POLICY BRIEF

13

Beyond the Stocktake (Part I):

Strategies for Leveraging Clean Energy Technology Finance

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Abstract

Clean energy development for almost all G20 countries, be it developing or developed, stands at restricted levels for green hydrogen produced from biomass for heat and electricity. Therefore, a greater emphasis must be placed on deploying renewable energy sources and helping clean technologies businesses gain the wherewithal to avoid the valley of death, the series of challenges that high-tech start-ups often face in the early stage of development culminating into failures. Developed countries are in a better position than developing countries to raise clean finance, i.e., for clean energy development. Challenges faced by G20 developing economies in raising clean finance include a lack of green taxonomies, a lack of an implementation mechanism for climate risk assessments, and the absence of proper effective initiatives towards a carbon pricing structure. A big-push is required to make early-stage clean energy technologies enter the market and get embraced by business developers, which needs commensurate supportive financial flows. Aside from a greater emphasis on international collaboration/cooperation to help the process, the issues that need resolution include a) matching the finance requirement with demand, b) accounting for differences in costs of capital, and c) establishing green state investment banks. There is a crucial need for the international community to step in and facilitate public financing of climate-related finance needs of developing economies. It has been observed that private investments in the broader climate technology are often set to fall, with the fear that the previous bust of investments in clean technology may repeat. While a significant scope of expansion of private investments exists, its risk-averse nature and the lack of initial support hinder the tapping of the opportunity.

Keywords: *Clean finance, Clean technologies, Climate, G20*

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Beyond the Stocktake (Part I): Strategies for Leveraging Clean Energy Technology Finance

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1. The Context

The world is moving towards an energy-intensive future with rising demand for energy. With the global stress on reducing emission levels and sustainable growth, there is a corresponding increase in the demand for clean energy investments. A major concern is the uneven distribution of the energy finance. In view of the obligations of the developed world for provision of climate finance arising from the commitments they made and the rising needs of the developing countries often beyond their capacities, there is a collective responsibility of the international community to take directed action and explore novel ways and means for meeting globally the raising need for clean energy finance.

The 2022 Indonesian presidency came up with a *Stocktake* report covering energy access, technology, and finance with an objective of laying out the current trends and priorities for accelerating the energy transition and aid the movement towards a carbon neutral future. The Report highlights that innovation, development and demonstration of clean energy technologies are required to increase by three times of the present value by 2030, estimated at USD 4.6 trillion and similarly increases are needed in the investments in clean power by 2025. It also stresses that more needs to be done for the developing economies where investments equivalent to USD 1 trillion was required by the end of 2020. This policy brief goes beyond the *Stocktake* Report in attempting to identify the financial instruments required at each stage of the technology cycle for clean energy technologies. With India having taken over the G20 presidency, the idea is to provide inputs towards an effective strategy for raising energy finance for the developing countries, whilst discussing the scenarios keeping the developed countries in picture.

2. G20 and Energy Finance

Energy finance forms a crucial component of mitigation finance in the broader scope of climate financing. With the G20 priorities set in action for the energy track and the worldwide focus on mitigation actions to achieve net zero pathways, a considerable impact of these developments has been observed on the financial flows in the sector. For the G20 set of developing countries[4], the multilateral route of funding is dominated by mitigation finance flows, garnering 91 per cent of the total approved funding (Goldar, Dasgupta, and Jain, 2022).

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[4] The cited study includes the following set of countries in its analysis: Argentina, Brazil, the PRC, India, Indonesia, Mexico, South Africa, and Turkey. While Saudi Arabia and Republic of Korea also fall under the category of developing countries, due to limited/lack of data for projects in the aforementioned countries, they have not been included in the analysis.

In this big share, a major component is attributed to the energy sector and its different constituents, highlighting the flow of energy financing within the G20 developing countries. As per the latest available data from Climate Funds Update (CFU)[5], the multilateral flow of approved energy finance stood at about USD 3.6 trillion, forming about 60 per cent of the total approved multi-theme multilateral finance to G20 developing countries (Heinrich-Böll-Stiftung and ODI, 2022). Furthermore, latest available numbers at the energy policy tracker[6] forum attribute a significant amount of at least USD 1.10 trillion in 2020-21 to commitments of governments in G20 countries towards different types of energy through new or amended energy policies. However, there still exists gaps.

The energy track has evolved over different G20 presidencies, with the scope and its constituents widening over the years. Recognising its responsibility towards a sustainable energy-based future, the forum has incorporated critical discussions on the subject matter of energy since 2008. The energy track of the recently concluded Indonesian presidency of the G20 took the previous agenda on ensuring a clean, sustainable, just, affordable, and inclusive energy transition forward. The Presidency put in place the *Bali Energy Transitions Roadmap*.[7] It is based on three components, 1) the *Bali Compact* with principles for accelerating clean energy transitions; 2) three key priorities of actions over the short to medium-term (through 2030); and 3) a Presidency Troika action plan with milestones.

The *Bali Compact*[8] defines a set of 9 voluntary principles for G20 member countries and beyond for energy transitions, depending on the national circumstances. Under the transitions roadmap, the Presidency set three priorities for the energy track, namely *Securing Energy Accessibility, Smart and Clean Technologies Scaling-Up,* and *Advancing Energy Financing*.

At the G20, development of diverse clean technologies and innovations in the sector have secured a constant support. At the same time, the need for greater mobilisation of clean energy finance has been acknowledged, with encouragement to newer sources of finance to enter the sector. It is plausible then that the development of clean energy technologies can provide one of the possible solutions to the situation. The energy transition process will demand the presence of efficient technologies to scale up the efforts. These technologies in turn require significant quantum of financing. They can thus serve as an effective medium for channelling greater clean energy finance. Table AN.1 in the annexure summarises the evolution of energy finance focus at the G20 beginning 2014, highlighting the discussion areas of investments in the stream along with an overall energy priority focus under the presidency.

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5 The dashboard has been updated for the latest available data as of January 2022, as accessed in November, 2022.

6 Available at: https://www.energypolicytracker.org/region/g20/ , Accessed on November 10th, 2022

7 G20 ENERGY TRANSITIONS MINISTERS' MEETING, Decade of Actions: Bali Energy Transitions Roadmap; http://www.g20.utoronto.ca/2022/Bali-Energy-Transitions-Roadmap_FINAL_Cover.pdf , Accessed on November 5th, 2022.

8 G20 ENERGY TRANSITIONS MINISTERS' MEETING, BALI COMPACT; http://www.g20.utoronto.ca/2022/G20-Bali-COMPACT_FINAL_Cover.pdf , Accessed on November 5th, 2022.

3. Stages of Technology: Challenges and Financial Solutions

In almost all G20 countries, developing or developed, clean energy technology development in respect of green hydrogen and CCUS remains at a restricted level (Goldar and Dasgupta, 2023). Supporting energy technologies has been an important component of the energy track priorities under different presidencies of G20. Looking ahead, there will be a need for substantial deployment of available and new technologies, some even yet to be developed. Ample financial initiatives are required towards the development, deployment, and diffusion of clean technologies for the accomplishment of the 1.5°C target. However, the type of financing mechanisms will be different depending on the type of technology, as well as the location as well as the stages of technology development (Deloitte, 2017).

There are four states in the process of building up a market-ready clean energy technology: (A) Research & Development (R&D)[9], (B) Demonstration and Deployment[10], (C) Initial and Limited Diffusion[11], and (D) Commercialization. The fourth or final stage of the technology is one when the technology becomes a part of the mainstream market, available for mass scale usage/adoption. Each of these stages require proper policy support and finance to leverage the process and ensure progress of the technology. For instances, for the wider diffusion of the technology, it may be important to use appropriate carbon pricing and subsidies to take care of market failures.

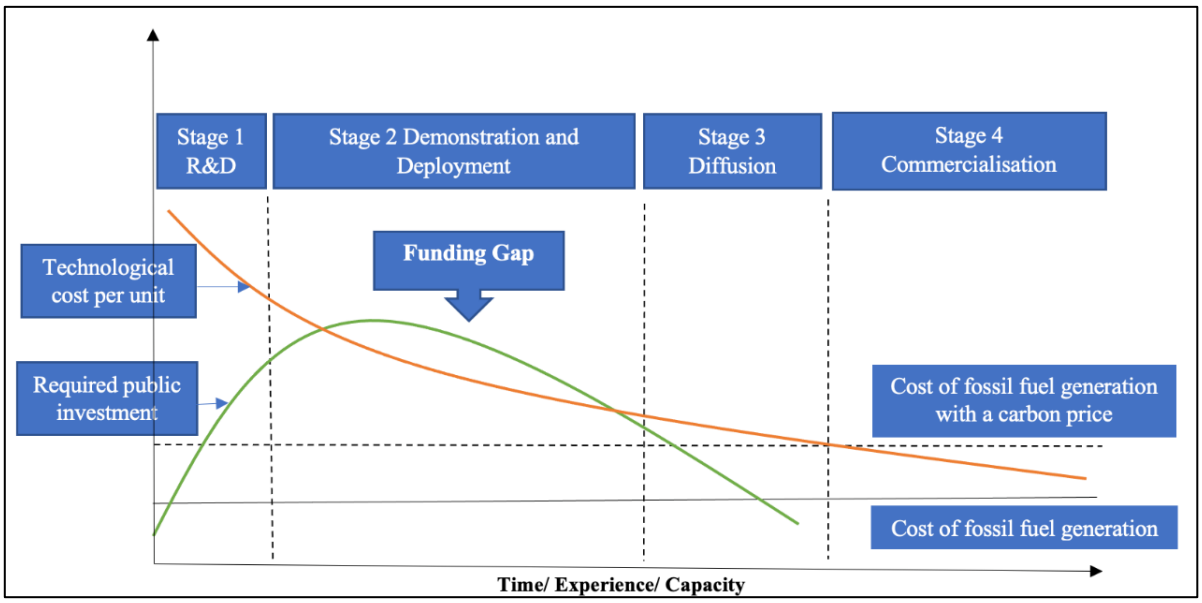
[9] The conception of a new idea of technology being developed into a prototype, or an existing technology being experimented for a new component. Adapted from IEA report on *Energy Technology Perspectives 2020: Special Report on Clean Energy Innovation*; (IEA, 2020). Available at: https://iea.blob.core.windows.net/assets/7f8aed40-89af-4348-be19-c8a67df0b9ea/Energy_Technology_Perspectives_2020_PDF.pdf

[10] A new technology is introduced in the market for the first time on an experimental basis, for further development and refinement . Adapted from IEA report on *Net Zero by 2050: The need for net zero demonstration projects*; (IEA, 2022). Available at: https://iea.blob.core.windows.net/assets/76426d5e-0c9c-4f9f-809f-feca6bde702e/Theneedfornetzerodemonstrationprojects.pdf

[11] A technology becomes available for limited use in relevant applications through adoption by a few. Adapted from OECD and IEA report on *Technology Innovation, Development and Diffusion*; (OECD & IEA, 2003). Available at: https://www.oecd.org/env/cc/2956490.pdf

Technology Maturity and Risks

Figure 1: Stages of Technology



Source: Adopted from UNEP (2008)

Figure 1 describes how costs, finance requirements and risks evolve along the path of maturity of technology across the aforementioned stages, increasing from left to right. The figure demonstrates that the per unit technological cost is monotonically decreasing as the technology matures over time, from the innovation till the commercialization stage. This is because the technological risks diminish over time and economies of scale sets in (UNFCCC, 2015). Further, the public investment needed for clean technology evolution forms an inverted U-shaped curve. This signifies that the public investment required in the initial stages increases till it reaches the demonstration and deployment stage, and then starts to decrease towards the later stages of the technology cycle. This translates to the need of additional sources of finance. Public funding alone cannot pull through all kinds of risks. This has been discussed in India's recently launched National Green Hydrogen Mission document (GOI, 2023). It discusses the ways in which hydrogen produced from biomass, a renewable input, can lead to economies of scale. It emphasizes the importance of further pilots required and aims to create low-cost models of biomass collection, delivery and the conversion cost of capital from biomass to hydrogen.

While the technological costs in a stage of technology cycle does not vary across countries, the required public investment does vary across countries and the sectors depending on the stage of technological maturity. The requirement for public investment is less in the first stage of technology innovation. In the second stage, however, the requirements for public funds are large and the failure to mobilize the funds because of lack of support from financing institutions could result in a closure of the technology projects, popularly known as the '*valley of death*' (Cervantes, Copeland, and Zarnic, 2018).

Sources of investments

As described above, the sources of investments will vary with the stage of maturity of technologies. In developing economies, elevated risks and high initiation costs as against return from projects are responsible for the lack of investments in climate technology financing. Further addition to the problem is the difficulty in adequate evaluation of risks and returns from low-carbon technologies due to the knowledge or information gap on investor's part.

The gaps for clean technology financing could be mitigated by select public financing instruments (UNFCCC, 2015). Different stages in the technology innovation process require a diverse set of public finance instruments. An analysis of the required sources of finance at every stage of technology innovation will provide a better understanding of the finance needs as well as the best fit of channelising medium.

The first R&D stage, also known as the innovation stage, requires support in the form of grants, tax credits, contracts, and has a major reliance on finance from research institutions that collaborate with businesses as a strategy towards knowledge and technology transfer (Cervantes, Copeland, and Zarnic, 2018). As per IPCC (2018), there is an investment requirement of USD 2.4 trillion in the energy mix, annually from 2016-2035. However, there remains a dearth of private funds in R&D due to fundamental risks of technology in scientific innovations, higher risks from failure due to inexperienced entrepreneurs, greater effort and capital required from venture capitalists, and long lead times in the market (Cervantes, Copeland, and Zarnic, 2018). While MDBs can help crowd-in private sector funds, government led fundings will play an important role in this stage.

The second stage of demonstration and deployment bears higher cost and risk than the innovation/conceptualization stage. It embraces all types of risks involved in the process of investing in projects and thus suffers from financing gaps. Mostly it is plagued with the technology *valley of death* and the lack of project development capacities and capital required therein. In the latter stages of deployment, when project developers are in the advanced stages of acquiring the required technology for use, they face high debt-equity gap and thus higher risks. Public finance instruments that have been recognised to fill these gaps more effectively include grants and guarantees, incubators, soft loans, loan facilities, credit lines, public/private equity, asset-based finance, and venture capital funds (UNEP, 2008). The funding gap at the demonstration and deployment stage, discussed in Figure 1 above could be filled using the capital from public venture capital funds.

The last two stages of technology diffusion and commercialization require public finance support for larger projects. These include for instance carbon pricing and mezzanine (debt credit lines), to boost start-up companies in wind and other renewable energy sectors. At this stage, public funds assume a smaller role in the form of back-end support as the technology business enters the commercialization Intellectual Property rights (IPR), cross-licensing agreements, and patents are some of the instruments that can help business developers in accessing finance from private investors for developing clean technologies.

Adding to the troubles of developing countries, there is a lack of clean energy technology projects that could be funded. Resolving this issue of lack of demand for clean technology projects will require inducement strategies and technical assistance for capacity building.

An analysis of the existing low carbon financial measures in G20 countries aids in the understanding of the mechanism towards raising energy finance (see Table 1).[12] An examination of the country profiles reveals that developed countries are in better position than the developing countries in terms of clean energy supply. However, at the same time the status of clean energy development for almost all countries, be it developing or developed, stands at restricted levels for green hydrogen produced from biomass. Average biomass development in clean energy technology in G20 countries is 6.2%. Brazil, India, Indonesia, South Korea, UK, EU and Germany stand above the line. Yet, the low carbon hydrogen is jammed in the demonstration and deployment stage (Goldar and Dasgupta, 2023).

The major issues faced by developing economies in raising clean finance include: a lack of green taxonomies that provide investors reliable information on sustainable activities, lack of an implementation mechanism of climate risk assessments, and proper effective initiatives towards a carbon pricing structure. Scaling down investment in fossil fuels and expanding carbon pricing schemes will serve as influential instruments in the process of channelizing greater clean energy finance. Financing opportunities for clean energy technologies need to be enhanced with domestic and international support.

[12] The current study utilises the classification as developed by Goldar and Dasgupta (2023), which provides the phases of clean energy technologies for developing economies, and by Polzin et al. (2021). The latter study classifies energy technologies like biomass and geothermal to fall in the initial (nascent) stages of technology cycle, offshore wind in the demonstration and deployment stage, solar PV in the demonstration, deployment and diffusion stage, and onshore wind and hydropower to be at the highest level of maturity that is, at the commercialization stage.

Table 1: Country-wise Clean Energy Development and Existing Financial Strategies

Country	% of Low Carbon (fossil fuels) in the total primary energy supply	Share of clean energy technology development in the total primary energy supply in 2021 (%)	Existing Finance Initiatives				
			Carbon tax Implementation	**Emission Trading System**	**Disclosing ESG information**	**Green Taxonomy**	**Public Finance for clean energy (average of 2019-20):**
Argentina	13(85)	Biomass for heat and electricity: 4.34% Solar and Wind: 1.92% Small hydro: 0.14%	Yes, on liquid fuels.	not introduced	began initiatives in 2021.	NA	NA; however public finance for fossil fuels was not evident from 2019.
Brazil	**45(52)**	Biomass for heat and electricity: 29.96% Solar and Wind: 2.41%	Does not exist.	planning to implement.	mandatory disclosure.	NA	17%
China	11(87)	Biomass for heat and electricity: 1.39% Solar and Wind: 2.34%	NA	little progress on its implementation	mandatory. Completed conducts stress tests.	initiatives in place.	2%
India	15(74)	Biomass for heat and electricity: 10.34% Solar and Wind: 1.27%	No	has trading policies for promoting energy efficiency and renewable energy.	NA	A task force was set up in 2021	1%
Indonesia	23(71)	Biomass for heat and electricity: 10% Geothermal: 12%	Deferred due to worldwide energy crisis	Pilot Stage	For Listed companies. Also became supporter of TCFD	introduced new taxonomy where the activities are divided into criteria signifying whether the project is harmful or not.	19%
Saudi Arabia	**0(100)**	Solar: 0.1%	Not imposed	under consideration, not implemented.	NA	NA	31%
South Korea	22(77)	Biomass for heat and electricity: 7.58% Solar and Wind: 0.78%	carbon prices in full operation	introduced in 2015	Will be implemented for listed corporations (from 2025) and some listed stock companies by 2030; Practices climate stress tests for banks	K-taxonomy began in 2021.	9%

					to evaluate transition risks		
South Africa	6(92)	Biomass for heat and electricity: 3.33% Solar and Wind: 0.93%	Yes	Yes	Mandatory	Green finance taxonomy	16%
Mexico	10(86)	Biomass for heat and electricity: 2.12% Solar and Wind: 1.83% Geothermal: 1.36%	Yes	Pilot Stage	Several initiatives taken	NA	33%
Turkey	14(85)	Biomass for heat and electricity: 1.68% Solar and Wind: 2.34% Geothermal: 5.75%	No	No	Began initiatives in 2020	NA - Sovereign green bond is under consideration	58%
Australia	8(91)	Biomass for heat and electricity: 2.7% Solar and Wind: 3.6%	Phased out in 2015	Has a voluntary emissions reduction fund where government purchases carbon credit to get projects that need the credits	- Began initiatives in 2021 - assesses climate vulnerability of banks	-	- It has been a very small amount reaching only USD 123K compared to USD 110m going to fossil fuels - Renewable projects are financed through Clean Energy Finance Corporation and other national institutions. - Commitment towards increasing penetration of renewable projects by investing in the electric grids.
UK	22(76)	Biomass for heat and electricity: 8.8% Solar and Wind: 4.3%	In operation since 2013	In operation. In 2021, national ETS replaced the EU ETS	Began from April 2022	- It is being developed by Advisory group - Evaluation of climate change stress tests	29%
USA	19(81)	Biomass for heat and electricity: 4.38% Solar and Wind: 2.17% Geothermal: 0.53%	In operation at state and regional level. But failed at federal level.	In operation.	In operation at state and regional level. But not significant at federal level	-	16%
EU	29(68)	Biomass for heat and electricity: 8.47% Solar and Wind: 3.44%	In operation	In operation since 2005	For credit institutions and investment firms	Under EU disclosure guidelines	58%

		Geothermal: 0.41%					
Japan	13(87)	Biomass for heat and electricity: 4.29% Solar and Wind: 2.17% Geothermal: 0.54%	In operation since 2012	In operation sub-nationally since 2010	Since 2021 for large listed companies in Stock Exchange primarily the blue-chip companies. In 2022, made mandatory for all.	-	9%
Russian Federation	11(89)	Biomass for heat and electricity: 1.2% Solar and Wind: 0.06% Geothermal: 0.05%	No	Pilot Stage	Exists for Joint stock companies. To be taken up by GHG emitters from 2023	Criteria exists for energy built by EU TEG on Sustainable Finance. Regulatory and institutional support are under discussions.	- 2.7% - International Public finance is provided to GEF Trust Fund and GCF.
Italy	18(79)	Biomass for heat and electricity: 5.93% Solar and Wind: 2.71% Geothermal: 3.45%	In operation	In operation	Under EU disclosure guidelines	Under EU disclosure guidelines	2%
Germany	21(77)	Biomass for heat and electricity: 9% Solar and Wind: 5.02%	In operation	In operation	Mandated in 2021	- Under EU disclosure guidelines - Climate sustainability labelling to assess risks of investment - One of the largest sovereign green bonds issuers	40%
France	**50(47)**	Biomass for heat and electricity: 5.07% Solar and Wind: 1.91% Geothermal: 0.05%	Yes, since 2014	In execution	Began initiatives in 2020	- Mandated in 2015 for institutional investors - Sovereign green bond issued in 2017 - Initiatives are taken towards assessing climate risks are at pilot stage	89%
Canada	23(76)	Biomass for heat and electricity: 3.54% Solar and Wind: 1.21%	In execution since 2019	-	Will begin in 2024 by financial institutions.	Several initiatives by private and public actors and banks are taken up to assess transition risks.	6%

Source: Authors' construction using data from Climate Transparency (2022)

4. Taking the finance agenda further: Recommendations and the Role of G20

Multiple nations have declared their 'net zero' targets, raising the need for cutting emissions sooner and quicker. Recently, India has published a National Green Hydrogen Mission document (GOI, 2023) wherein the role of demand creation, institutional and financial pathways for research and development, international cooperation are focussed on. The accelerating pace of mitigation actions, combined with the increasing demand for energy will translate into huge investment requirements. All these concerns and commitments will face a roadblock without an adequate availability of finance. Among other mediums, energy technology represents a viable route for channelization of greater financing into the sector. Providing avenues for a substantial role of the private investors, albeit requiring adequate support from public sources of finance, it can prove to be an effective finance medium for the entire energy segment.

Keeping in mind the previous discussions on the energy technology focus, there are a few considerations that can prove to be useful while planning action for scaling up of energy technology finance.

- Matching of the required financial resources with the demand

As a clean energy technology moves along the innovation cycle, the risk exposure evolves, translating to changes in the financing requirement as well as the in the source of that finance. Thus, establishing a qualitative match between the demand for finance and type of finance made available can prove to be an effective strategy towards better utilisation of the finance available (Egli et al., 2022). The matching will further aid in the mobilisation of private capital as well.

- Accounting for varying cost of capital

The is varying cost of capital across countries and technologies. These variation in the costs of capital has far reaching effects on the total cost of energy technologies. Accounting for the financing cost differences by countries and technologies is essential for understating the quantum as well as the direction of finance at both, the country and the technology level (Egli et al., 2022).

- Establishing green state investment banks (SIBs)

Taking the energy finance agenda further, green SIBs can and have played multiple roles. In Germany and UK, these banks have facilitated investments for renewable energy technologies in different forms that were perceived as risky by the market and have also provided loan guarantees to de-risk projects (Geddes, Schmidt and Steffen, 2018). Further, these banks can help to educate project developers and investors towards technology risk assessments. Due to their specific green capabilities, SIB investments have the ability to serve as signals to other market stakeholders of the quality of technology and of the safety of investments. This in turn

also helps to catalyse private sector interest (Egli et al., 2022). The presence of entities like green SIB will help to build the confidence and reduce the perception of risk for private money.

- Pushing technology innovation at the national level and greater international responsibility

Changes are needed at all levels, starting at the level of domestic governments. Apart from being a critical investor in the early stages of technology, the role of domestic governments extends beyond, towards encouraging innovation. This forms a crucial part of the low carbon strategy for the nation as well as serves as a signal to the investor community towards the commitment that the nation allots to the priority of sustainable energy.

At the same time, it is critical to highlight the role that international public financing should assume, in the raising of energy finance. When national governments will assume a greater share of this responsibility as discussed in different forms of public finance mechanisms previously, the growing development agenda and the many forms of sustainable growth responsibilities makes them pressed for finances. Thus arises the need for the international community to step in and facilitate public financing of climate needs as well.

Role of the G20

While there exist ample opportunities to use diverse sources of investment, like blended finance, developmental finance, philanthropic funds etc., to further raise energy finance, there is an important role in the same for the G20 as well. The G20 forum has always aimed at collective and sustainable growth, with all presidencies allotting due priorities to energy track issues. It is a powerful congregation with influential members, facilitating a strategic position to impact global strategies and policy decisions.

- There is a need for a strong platform like G20 to take the onus of providing support to climate technology capacity development and knowledge sharing programmes. They have the ability to serve as the connecting link between inter country technology development and sharing, and thus between technology developers and investors across the globe as well. Such collaborations and links will help to not only channelise greater energy finance, but also aid the global energy communities to benefit from each other's knowledge and grow sustainably together towards a low carbon future (UNFCCC Technology Executive Committee (TEC), 2015).

- Extending the coordination between countries argument, it is critical to understand that cost estimates for shifting to low carbon technologies need to also account for the fact that not all countries, particularly the developing set of countries will already possess the required technology. While in some countries the technology can lay in stage two or three, there will also be countries where the technology would be in the preliminary R&D stage. The costs for the same, thus also needs to be accounted for while estimating finance allotments or commitments at international forums like the G20. At the same time, this again highlights the existing scope of technology cooperation between countries that can be facilitated to a great extent by the G20 forum.

- Further, additional coordination with the existing G20 Climate Sustainability Working Group (CSWG), G20 Finance Track, and the Energy Sustainability Working Group (ESWG) can help to bolster financing efforts. Given the interconnections between different groups already existing at the G20, a closer collaborative effort will help to take the agenda for each group more comprehensively to greater heights.

- Assuming G20 presidency for 2023, India has been diligently working on ensuring achievement of its clean energy goals. Clean energy technology deployment has been accelerating with significant additions to the renewable energy capacity of the country. Investments in the field would thus need to be scaled up to ensure the realisation of rising clean energy benefits. However, the country also faces its own set of challenges, like the high overcall cost of debt in the country, added to that the limited capacity of domestic investors to provide long term fixed price loans for clean energy products, etc. With a fair understanding of the developing country perspective, India can definitely take this opportunity to highlight for the world, financial mechanisms that enable multiplier economic effects. Measures like a focus on supportive clean energy infrastructure and skilled labour creation to take the energy transition forward will form key determinants from the developing and emerging country perspective in the energy transition for the time to come. India could stress on these while deciding its energy transition priorities (OECD, 2022).

A big-push is required for early-stage clean energy technologies to enter the market and get embraced by businesses developers to cater to the mitigation and adaptation aspects of climate change. As understood from the G20 country analysis in this paper, it is clear that the G20 countries require strong long-term financing support to move clean technologies from the deployment to commercialisation stage in the market. Thus, prudent financial planning is summoned for each country, depending on the stage of technology they are in to bear the actual risks of decarbonization rather than just speculating the amount of global investments required. This analysis helps to provide small but pivotal clarity for countries to understand the stages of clean technologies and the funding they require, along with the plausible sources. This will help to aid financial planning and provide better understanding of the ways of leveraging funding policies, so as to channelize those funds at the right place and thus plan resources better.

Recognition to the vitality of the need for energy finance, paired with action in right direction and effective implementation will help to ensure effective funding raising mechanisms in place.

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Annexure

Table AN.1: G20 and the Energy Priority

G20 year	G20 Presidency	Energy focus
2014	Australia	• Acknowledged the importance of increasing collaborations on energy, declaring it as a priority. • The presidency saw the endorsement of the *G20 Principles on Energy Collaboration*. These discussed diverse topic areas including energy access, energy security, phasing out of fossil fuel subsidies, as well as the need for promoting energy investments and the cost-effective means of clean energy technologies.[13] • There was budding recognition to the concern of energy efficiency. • Increased pressure was placed to not only look at cost effective renewable and clean energy, but also encourage innovative energy technologies for sustainable growth of the sector. • Whilst there were discussions on promoting energy sector investments, a full fledge focus on raising this finance was missing.
2015	Turkey	• The Presidency witnessed the first ever meeting of the G20 Energy Ministers.[14] • Discussions focused on a variety of issues from energy access, market transparency, energy security, phasing out of fossil fuel subsidies, energy efficiency, renewable energy, to innovative energy technologies. The nature of specific meeting translated to more elaborate discussions in the energy subject arena. • The presidency stressed on the need for financing for energy efficiency, welcoming the *Voluntary Energy Efficiency Investment Principles* for G20 countries. • Renewable energy investments were also encouraged. Clean energy technology investments were recognised as crucial, requiring essential public-private participation.
2016	China	• The Chinese presidency reaffirmed the importance of energy collaborations and introduced three actions plans, including *Enhancing Energy Access in Asia and the Pacific: Key Challenges and G20 Voluntary Collaboration Action Plan*, *G20 Voluntary Action Plan on Renewable Energy*, and *G20 Energy Efficiency Leading Programme (EELP).*[15] • While the summit recognised the need to scale up green financing, the energy finance focus under the presidency was found to be majorly concentrated around encouraging investments in renewable energy. • Phasing out of fossil fuel subsidies formed a common priority for this presidency as well. • Technical development and deployment of different energy technologies was promoted and sought after. • Market transparency was also recognised to be a critical prerequisite for ensuring energy security as well as for encouraging investments. The Joint Organisations Data Initiative (JODI) was committed to strengthen further.
2017	Germany	• The German presidency was witness to the *Hamburg Climate and Energy Action Plan for Growth.*

[13] G20 Principles on Energy Collaboration, 16 NOVEMBER 2014, G20 Australia; http://www.g20.utoronto.ca/2014/g20_principles_energy_collaboration.pdf , Accessed on November 1st, 2022.

[14] Communiqué: G20 Energy Ministers Meeting; http://www.g20.utoronto.ca/2015/151002-energy.html , Accessed on November 1st, 2022.

[15] G20 ENERGY MINISTERIAL MEETING BEIJING COMMUNIQUÉ; http://www.g20.utoronto.ca/2016/160629-energy.pdf , Accessed on November 2nd, 2022.

		• There was recognition to the fact that economic growth and sustainable development rely on affordable, reliable and sustainable energy sources, and clean energy technologies and infrastructure. • Focusing on greater energy collaborations, energy security was regarded as one of the guiding principles for the transformation of energy systems. • It was agreed upon to work on open, flexible, and transparent markets for energy commodities and technologies. Sustainable and clean energy technologies, energy efficiency, energy infrastructure and energy projects were recognised as key areas for increased investments.[16] • Apart from encouraging international cooperation on the development, deployment, and commercialisation of sustainable and clean energy technologies, the energy finance agenda witnessed support in the promotion of private sector investments as well as a push to Multilateral Development Banks (MDBs) to promote universal access to affordable, reliable, sustainable and clean energy.[17] • The importance of energy transition was recognised as well, with emphasis on joint work by G20 members.
2018	Argentina	• There was recognition that ensuring an effective energy transition required combined efforts on both the demand and supply side.[18] • Across all energy track issues, greater investments were encouraged through multiple sources including public and private sector, MDBs, and financial institutions, as well as through risk mitigation initiatives. • While the financial gap in infrastructure investments to ensure energy security was highlighted, there was also an acknowledgment of the vitality of clean energy technologies and the need for innovation in technologies along with technology transfers.
2019	Japan	• The Japanese presidency acknowledged the importance of energy transitions that realize the "3E+S" (Energy Security, Economic Efficiency, and Environment + Safety). • Recognising the close nexus between energy security, economic growth, climate and environment protection, the *G20 Karuizawa Innovation Action Plan on Energy Transitions and Global Environment for Sustainable Growth* was adopted with the intention of reinforcing and enhancing initiatives involving multiple stakeholders. • The Plan encouraged financing efforts towards improving the market and investment environment for various energy options, innovative technologies and quality infrastructure that enhance energy access, resilience, cleaner environment and water access. • The role of public finance was recognised, with an acceptance of efforts required to mobilise private finance. • The Plan also stressed on improvement of business environments for the power sector to enhance security and flexibility of electricity, as well exploring innovative storage and distribution technologies.[19]

16 G20 Hamburg Climate and Energy Action Plan for Growth; http://www.g20.utoronto.ca/2017/2017-g20-climate-and-energy-en.pdf , Accessed on November 3rd, 2022.

17 G20 Leaders´ Declaration; http://www.g20.utoronto.ca/2017/2017-G20-leaders-declaration.pdf , Accessed on November 3rd, 2022.

18 G20 ENERGY MINISTERS COMMUNIQUÉ; http://www.g20.utoronto.ca/2018/2018-06-15-energy_communique.pdf , Accessed on November 3rd, 2022.

19 G20 Karuizawa Innovation Action Plan on Energy Transitions and Global Environment for Sustainable Growth; http://www.g20.utoronto.ca/2019/2019-G20-Karuizawa-Innovation-Action-Plan.pdf, Accessed on November 4th, 2022.

		• In addition, to encourage innovation in energy technologies the G20 Japanese Presidency launched an initiative called Research and Development 20 for clean energy technologies (RD20) for promoting international collaborations among leading R&D institutes from G20 members.[20]
2020	Saudi Arabia	• With the world in midst of the Covid-19 pandemic, the Saudi Arabian presidency recognised the impact of the pandemic on destabilisation of global energy markets. • There was recognition to the need for utilising the widest variety of fuels and technology options to ensure an uninterrupted supply of energy. • The presidency reaffirmed the importance of "3E+S" to lead energy transitions. • The stress on public and private investments as well as on encouraging innovative financing was re-established. • There was agreement on collaborations on mobilisation of greater investments in various energy sectors, including innovative technologies and quality infrastructure in line with national circumstances, to enhance energy security. • An Energy Focus Group (EFG) was established under the presidency to rebalance energy markets, which also stressed on continued capital investments to support short and long-term global energy security and stability. • Phasing-out of inefficient fossil fuel subsidies continued to remain a focus point for this presidency as well.[21]
2021	Italy	• The Italian Presidency organised the first ever joint G20 Energy - Climate ministerial.[22] • The energy track dominantly focused on clean energy transitions. • The stress was majorly on the importance of escalating zero and low emission technologies and furthering innovations in the field. • Investment focus was thus on similar lines, with recognition on the need for financing critical low emissions and innovative clean technological solutions, along with advanced and clean technologies like Carbon capture, utilisation and storage (CCUS)/Carbon Recycling and other related technologies. • Phasing out fossil fuel subsidies remained a constant part of the G20 agenda for 2021 as well.

Source: Authors' compilation from G20 communiques over the years

[20] Communiqué G20 Ministerial Meeting on Energy Transitions and Global Environment for Sustainable Growth; http://www.g20.utoronto.ca/2019/2019-energy-environment-communique.pdf , Accessed on November 4th, 2022.

[21] G20 Energy Ministerial Meeting Communique; http://www.g20.utoronto.ca/2020/G20SS_Energy_Ministers_Meeting_Communique.pdf , Accessed on November 4th, 2022.

[22] ENERGY TRANSITION AND CLIMATE SUSTAINABILITY WORKING GROUPS Joint G20 Energy-Climate Ministerial Communiqué; http://www.g20.utoronto.ca/2021/2021_G20-Energy-Climate-joint-Ministerial-Communique.pdf , Accessed on November 5th, 2022.

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