainable development, focuses on JET, sustainable urban development, green mobility, among others. On EU level, India and EU agreed in 2021 on deepened cooperation in the areas of renewable energy and transmission and storage technology as well as energy efficiency, green hydrogen and sustainable financing, among others.

Currently, new strengthened cooperation in terms of more comprehensive partnerships is in discussion between India and Germany, India and EU/G7. Early agreement on these partnerships must be sought upon, and should be negotiated during India's presidency of the G20. Their joint objective should be to support India in reaching the ambitious national targets in the sectors; climate, energy and development. These official government partnerships should be inclusive for business actors, research and think tanks as well as for NGOs and civil society.

3.2 Proposed partnerships

I. Increase climate finance

The public and the private sector investors play an important role in mobilizing capital for climate solutions largely aligned with the SDG framework or the Paris Accord in their impact investments.[39] The need to transition to a low-carbon economy will create risks as well as investment opportunities across the sectors. The climate risk will affect the investors due to the negative impact on the economic growth and also on the investment returns. Thus, the climate finance investments made, based on time-bound targets such as short, medium and the long term, will help in analyzing tangible and intangible effects, and in achieving time-bound deliverables.

New-age markets for climate business solutions in different sectors like sustainable transport, green buildings, renewable energy, climate-smart agriculture (CSA) are evolving. By developing theme-driven impact funds new opportunities can be created for investments in these emerging markets. The Rewa Ultra Mega Solar Park in Madhya Pradesh (India) of 750 MW capacity is an example of public-private partnership, through an alliance between international investors and State-led Independent Power Producer.[40] This project is supported by the International Finance Corporation (IFC) and the World Bank's 'Shared Infrastructure for Solar Park Projects for India' for scaling the state's renewable energy.

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[39] Impact Investment Network (2019). Annual Impact Investor Survey 2019. GIIN_2019 Annual Impact Investor Survey_webfile.pdf (thegiin.org)

[40] Scaling Infrastructure, Rewa Solar (India) : Removing Barriers to Scale Scaling Infrastructure: Rewa Solar (India)

Accessing low-cost financing – Pension, Trust Funds, etc

Investments in the form of green bonds, pension funds and trust funds have taken shape in climate change mitigation and adaptation projects, even with low-interest rates. These investments are usually long-term investments, with varying asset classes and risk return profiles. The Paris Climate Bond, a bond size of EUR 300 million (term end of 2030) with an annual interest rate of 1.75% was issued to meet the goal of the Paris Climate Action Plan.

Need for low-cost long-term financing in India has been growing in an unprecedented manner majorly for the upcoming and to-be-announced large scale infrastructure projects, both at the central and subnational level.

The low and declining interest rates in Europe have been compelling banks and fund operators to explore markets that would offer better returns.[41] Last year, leading banks in Germany were forced to ask their customers an annual 0.5% payment for holding large deposits.[42] As countries like Germany have been looking beyond domestic actions to fulfill the global climate goals.[43] One area to bridge gaps would be opening access to low-returning funds in Germany and EU so as to enhance climate finance flows to developing countries like India that are planning for energy transition / net zero goals.

II. Targeted grant-making

Increased philanthropic monies for climate mitigation and adaptation

As per IPCC estimates, investments of around $13 million would be required for stabilising greenhouse gas emission levels till 2030. As per the latest "India Philanthropy Report-2022" by Bain & Company, less than 4% of total CSR funds are allocated to Environmental Sustainability. Speaking specifically about philanthropic money, in the USA, less than 2% of philanthropic funds are given for climate change. The disparity is no different in other regions as well. It is thus imperative to establish new channels and popularize existing ones so as to encourage philanthropic funds even from large agglomerates like Amazon, which was recently in news for its $10 billion donation to climate cause.

III. Continuous dialogue across levels

Various stakeholders are affected, either directly or indirectly across the different stages of climate and energy projects, right from securing the fund to the operational phase. The lengthy timeline of most such projects also tends to witness changing dynamics in the stakeholder ecosystem. Involving stakeholders across all levels throughout the tenure of partnerships not only helps in informed decision making, but also ensures effective utilization of all resources mobilized for materializing the partnership goals.

While the stage for such partnerships could always be set by high-level political leaders, quite often, for want of capacity or expertise or resources, it is the Track II and III channels that help in taking forward national goals. Participants in Track II and III channels also include non-governmental/civil society organizations, influencers and people-led communities at local level etc. These channels help developing nations exercise their soft power to influence communities beyond borders for a united cause.

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[41] "Pension Funds in Figure 2021 - OECD." Pension Funds in Figure 2021.

[42] "Banks in Germany Tell Customers to Take Deposits Elsewhere - WSJ." 1 Mar. 2021, Banks in Germany Tell Customers to Take Deposits Elsewhere - WSJ.

[43] "Paris-Partnerschaften - Germanwatch eV." 9 Feb. 2021, https://www.germanwatch.org/sites/default/files/Studie_Paris-Partnerschaften_0.pdf.

IV. *Increased sub-national actions*

It is crucial to develop and map-out development cooperation programmes, as well as strengthen the capacities of sub-national/local agencies and institutions. Sub-national territorial entities, which are generally known as 'states' in India, independently hold cooperation and/or bilateral agreements with their international counterparts and other countries. For instance, both Maharashtra and Uttar Pradesh have independent MoC[44] with the Ministry of Agriculture, Forestry and Fisheries of Japan; the other example is that of the MoU between Gujarat Government and Hyōgo Province (Prefecture) Government, Japan. There is a need to ramp up such collaborations at the sub-national levels in the climate/clean energy/sustainable transport/sustainable development domains.

a. **Technical Assistance:** For sub-national climate cooperation, one of the key focus areas can be the research, development, and demonstration (RD&D) of low-carbon energy (or clean) technologies to accelerate decarbonization across sectors (manufacturing, transport, construction, tourism etc.) These partnerships can also act as a precursor for formulation of policy frameworks to promote the deployment of such technologies (Grunewald et al., 2013).
b. **Finance:** Generally, the mid-size and small infrastructure development projects that are crucial for a city/community's mitigation and adaptation, have limited access to traditional funders / investors, simply because of the smaller size of such projects. Overcoming this need-based funding gap is crucial to accelerate local climate actions. Subnational entities will better contribute to global climate endeavours, if a decentralized approach is adopted (in partnerships or cooperations), that allows direct access to climate finance.

c. **Capacity Building/ Mentorship programs:** Equipping sub-national entities with the appropriate tools, skills, and knowledge will aid in taking immediate actions to address the challenges of climate change from all levels / sectors (Mytelka et al., 2012). The forthcoming co-operations and bilateral relations can focus on: education, outreach and awareness, peer learning, knowledge platforms, information exchange, and technical assistance.

V. *Enhance Partnerships and Collaborations*

The numerous complex challenges that have been emerging in the growing economic era, predominantly the climate challenge, has increasingly been indicating the need for extraordinary levels of commitment and action for fruitful results.[45] The ever-increasing need of attaining goals in a limited span of time has made furthering partnerships and collaborations on common missions inevitable. Such tie-ups create win-win situations for all parties involved and helps in unlocking the true potential of the alliance. Some of the projects worth mentioning include Global Green Growth Alliance, GGGI, IGEN-Access programme etc.

Governments and multilateral institutions can thus set a supportive stage for growth in B2B partnerships and joint ventures. The ever booming start up industry in India has been bringing in unique approaches in the business arena across sectors. Cross-border collaborative networks offer new avenues and opportunities while venturing into foreign markets thereby multiplying the collective benefits. There are more than 61,400 startups recognized in India, out of which 83 are *unicorns* (valuation above $1 billion) with total valuation of $277.8 billion.[46] Most of the startups operate in the

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[44] Memorandum of Cooperation

[45] "The Next Generation of Climate Innovation - BCG." 22 Mar. 2021, [The Next Generation of Climate Innovation].

[46] "Economic Survey 2022: India Has Recognised 14,000 New Startups ...." 31 Jan. 2022, [Economic Survey 2022: India Has Recognised 14,000 New Startups In FY22 So Far]

information technology or knowledge-based sectors in India. Similarly, Civil Society Organizations (CSO) in India are aplenty and are key knowledge centres for outcome-based actions at the local level. Moreover, the trained resource groups and established monitoring mechanisms available at the CSO level remain a potential tool that can be leveraged for realizing long-term partnership goals. With such a huge potential within the startup arena and the CSO space, startup accelerators from Germany and other countries of the European Union and G7 can collaborate and exchange best practices for collective benefit.

4. Recommendations

Through this policy brief, various arenas of financial, technological and capacity building cooperation have been described along with their merits. Effective partnerships resulting in technological, financial, and social benefit transfer, could help strengthen the global effort towards a sustainable future. In an attempt to generate actionable insights, this section captures the key recommendations which have been categorized into three groups – demand-side interventions, supply-side interventions, Research and Development (R&D) and Channelizing Finance interventions.

Recommendations listed below – tentatively grouped under aforementioned categories

Supply-side

- India with its target for green hydrogen production could benefit from partnering with the EU to ramp up its green hydrogen production technologies. The element of scale could benefit both parties from a technological and financial standpoint.
- The EU, and specifically Germany have developed sizable offshore-wind projects and are a global leader in this sector. The policies and incentives offered in Germany could provide direction to formulate India's policy support to the offshore wind industry. Partnership resulting in investments for offshore-wind projects and demonstration of economical capacity addition methods could help India accelerate their efforts to achieve its 2030 target of 30 GW of offshore wind energy.
- India has significant untapped PHES potential. Having established the benefits of PHES, the technology warrants scaling of PHES projects. However, the implementation of these projects is often marred by various ecological, and societal considerations, such as the displacement of communities. Collaborating with PHES veterans such as the USA, and upcoming countries like Austria which are rapidly developing PHES capacity could help demonstrate the method to accommodate and navigate through the challenges posed by PHES projects. Apart from technology transfer, India could also benefit from developing support policies that address the externalities arising from PHES projects on the environment and communities.
- Digital technologies in the form of applications like climate information and early warning systems could provide impactful benefits in climate change adaptation. Integrating Information, Communication and Technologies (ICT) like remote sensing, geographic information systems, improved communication through radio, internet of things (IOT) in an early warning system will help to prepare, cope and recover from climate shocks. For example, the Meteoalarm,[47] a multihazard web-based tool provides extreme weather warning systems with severity and impacts across Europe.
- Strengthen the capacity for satellite-based monitoring and other technologies for enhancing green cover. This in turn would build the resilience capacity and help in adapting to the extreme heat waves and droughts. Knowledge sharing on biotechnology and institutional capacity building would provide support in restoring and better management of mangrove forests which would aid in reducing the intensity of coastal hazards, like cyclones and floods.
- Knowledge transfer and financial support for infrastructure development for concepts like 'walk to work', 'transit-oriented development', 'non-motorized transport' would benefit urban centres as it adapts to higher influx of residents. In highly populated cities like Delhi,

[47] https://www.meteoalarm.org/en/

developing urban spaces in this manner would also have positive implications on the constantly disturbing air quality.

Demand-side

- With the EU having undertaken research to establish the feasibility of using existing natural gas pipelines subject to leakage and embrittlement caveats, similar transportation models could be derived for India. Examination of Indian pipelines based on parameters established by the EU could aid in developing an economical way to transport green hydrogen.
- As green hydrogen space in India is nascent, several large-scale demonstration projects across sectors like long-haul trucking, steel, and mining industrial clusters will infuse confidence in Indian investors around the viability and future of these projects.
- The circular economy of solar PV modules raises critical concerns with respect to its end-of-life management. The EU has been a pioneer on this front with its policies such as Waste Electrical and Electronic Equipment (WEEE) directive. A partnership for knowledge and technology transfer could ensure that solar PV remains a sustainable energy technology across its value chain.
- Technology transfer, knowledge sharing and market exposure is needed in the building sector for net-zero buildings: reducing energy demand, efficient insulation, water use efficiency, etc.

R&D

- Hydrogen carriers such as ammonia and methanol are an attractive option for hydrogen storage and transport, owing to their direct use in fuel cells. There is an R&D gap surrounding the handling of these hydrogen carriers which inhibits their scalability. Knowledge transfers and demonstration projects between India and the EU could catalyze the sustainability of this economical hydrogen-transport option.
- To negate over-dependency on a single solar PV technology, there is a need for India to collaborate with R&D institutes like the Fraunhofer Institute for Solar Energy Systems ISE, Germany. Pilot projects demonstrating the utility of next-generation technologies like perovskite, tandem cell, and Bio-solar in comparison to existing technologies, could aid in mainstreaming the same.
- Knowledge transfer channels with research entities in Sweden could help demonstrate the financial feasibility of these new materials. Pilot projects could support the development of policies to scale gravity-based energy storage technologies which could provide India with fast ramp-up and ramp-down storage capacity.
- Addressing knowledge gaps at the local level through enhanced observation and research can help to reduce uncertainty and design effective risk management and adaptation strategies.

Channelise Finance

- The developed countries/corporates/banks need to jointly evolve credible financial targets and abide by them. There is also a need for government agencies, banks and the private sector in India to engage in greater dialogue and cooperation, with donor governments, bilateral and multilateral development agencies, development banks, climate funds and private investors in developed countries. For example: International Solar Alliance (ISA) can play an important role in this regard by cooperating with international organisations to help RE power producers in India get access to affordable debt.

- Bilateral and Multilateral Development Banks (MDB) constitute a significant share of external finance. Their support addresses the financial barriers for clean energy projects by mitigating the high perceived risks and limited economic viability of the projects while addressing the problem of the limited supply of low-cost, long-term capital. Overall, the scale of MDB lending needs to go up to support the clean energy transition. There is a need for targeted use of public, climate and development finance to enable a pipeline of bankable and investor-ready projects.
- In addition to direct grants or loans, the MDB lending should be creatively structured to leverage private flows into climate change. Donor money can be invested in private equity in clean energy projects and can be deployed as financial guarantees, credit – enhancement support and payment–security instruments. This could further help in undertaking sectoral reforms (such as electricity distribution reform) and support policy development. The recently created Glasgow Financial Alliance for Net Zero – a corporate investor group could be used as ideal platform to mobilise funds in developing countries. The group is supported by more than 280 members from the Europe, Middle East and African region controlling a net worth of over USD 65 trillion funds.
- India's international partnerships should encourage innovative and catalytic financing mechanisms such as Green Banks, Green Bonds, Infrastructure Debt Fund and Infrastructure Investment Funds to especially support new sectors such as Electric Vehicles and Green Hydrogen. Support in the form of direct grants to bridge the viability gap should be considered in the partnerships.
- Findings of the 'State of Climate in Asia 2020' Report by WMO suggest that India suffered an estimated US$ 87 billion as average annual loss (AAL) from extreme weather. Such mounting losses and its associated impacts on farmers, pastoral communities and others need to be managed through appropriate financial instruments. Further, studies show that there is a large gap between economic and insured losses from extreme weather events in India. This indicates the need for collaborations for greater penetration of insurance in both urban and rural areas as well as across sectors.

The transition of major sectors and key activities towards sustainable, low carbon pathways will lead to economic restructuring at global and regional level. This in turn will greatly impact the current workforce, especially the ones that work in fossil fuel heavy industries (like the mining, power plants, automobile etc.).

To ensure that transition to emission mitigation is "just" in nature, it becomes crucial that appropriate reskilling and capacity building as well as creation of quality jobs becomes an integral part of climate planning and execution. Beyond the energy sector, just transition will be applicable across the board, for waste management workers, farmers, pastoral communities.

Annexure

Technology Readiness Levels	Criteria[48]
1	Initial Idea
2	Application Formulated
3	Concept needs validation
4	Early Prototype
5	Large Prototype
6	Full Prototype at scale
7	Pre-commercial demonstration
8	First-of-a-kind commercial
9	Commercial operation in relevant environment
10	Integration needed at scale
11	Proof of stability reached

[48] https://www.iea.org/data-and-statistics/data-tools/etp-clean-energy-technology-guide

Technology	Technology Sub-level	Type	Technology Readiness Level	Importance for net-zero emissions	Key G7/ EU Leaders in this space	Current Status in India (Research & Development, Demonstration, Deployment)	Key Projects/Players in India
Hydrogen	Production-Green	Polymer Electrolyte Membrane	9	Very High	UK, Germany, Japan	Demonstration	~ DST has setup International Advanced Research Centre for Powder Metallurgy & New Materials (ARCI) ~ Key players entering into the market like Adani, Ohmium
		Alkaline Electrolyzer	9	Very High	France, Denmark	Demonstration	~ Bharat Petroleum collaborates with Bhabha Atomic Research Centre for Green Hydrogen production ~ L&T and Norway's hydrogen pro to setup alkaline electrolyzer Giga factory in India
		Solid Oxide Electrolyzer	7	Moderate	Germany, US, Denmark	Demonstration	~H2e Power to set up 1GW electrolyzer plant in Maharashtra ~ Bloom Energy to Power India's First Green Hydrogen Microgrid to power NTPC's Guest House in Simhadri
	Transport	Hydrogen blending in Natural Gas Network	7	Moderate	France, UK, Germany, US	Demonstration	~ Gail starts India's maiden project of blending hydrogen into the natural gas system in Indore ~ Delhi government conducted a pilot project for 50 hydrogen enrich buses in 2020-21
		Liquid organic hydrogen carrier tanker	6	Moderate	Norway, Japan	Research & Development	~Recent Advances in Liquid Organic Hydrogen Carriers: An Alcohol-Based Hydrogen Economy ~ Indian automotive components manufacturer Advik Hi-Tech has entered into a JV with Australia's H2X Global to develop fuel cell based on liquid-organic hydrogen carrier
		Liquid Hydrogen Tanker	5	Moderate	Japan	-	-
		Pipeline	11	Moderate	Belgium, France, Germany, Netherlands, USA	-	-
	Storage	Depleted oil & gas fields, aquifers	3	High	-	-	-
		Salt cavern storage	9.5	High	USA, UK	-	-
		Storage Tank	11	High	-	Demonstration	VRV Asia Pacific manufactured the storage tank with Liquid Nitrogen LIN shield in a collaborative effort with Satish Dhawan Space Centre SDSC for ISRO

Technology	Technology Sub-level	Type	Technology Readiness Level	Importance for net-zero emissions	Key G7/ EU Leaders in this space	Current Status in India (Research & Development, Demonstration, Deployment)	Key Projects/Players in India
Renewable Energy Sources	Solar	Crystalline Silicon PV	9.5	High	Germany, Japan, Italy, USA	Deployment	~ Bhadla Solar Park (2180MW), Jalun Solar Park (1200MW), Rewa Solar Park (750 mW) ~ At present, the cumulative solar cell and module manufacturing capacities of India are about 4 GW and 16 GW respectively. Deployed Capacity
		Floating Solar PV	8	Moderate	France, Japan, Netherlands, UK, USA	Deployment	~ 25 MW India's largest Floating Solar PV plant, at NTPC Simhadri in Andhra Pradesh ~ SPIC captive solar plant of 25.3 MW in Tamil Nadu ~ KSEB has floated tenders over 100 MW of floating solar in Kerala
		Multi-junction Solar PV	9	Moderate	Germany, USA, France, Japan, Spain	Research & Development	~ NISE & NCPRE are managing the R&D for different PV technologies
		Organic Thin Film Solar PV	6	Moderate	Germany	Research & Development	
		Perovskite Solar PV	4	Moderate	-	Research & Development	~P3C has developed the cell
		Thin Film PV	8	Moderate	Germany, USA, Japan	Deployment	~Moser Baer Rolls Out Thin-Film, Builds Power Plant
		Linear Fresnel Reflector	9	High	-	Demonstration	~Rajasthan Sun Technique Energy, a subsidiary of Reliance Power, has commissioned its 100 MW concentrated solar power (CSP) plant
		Parabolic Trough	9	High	-	Demonstration	~Godawari green energy limited 50MW
		Solar Tower	8.5	High	Canada, France, UK, Netherlands	Demonstration	~ACME Solar Tower CSP Project of 2.5 MW in Rajasthan
	Off-shore Wind	Floating hybrid energy platform	5	Moderate	Denmark, UK	Research & Development	~ NIWE has conducted the assessment study and found the potential of India is 127 GW out of which 36 GW in Gujarat and 35 GW in Tamil Nadu ~ MNRE has decided to launch a measurement campaign deploying Light Detection and Ranging (LiDARs) at the identified zones off the coast of Gujarat and Tamil Nadu.
		Floating off-shore wind turbine	8	High	Germany, France, Norway, Japan, Sweden, Portugal, UK, USA		
		Seabed fixed offshore wind turbine	9	High	-		
	Ocean Energy	Tidal	8.5	High	Canada, France, UK, Netherlands	Research & Development	~ As per the study conducted by Indian Institute of Technology, Chennai in association with CRISIL Risk and Infrastructure Solutions Limited in

Technology	Technology Sub-level	Type	Technology Readiness Level	Importance for net-zero emissions	Key G7/ EU Leaders in this space	Current Status in India (Research & Development, Demonstration, Deployment)	Key Projects/Players in India
		Ocean Current	5	High	Canada, France, UK, Netherlands, Japan, Norway, Sweden, USA		December 2014, the tidal power potential is estimated at around 12,455 MW in India
Energy Storage	Mechanical Storage	Pumped Hydro Storage	11	High	-	Deployment	~ As of Feb 2021, a total of 3,305 MW of pumped hydro storage was operational in India. Moreover, around 1580 MW of pumped hydro projects are under construction phase and around 9730 MW of projects are under proposal development ~ Some of the Operational plants are Kadamparai- Tamil Nadu, Bhira-Maharashtra
		Gravimetric Energy Storage*	4	High	Sweden, Switzerland	Research & Development	~ Tata Power in India had an agreement to buy 35MWh of gravity-based energy storage from Energy Vault

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