AIIB Annual Meeting 2018

Host Country Seminars

BACKGROUND PAPERS

Ministry of Finance
Government of India

AIIB ANNUAL MEETING 2018 MUMBAI INDIA

RIS
Research and Information System for Developing Countries
विकासशील देशों की अनुसंधान एवं सूचना प्रणाली

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Forging Collaborations and Partnerships: Evolving Strategies and Collective Efforts

Introduction

With an aim "to end poverty in all its dimensions and craft an equal, just and secure world – for people, planet and prosperity by 2030", member states of United Nations adopted the 2030 agenda for sustainable development – the Sustainable Development Goals (SDGs). SDGs comprise of 17 goals and 169 targets aimed at inclusive and sustainable development. Under SDG-9, countries have agreed to build resilient and sustainable infrastructure across all sectors which includes both regional and trans-border infrastructure. SDG-9 focuses on technological progress as a key to finding solutions for both economic and environmental challenges. Similarly, SDG-11 on 'Sustainable Cities and Communities' encourages countries to make cities and human settlements inclusive, safe, resilient, and sustainable. Safe and affordable drinking water, and access to sanitation and hygiene facilities, which are the basic necessities for human beings, form the focus for SDG-6. As the global population continues to rise, so does the demand for alternative sources of energy. With this in mind, SDG-7 targets to ensure access to affordable, reliable, sustainable and modern energy for all.

However, despite fast economic growth, many countries are finding it difficult to meet these targets. Particularly in case of developing countries, the rate at which the countries are growing is faster than their ability to match the simultaneous growth in infrastructure requirements. Poor infrastructure, in terms of both quality and quantity, affects the productivity of a country and influences its ability to fight poverty[1].

India, one of the fastest growing economies in the world, also faces similar challenges with respect to infrastructure development. For India to sustain its current level of growth, it is important to deliver the required infrastructure needs across all sectors covering roadways, railways, airports, ports and coastal infrastructure, digital infrastructure, energy generation, provision of safe and affordable drinking water and waste management services[2]. Investment in infrastructure not only enables trade but also significantly improves the quality of life of the population, leads to job creation and encourages efficient use of financial resources[3]. Despite these benefits, infrastructure investments in many emerging economies have been grossly inadequate. Several reasons account for this - first, investments in infrastructure are lumpy and huge, and resource constrained developing countries find it difficult to balance infrastructure demands against other pressing social and economic issues; second, there is often lack of familiarity or experience in building high quality sustainable infrastructure and an in-depth understanding of the accompanying sector specific risks, third, infrastructure projects frequently suffer delays in execution and entail high upfront costs thus making investments in this sector less attractive, and last, there are often inadequate uniform data collection and monitoring systems which can help in the proper assessment and viability of projects.[4]

These are all fairly significant challenges. One effective way for developing countries, to overcome these challenges is to collaborate with other agencies. These partnerships would not only help in overcoming the investment gap but would also help in efficient and sustainable designing and implementation of infrastructure projects, including, paying adequate attention to environmental and social impacts of such projects.

This paper focuses on the collaborative actions and efforts that can be undertaken by countries such as India with other stakeholders to build infrastructure capabilities at home and abroad.

State of Infrastructure in India

Before looking at the collective efforts undertaken across the globe, this section analyzes the current state of infrastructure in India. In spite of significant investments in infrastructure in recent years, India's infrastructure needs are still huge. The government has recognized infrastructure development as a national priority. For FY 2018-19, the government has increased the total capital outlay on infrastructure to Rs. 5.97 trillion (or 88 billion USD). With the aim of achieving universal household electrification in both rural and urban areas, the government is spending Rs. 160 billion (or 2.3 billion USD) towards the 'Sahaj Bijli Har Ghar Yojana' (Saubhagya). Of the total households in the country, nearly 23% or 40 million households were unelectrified at the time of the launch of this scheme in September 2017. Since then this number has come down to nearly 16%. As India aims to be self-reliant in meeting its energy demand, which is expected to reach 15,820 TWh by 2040[5], focus has also shifted towards advancing the renewable energy sector. Accordingly, allocation to the state-owned Solar Energy Corporation of India has increased by nearly 22% to Rs 2.17 billion (or 32 million USD), this year. Further, the centre aims to work with the states for installation of solar water pumps to help farmers irrigate their fields[6].

Rapid urbanization has put great pressure on the current infrastructure available in urban areas. Therefore the government of India aims to develop 100 smart cities by 2022 that would provide for the needs of the citizens in terms of sustainable and comprehensive infrastructure services[7]. These smart cities will not only improve the quality of life of the residents but would also stimulate economic growth, create employment and harness new technology. Greenfield areas would be developed around the cities in order to accommodate the growing population. In order to address the housing requirement of urban poor and slum dwellers, the Pradhan Mantri Awas Yojana (Urban) has been launched which aims to provide 'Housing for All' by 2022. Under the Swachh Bharat Mission and National Rural Drinking Water Program (NRDWP), the government has made tremendous efforts to provide safe and affordable drinking water and sanitation facilities to all segments of the society. Under the Swachh Bharat Mission, sanitation coverage in India has more than doubled, since its inception on 2nd October 2014. Over 72 million household toilets have been constructed under this mission, as a result of which, number of people defecating in the open has come down from 550 million to less than 200 million today. With NRDWP, water supply for habitations with over 40 Litres per Capita per Day (LPCD) has increased to 78%, of which 57% of the population is also covered by piped water supply through public stand posts.[8]

India is a significant investment destination for long-term global infrastructure investors. The WEF's latest 'Global Competitiveness Report, 2017–2018' ranks India 40th (of 137 countries) on an overall basis and 46th in terms of 'Quality of overall infrastructure' (Figure 1). Given the already booming IT and services sector in India, there is great potential for embracing and implementing new and innovative technologies for infrastructure development. Technological innovations for capacity building can happen in the form of building smart cities, using renewable sources of energy, enhancing regional connectivity, finding new financing options and for digitization.

Figure 1: India's Infrastructure Ranking 2017–2018

Index Component	Rank/137	Value	Trend
2nd pillar: Infrastructure	66	4.2	
2.01 Quality of overall infrastructure	46	4.6	
2.02 Quality of roads	55	4.3	
2.03 Quality of railroad infrastructure	28	4.4	
2.04 Quality of port infrastructure	47	4.6	
2.05 Quality of air transport infrastructure	61	4.6	
2.06 Available airline seat kilometers millions/week	8	4,888.9	
2.07 Quality of electricity supply	80	4.7	
2.08 Mobile-cellular telephone subscriptions /100 pop.	110	87.0	
2.09 Fixed-telephone lines /100 pop.	111	1.9	

Source: Global Competitiveness Report, 2017–2018.

Note: Value represents score ranging from 1-7 where 1 is the lowest and 7 the highest.

However, in spite of significant progress, India's infrastructure is still far from adequate. Financial requirements to meet the country's desired level of infrastructure are thus huge. According to the Global Infrastructure Outlook Report 2017, India would require US$ 4.5 trillion worth of investments till 2040 to develop its infrastructure. Economic Survey, 2017-18, notes that India can meet a very significant portion (US$ 3.9 trillion, about 87%) of the required investment, but this still leaves a financing gap of about US$ 526 billion[9]. Similar is the situation in other parts of the world. According to the ADB report on 'Meeting Asia's Infrastructure Needs', Asia and Pacific region needs to invest US$22.6 trillion through 2030, or US$1.5 trillion per year (not including climate-adjusted costs), given its current growth rate, to overcome the infrastructure shortage that exists in this region[10]. In order to meet this demand-supply gap, collaborations with national and international financing institutions such as the Asian Infrastructure Investment Bank (AIIB), Asian Development Bank (ADB), New Development Bank (NDB), World Bank (WB), and others could be a potential solution. Undertaking collaborative efforts and learning from similar experiences from across the globe can bring about the required balance in the infrastructure sector.

Collaborations and Collective Efforts

Understanding Collaboration

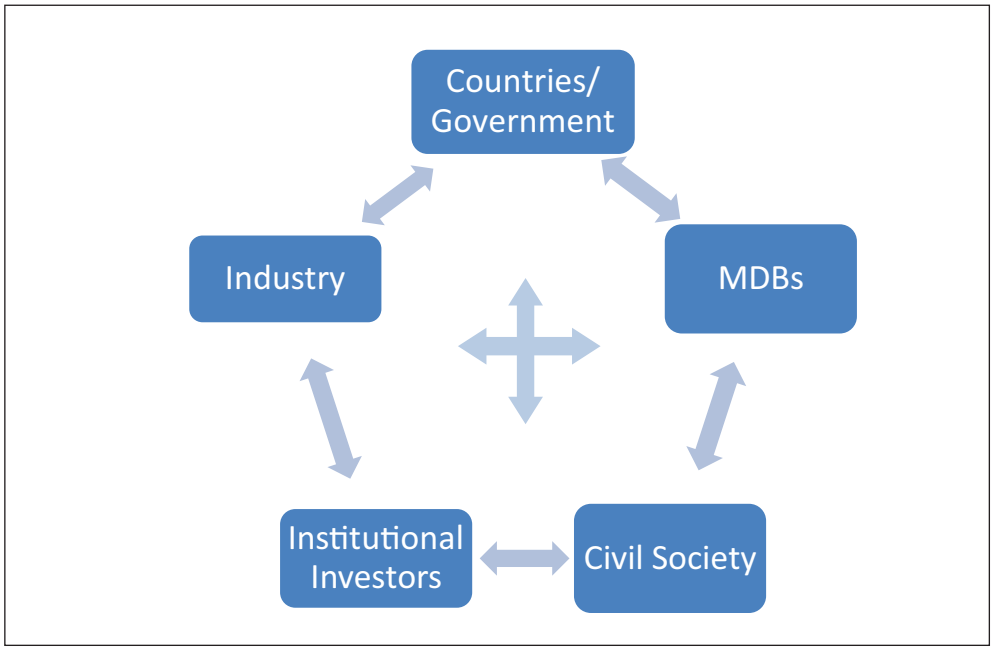
The world around us is growing rapidly, as a result of which new investment avenues and sources of expertise are emerging faster than ever. Many countries across the world share the same roadblocks, challenges, and aspirations in developing infrastructure facilities. Thus, activities could be more effectively scaled up and implemented if stakeholders come together to develop and plan future projects. These stakeholders include the countries themselves, Multilateral Development Banks (MDBs), institutional investors, civil society and the industry[11].

Collaboration implies that partners work together in order to achieve a common objective. It is important to realize that the public sector alone cannot meet the rising infrastructure demand and partnerships with the private sector both in resource mobilization and project implementation are not only strongly desirable but inevitable. Public and private sector participants have different

unique comparative advantages and their complementarities can be used to meet a country's growing infrastructure needs.

Collaboration does not necessarily need a strict leadership order and can successfully produce results if the ideals and objectives of all parties involved are properly aligned. Figure 2 shows different types of collaborations and their links that can potentially be formed between the stakeholders. The infrastructure ecosystem can be better evolved by exploiting the synergies that exist between these agents. For example, on one hand, the public sector can contribute towards an enabling environment by providing exemptions on acquisition of land and legal matters, and on the other hand, the private sector can contribute towards smooth and timely execution of projects. Similarly, the civil society, which represents the interest of people, can play an important role in enhancing transparency, creating awareness and helping the government to make an impact at the grass roots level.

Figure 2: Types of Collaborations



Source: Adapted from IDB and Mercer, 2017[12]

Ways to Collaborate

There are many ways in which different stakeholders can collaborate with each other. Collaboration between countries or governments which are at different stages of development can be effectively used to tackle infrastructure related issues through knowledge and resource sharing. South-South Cooperation or a partnership between countries at a similar level of development will also be useful as the political, economic, cultural and environmental challenges faced by developing countries are similar in nature.

Similarly, collaboration between Governments and MDBs can help countries cover the investment gaps that cannot be met domestically. MDBs can also provide the recipient countries with planning and financial support which is more regional in nature and takes into consideration country and region specific challenges and opportunities. This form of partnership also helps MDBs to form a clear framework for investment that is in tune with the policies and initiatives adopted by a country[13].

Collaboration between governments and industry helps in creation, diffusion, and adoption of new age solutions. It also helps to recognize the challenges faced by the industry in adopting the framework suggested by the government. Investment in infrastructure reaps fair returns. Thus, a partnership between the industry and Government can help both the sides to generate revenue while proving sustainable infrastructure to the citizens.

One of the biggest challenges in monitoring and accessing an infrastructure project is the absence of substantial and standardized data. Collaborations can come about between industry, Governments, and MDBs that enables proper collection and dissemination of data.

Enabling Collaborations

In order to ensure that the stakeholders collaborate successfully, it is important that the following concerns are addressed:[14]

- Administrative and Organizations complexities should be reduced in order to facilitate smooth functioning of all the agents involved.
- Partnerships between different agents require a well-defined system and coordination structure. Thus, a clear framework should be instituted at the initiation of each project which distinctly defines the role of all the stakeholders involved to avoid duplication of efforts.
- To ensure a meaningful participation from the private sector, the government should lay out specific targets in a systematic manner which can be adopted by the industry.
- Both short-and long-term planning can be improved by making use of infrastructure assessment tools. Thus, a mechanism to monitor the progress of infrastructure projects should be instituted which is both accurate and flexible to integrate with other platforms.
- Given the diversity in the nature of the organizations involved, all participating agents must show a willingness to not only learn from each other's experience but also to adopt the best practices from across the world.

Collaborative Efforts From Across the World

Collaborative Efforts by India

In this section, we look at collaboration initiatives undertaken by India, across different infrastructure sectors, which have resulted in proper utilization of resources and productive gains for all the stakeholders. These past experiences not only help us in learning from previous collaborations but also guide us in planning sustainable infrastructure for the future.

India and Russia share collaborative ties in various sectors. One of them, for example, is the mass rapid transportation system. The Indian Railways has collaborated with the Russian Railways to increase the speed of passenger trains in India up to 200 kmph, which is currently 160 kmph[15]. A joint venture between Hindustan Construction Company Ltd and Russia's Mosmetrostroy has also been signed to construct a part of Mumbai's first underground metro line. It also involves a collaboration between Larsen & Toubro (L&T) with STEC, its Chinese partner[16]. On completion, this would be a 33.5 km long line providing the much needed North-South connectivity in the city, which will help in smoother movement for passengers. India has also signed a Memorandum of Understanding (MoU) with Russia for implementation of its smart cities program by using the IT solutions offered by Russian companies like Skolkovo which is a leading Russian technology hub. This collaboration will help the government to realize its vision of upgrading the way urban India lives.

Further, India is looking to expand its ties with Sweden, in the capital goods market. Though there are many Swedish companies operating in India, like Sandvik and ABB and SKF, the government further aims to expand the scope of Indo-Swedish collaboration in industrial goods[17].

Sustainability is a crucial element for new capacity building across all sectors. MDBs have agreed to deepen their collaboration to encourage private sector investment in vital infrastructure needed to support sustainable and inclusive economic growth throughout the world. In one such effort, to address infrastructure gaps in Asia, the AIIB has followed a collaborative approach and invested US$150 million in the IFC's Emerging Asia Fund and also co-financed a project with the ADB to improve energy connectivity in India by strengthening its power transmission system. This collaborative effort will also promote job creation through availability of capital and expertise. In another such initiative, the Government of India and World Bank have signed an agreement to setup large-scale solar parks which will help India in increasing its power generation capacity. Furthermore, Government of India and ADB under the Clean Energy Finance Investment Program are working towards providing long term financing options for renewable energy projects like wind, biomass, hydropower, and solar[18].

India–Bhutan partnership in the hydropower sector is another illustration of a successful and mutually beneficial collaboration where renewable energy is used for supplementing the energy requirements of a country. These projects not only provide clean electricity to India but also generate export revenue for Bhutan, further strengthening their relationship. So far, the two countries have signed several agreements concerning development of joint venture hydropower projects and have commissioned various hydropower projects like 336 MW Chukha Hydropower Project (CHP), 1020 MW Tala Hydroelectric Project and 600 MW Kholongchu hydro-electric project to name a few[19].

India also plays a pivotal role in strengthening connectivity within the ambit of Heart of Asia (HoA) by developing various facets of connectivity through mutually beneficial cooperative initiatives. One such example is the proposed 1,814 kilometer long Turkmenistan-Afghanistan-Pakistan-India (TAPI) gas pipeline that aims to export nearly 33 billion cubic meters of natural gas, annually from Turkmenistan to Afghanistan, Pakistan and India[20]. This project will not only help in supplementing energy needs of the countries involved but will also hopefully provide significant peace dividends.

Collaborative Efforts from Other Parts of the World

Across the world, countries both rich and poor are adopting new partnerships to develop sustainable infrastructure facilities. Adopting practices that are eco-friendly will not only safeguard our existing resources but will also benefit the generations to come. With this view in mind, the 2017 Global Infrastructure Forum hosted by various MDBs[21], was organized to discuss ways for delivering inclusive and sustainable infrastructure and comprehending ways for governments in developing countries and their working partners to attract more resources for infrastructure. While these collaborations provide synergies, they also create challenges for execution given concerns on sustainability and popular support. It is important to draw upon such experiences to guide policy makers as well as investors in pursuing collaborative partnerships.

There is a need amongst countries across the globe to collaborate in order to ensure that technologies pertaining to renewable energy are utilized appropriately. A recent example is the 'International Solar Alliance' (ISA), based in New Delhi, a coalition of solar resource rich countries, launched with the aim of using solar energy to meet energy requirements in a safe, convenient, affordable, equitable and sustainable manner. It aims to deploy over 1000 GW of solar energy and mobilize more than US$ 1000 billion of investments in solar power by 2030. ISA is open to 121 prospective member countries, of which 61 countries have signed the ISA Framework Agreement and 33 countries have ratified it. ISA formally acquired the status of 'International Organization' in December 2017[22].

In an effort to reduce poverty in Asia and Pacific, ADB has formulated co-financing partnerships with other development organizations to enable the flow of financial resources and technical know-how in the region. These partnerships are formulated jointly with Multilateral Development Banks and agencies (like AIIB, Commonwealth Secretariat, Eurasian Development Bank, Islamic Development Bank etc), bilateral institutions under respective Governments (like Abu Dhabi Fund for Development, China Exim Bank, Spanish Agency for International Development Cooperation, Export-Import Bank of India etc), global funds (like Climate Investment Fund, Green Climate Fund etc), private sector partners (like Bill & Melinda Gates Foundation, Credit Suisse, The Rockefeller Foundation etc)[23], and other emerging development partners[24]. For example, to develop an energy project in China, ADB has partnered with the Bank of Beijing and with the Saudi Fund to develop a transportation project in Kyrgyz Republic.[25]

World Bank and AIIB also signed their first co-financing agreement in 2016 to jointly fund infrastructure development projects that would help in addressing development challenges across the world. The two institutions are also discussing several co-financed projects in areas such as transport, water and energy in Central Asia, South Asia and East Asia[26].

Way Forward

Most countries across the globe have realized the importance of sustainable and resilient infrastructure. With this view in mind, the UN Sustainable Development Goals 2030 were envisioned with an aim of creating a holistic world that focuses on the 5 Ps – People, Prosperity, Peace, Partnership, and Planet.

Sweden, for example, has put in tremendous efforts to create sustainable infrastructure facilities. These efforts range from introduction of green buses that run on biogas and ethanol to trains powered by electricity. The new purchases made by Stockholm Public Transport (SL) are at least 98% recyclable. Sweden has also shifted from oil to district heating with an aim of reducing country's greenhouse gas emissions. Swedish Prime Minister Stefan Lofven, set the aim for Sweden to become the 'first fossil fuel-free country in the world' by 2040[27].

Similar efforts are being carried out by different countries around the globe. Mato Grosso do Sul State Road Transport Project, in Brazil, adopted more sustainable approaches to control for erosion which saved the country US$ 46 million. Another such example emerged in the natural dry forest area of Argentina – a 60 km long road through this biodiverse area was built keeping in mind sustainable measures like installation of awareness signs, speed reduction measures in critical habitat areas, and construction of special wildlife crossing/connectivity points[28]. Likewise, Hudson Valley in the New York State region has adopted Green Infrastructure practices for stormwater management.

These initiatives and many more have brought about improved utilization of resources to create resilient infrastructure that is essential for sustainable community development. Examples of such kind are a repository of best practices that could be scaled and replicated by other countries. These initiatives also help in identifying and preparing a roadmap to meet the gaps in creation and financing of infrastructure.

However, the resources available with countries alone are not sufficient to develop infrastructure facilities that also comply with the SDGs. One way out for countries is to collaborate with other agencies in order to meet its growing infrastructure needs. These agencies or stakeholders include multinational development banks, institutional investors, private players and civil society agents.

Collaborative efforts of such kind have many benefits. It brings to the table expertise from each stakeholder, helps to cover the investment gap that exists within a country or between partner nations, and ensures good infrastructure planning and delivery. However, for such collaborations

to come about, it is important that following issues are dealt with. First, administrative complexities should be minimized; second, a well-defined framework should be established from the beginning that clearly defines the role of all the stakeholders involved; third, the government should have a clear focus and precise objectives that are to be adopted by the private players; fourth self-assessment tools for timely evaluation of the project should be used; fifth, there should be both a willingness and incentive to adopt best practices from across the world.

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Financing Infrastructure: Mobilizing Resources and Exploring New Instruments

Introduction

Gaps in infrastructure financing are widely observed across different regions of the world. As infrastructure development is critical for the socio-economic development of the developing and less developed countries, the shortfalls in funding infrastructure projects send worrying signals. The need for mobilizing resources for infrastructure, especially maintenance of ageing infrastructure, is felt even in developed countries as well. Moreover, poor infrastructure continues to remain a major bottleneck in the quest for high and inclusive economic growth. Besides institutional and regulatory issues, lack of finance is often viewed as a major reason for slow pace of infrastructure development in developing countries. As per McKinsey (2017) report, the world needs to invest $3.7 trillion[1] per annum on economic infrastructure through 2035.

In general, the infrastructure financing landscape is experiencing radical changes in view of the protracted slowdown in advanced economies of the world, importance of supply-side reforms, frequent recourse to fiscal stimulus measures, deepening global value-chains, increasing role of private capital, among others[2]. As a result, it is not only the creation of infrastructure in the form of new highways, bridges, railways tracks, ports, etc but equal attention needs to be given for maintenance of ageing infrastructure. In addition, the spread of IT applications in economic activities demands investment in the digital infrastructure as well. In that drive, the concerns for sustainable, inclusive and resilient infrastructure are recognized as crucial in the arena of conception, funding and implementation of infrastructure projects. These developments have not only scaled up the desired volume of investments for building infrastructure in developing countries but have indicated the need for diversification of financing sources and instruments.

Against this backdrop, this note attempts to explore innovative financial instruments that would help efficient mobilization of financial resources for infrastructure development with a specific focus on the developing country priorities.

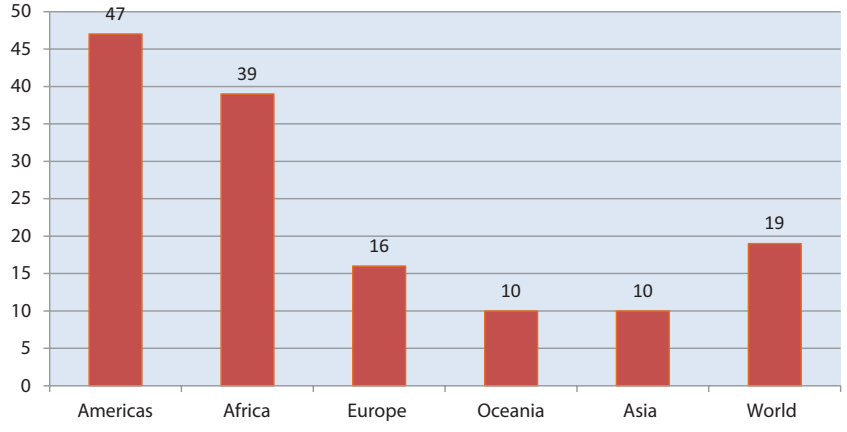
Need and Sources of Infrastructure Finance

Infrastructure financing is vast in scope and complex in terms of instruments and risk parameters. One fundamental difference between the standard financial investments and the infrastructure investments is the valuation and the pricing aspects. The non-exclusivity features of the most of the economic and social infrastructure projects complicate valuation of impacts, and hence, pricing of the benefits of services. Over the years, the demand for infrastructure financing has gone up drastically across countries necessitating diversification of sources of funding and innovative solutions. While financing solutions are being envisioned worldwide, financing gaps have significantly widened for infrastructure projects. There are several estimates of infrastructure

financing requirements by multilateral bodies and consultancy agencies. As per the estimates by the Oxford Economics and Global Infrastructure Hub, the gaps in infrastructure financing are substantial. Further, the achievement of SDGs would require additional spending on the basic economic and social infrastructure such as water and sanitation, electricity, roads, and so on (Fig1; Table 1).

Figure 1: Estimates of Infrastructure Investment Gaps for 2016-2040 (Per cent)

(Extent to which estimated investment need is greater than investment expected under current trends (Per cent))



Source: Oxford Economics and Global Infrastructure Hub (2017)

Table 1: Estimates of Infrastructure Investment Gaps for 2016-2040

(Per cent of GDP)

Region/Sector	Current Trends	Investment Need	Gap (C-B)	SDG (Over and Above (C))*
(A)	(B)	(C)	(D)	(E)
Sector				
Road	1.0	1.3	0.3	
Electricity	1.0	1.1	0.1	0.2
Rail	0.4	0.4	-	
Telecoms	0.3	0.3	-	
Water	0.2	0.2	-	0.1
Airports	0.1	0.1	-	
Ports	0.1	0.1	-	
Region				
Asia	4.0	4.4	0.4	0.3
America	1.7	2.5	0.8	0.1
Europe	2.3	2.6	0.4	-
Africa	4.3	5.9	1.7	3.4
Oceania	3.5	3.8	0.4	-

*2016-2030

Source: Oxford Economics and Global Infrastructure Hub (2017)

Both conventional and sophisticated financing instruments are often used to raise finances for infrastructure projects. While bank loans remain the most widely used conventional source of funding infrastructure, syndicated loans, MDB financing and range of financial instruments with varying risk and return features are often considered for infrastructure financing (Table 2). Risks associated with Greenfield investments are relatively high compared to Brownfield and post-construction investments. Both equity and debt instruments are prevalent in infrastructure financing. Hybrid instruments involving both equity and debt features such as mezzanine capital are also widely used for infrastructure projects. In the recent years, among investment routes, the focus is more on corporate bonds and municipal bonds even though government bonds dominate the bulk of project financing in the developing countries. Private equity and infrastructure funds are investing in infrastructure assets as well. As the demand for infrastructure financing in the recent years is growing, the contribution of institutional investors has become vital.

Table 2: Types, Sources and Instruments of Infrastructure Financing

<table>
<tr><td colspan="9">Types of Infrastructure Investments</td></tr>
<tr><td colspan="4">Economic Infrastructure</td><td colspan="5">Social Infrastructure</td></tr>
<tr><td colspan="4">Greenfield Investments (Higher Risk)
• (e.g., construction, design, build and operation risk)</td><td colspan="3">Brownfield Investments (Medium Risk)
• (e.g., operating toll road with significant capital investment)</td><td colspan="2">Secondary Stage Investments
(Low Risk, Low Return, well-established cash flows)
• (e.g., post-construction investments)</td></tr>
<tr><td colspan="9">Financing Options</td></tr>
<tr><td>Financing instrument (equity/debt)</td><td colspan="2">Equity</td><td colspan="6">Debt</td></tr>
<tr><td>Investment vehicle (public-private)</td><td>Listed</td><td>Unlisted</td><td colspan="4">Capital Market</td><td colspan="2">Private Debt</td></tr>
<tr><td>Investment route (direct)</td><td>Infrastructure stocks</td><td>Infrastructure project/SPE</td><td>Government infra bonds</td><td colspan="2">Corporate bonds</td><td>Project bonds</td><td>Loans to infra companies</td><td>Project loans</td></tr>
<tr><td>Examples of Funds (indirect)</td><td>Infrastructure stock fund</td><td>Private equity/ mutual fund</td><td>Municipal bond fund</td><td colspan="2">Infrastructure bond fund</td><td>PPP fund</td><td>Infrastructure debt fund</td><td>Infra-structure loan fund</td></tr>
<tr><td colspan="9">Sources of Infrastructure Finance</td></tr>
<tr><td colspan="3">Public</td><td colspan="6">Private</td></tr>
<tr><td rowspan="2">Governments</td><td rowspan="2">Sub-national</td><td rowspan="2">Development Institutions</td><td colspan="3">Corporate finance</td><td colspan="2">Project finance</td></tr>
<tr><td>Public Companies</td><td colspan="2">Private Companies</td><td>Non-PPP</td><td>PPP</td></tr>
</table>

Source: Adapted from Fig. 4 & 5 in Inderst and Stewart (2014) and Fig.2 in Inderst (2016).

Diversification of Sources and Innovative Instruments

Over the years, infrastructure development has largely been funded by the public sector with budgetary outlays. In most cases, the loans extended by the Multilateral Development Banks (MDBs) were backed by sovereign guarantees. As a result, infrastructure investments never developed as a preferred asset class for the private investors, especially for institutional investors. Infrastructure assets remained a special category of investments for long with very high level of perceived risks. With little participation of capital market in infrastructure financing, the choice of financing instruments also became limited. Non-sovereign lending, to a great extent, was viewed as very risky category of investments. This insulated treatment to infrastructure projects, perhaps confined MDB financing to select sectors across countries in the world. Given the pervasive demand-supply mismatch in infrastructure financing, which is widening fast, there is a growing recognition of diversification of sources of funding for infrastructure development. Some of the innovative steps that could mitigate the deficits in pooling resources from the market for infrastructure projects are discussed in the following paragraphs.

Tapping Institutional Investors

While bank financing of infrastructure projects appears to be grossly inadequate to match ever-increasing demand, institutional investors like pension funds, insurance companies, social security funds and sovereign wealth funds can be the potential sources of the infrastructure finance. Typically, institutional investors prefer investing in select portfolios of long-term, low-risk and low-return assets; mostly ending up in government securities/bonds and brownfield investments. Over time, the need for diversification of portfolios is increasingly recognized by the institutional investors; especially after the Global Economic Recession in 2008-09. The post-crisis global financial market characterized by low interest rate and higher risk aversion somehow pushed institutional investors to move for alternate investment assets with higher yields in segments like real estate, hedge funds, private equity and other assets. Moreover, Basel-III regulations and disappearance of monoline insurance companies also squeezed investment opportunities during the post-crisis period. The attractiveness of the infrastructure assets for the institutional investors was an outcome of the pessimism in the traditional segments of long-term finance. As a result, the institutional investors are showing tendency to effect changes in their long-term asset allocation strategies.

Theoretically, infrastructure investments suit the liability structure of the institutional investors; as the long-term liabilities of the institutional investors would ideally require a stable stream of cash flow over the long-run. Since infrastructure projects have long-gestation period, insurance companies, pension funds and sovereign wealth funds increasingly consider in investing in infrastructure assets, which are often backed by sovereign guarantees. Currently, the level of investment in infrastructure by the institutional investors is very low globally, even though pension funds and insurance companies are major investors, in general, and constitute 60 per cent of GDP. Infrastructure is yet to emerge as a preferred asset class for individual as well as institutional investor. Factors that constrain growth of this segment are limited investment and risk management expertise in the local market, lack of appropriate financing vehicles, short-term focus, and regulatory barriers, among others.

As per the IFC (2017), the total assets under the management of the traditional institutional investors doubled from $36 trillion in 2000 to $73.4 trillion in 2011, and increased in subsequent years also. Although investment size is relatively higher in developed economies, the market for institutional investment is growing in developing countries as well. Pension funds in developing

countries have potential to reach $17 to $25 trillion by 2050. Some developing countries are substantial in absolute terms; given the overall shallowness in institutional investment markets of the developing countries. The biggest pension assets in developing countries are in the following order: China ($1214 billion), Brazil ($308 billion), Mexico ($148 billion), Chile ($145 billion), Malaysia ($106 billion), India ($129 billion), South Africa ($84 billion), Egypt ($54 billion) and Russia ($78 billion).[3] Likewise, insurance penetration in both life and non-life segments is growing worldwide with huge untapped potential in emerging markets and developing economies. The assets managed by the sovereign wealth funds in different countries are quite large. This vast untapped segment can be efficiently leveraged for infrastructure financing; provided the risks faced by them are amicably addressed. The major risks, mostly cited, are appropriation risks, poor governance standards, stable legal and regulatory systems, lack of a pipeline of investment grade assets, lack of scale and capacity and lack of data on historical track record of investment performances for risk management.

Bank financing, the main component of debt finance to infrastructure, suffers from asset-liability mismatch. To address this issue, India is trying to promote institutional investment from pension, insurance and sovereign wealth funds into infrastructure. One instrumentality in this regard is development of Brownfield assets as a separate asset class for infrastructure investment. Brownfield assets are in the operational stage and are thus considerably de-risked as they are past land acquisition and environment and forest clearance stage. This makes them amenable to long-term institutional investment from pension, insurance and sovereign wealth funds. In the road sector, India has successfully launched the Toll-Operate-Transfer model as an example of development of Brownfield assets as a separate asset class. Financial vehicles like Infrastructure Investment Trusts (InvlTs) and Real Estate Investment Trust (REITs) have also been launched for attracting long-term investment from institutional investors in the infrastructure and real estate sectors respectively.

Land Value Capture Finance

Land Value Capture Finance (LVC) is increasingly adopted by the municipal governments and development authorities worldwide as an innovative instrument of financing urban infrastructure. The rationale for considering LVC as a means of generating resources for urban administration is derived from the value generated from the land adjacent to transport infrastructure built in the urban spaces. Transport infrastructure like metro rail stations, flyovers, bus depots etc improves access to the public in the form of jobs, shops, schools, entertainment and recreation. With proper contract arrangements those pieces of land may be leased to private developers, which in turn would create business opportunities. The value generated with this improved access can be a source of revenue for urban authorities. Instead of direct sale of lands, which is an inefficient form of resource mobilization, LVC captures the economic impact created by transportation infrastructure.[4] In essence, LVC is a new tool of raising revenue in proportion to increase in land value, resulting from new or improved infrastructure.

The standard techniques used for value capture financing are impact fees, air rights, betterment fees, joint development, special arrangement districts, and so on. While the effectiveness of these techniques is context-specific, developing a mix of instruments would be desirable. For instance, land value tax is considered the most efficient means of all value capture methods in some occasions. Globally, LVC has been successfully practised in Denmark, Australia, Poland, New Zealand, USA, UK etc.[5] In India, a good number of states have implemented LVC for mobilization of resources for urban infrastructure. Impact fees are effectively implemented in Indian states

including Andhra Pradesh, Gujarat, Maharashtra, Tamil Nadu and Madhya Pradesh. Moreover, Tamil Nadu and Maharashtra have amended state laws expanding the scope of value capture mechanism to urban lands also. The transport and economic corridor projects like the Delhi-Mumbai Industrial Corridor (DMIC), Sagarmala and metro rail projects in Delhi, Bengaluru, Hyderabad, Lucknow, etc are some of the examples for value capture finance. Haryana and Gujarat have used successfully land -pooling schemes. In addition, the urban bodies like the Mumbai Metropolitan Region Development Authority (MMRDA) and City and Industrial Development Corporation of Maharashtra Lt (CIDCO) have also tried LVC for resource mobilization.[6] Although land-based financing is gaining popularity among the city administrators globally, it has certain risks such as volatility and bubble in land markets, lack of transparency and accountability in land sale, efficient end-use of realized revenue from land, and so on.[7]

Local Currency Financing

Currency risk has been an important decision factor in project finance, particularly, in the large infrastructure projects for which uncertainty over exchange rate movements is quite natural, as the project cycle is long and involves many phases. Borrowing in hard currency could exacerbate currency risks in case of depreciation which along with the cost of hedging can add to the price/ tariff rate of infrastructure services. In the absence of the deep and diversified local capital market in most developing countries of the world, there were hardly choices for countries to borrow for infrastructure funding, except borrowing in hard currencies such as USD, sterling or euro. To reduce overall cost of capital accruing from zero exchange rate risk, the benefits of lending in local currency is being propagated as an innovative instrument of financing infrastructure. Local currency financing is preferred as both repayment and revenue generation materialize in the same currency besides its importance for local capital market development. Its popularity is growing in the recent years as the new multilateral banks, such New Development Bank (NDB) and Asian Infrastructure Investment Bank (AIIB), emphasize on it in their lending portfolio. The Black Sea Trade and Development Bank has expanded its local currency lending, and has issued bonds since the last few years with an aim to support small and medium enterprises development and local market development.

Local currency financing has assumed tremendous importance after the East Asian Financial Crisis in 1997. Borrowing short-term and lending long-term in hard currency amplified the cost of repayment when sudden repayments of short-term external commercial loans were demanded by the financiers following sharp depreciation of the Thai baht and consequent spread of contagion across the East Asian region. The success of the local currency financing is contingent upon the existence of deep local capital market. It would facilitate issuance of bonds in the local currency in the local financial markets. Based on the experience of the Asian Bond Market Initiative (ABMI), the promotion of local capital market is a feasible way provided proper institutional mechanism is put in place. The growth of local currency bond market would require necessary initial conditions like secondary market liquidity, reasonably large size of issuance, market makers, underwriting by international investment banks, regulatory reforms like streamlining of stamp duties, withholding taxes, etc. Very often, lack of liquidity and 'buy-to-hold' behaviour affect orderly growth of local capital market in the emerging markets and developing countries. Novelty in financing contracts in the form of Power Purchase Agreements would be useful in implementing local currency financing option efficiently. The Nam Theun 2 Hydropower Project in Laos and Bhutanese hydropower projects are best examples of such arrangements. The International Financial Corporation (IFC) has issued Umugada bond in Rwanda as an instrument of local currency financing.

Co-Financing

Infrastructure projects typically involve heavy investments, spanning over a relatively longer project cycle. The nature of risks is different at varied stages of project implementation. While public funding would be required at the initial stage of design and construction, in subsequent phases equity financing is more efficient. In operation phase, debt investments would flow in due to the predictable cash flows. Even refinancing becomes more feasible and attractive in operation phase. This entails diversity of instruments required for addressing different aspects of financing infrastructure projects. Given the large size of investments and diversity of risks, no single MDB or financial institution would be in a position to finance spending cycle of the entire project. Co-financing is an ideal mechanism to fill the gap in financing. All the multilateral development banks are party to some or other forms of co-financing arrangements with the other development banks.

The Africa 50 Infrastructure Fund by the African Development Bank and Managed Co-lending Portfolio Program (MCPP) Infrastructure by the IFC are the examples of co-financing arrangements. AfDB has created a new department to increase syndication and co-financing activities. Besides leveraging co-financing from the World Bank, EU, European Investment Bank, Islamic Development Bank and other development banks, AfDB has several private sector syndications as well.[8] AfDB believes that co-financing would crowd-in additional financing. Likewise, Black Sea Trade and Development Bank has stepped up its co-financing activities. In 2016, 68.9 per cent of signed portfolio of the bank was through co-financing route.[9] In similar fashion, ADB underscores vitality of co-financing for meeting SDGs. In 2017, $5.95 billion were mobilized in commercial co-financing to maximize development impact of ADB lending.[10] The Inter-American Development Bank (IADB) mobilized $2.9 billion in 2017 through co-financing which comprised 89 per cent of all resources mobilized in the year.[11]

Green Finance

The world is at present witnessing the challenge of meeting the demands of the sustainable and resilient infrastructure. It has implications for financing as the traditional criteria of the project assessment stands outdated, given the externalities associated with the creation of green and sustainable infrastructure. Pricing of externalities is difficult in the case of green finance. However, green finance could be an innovative instrument for mobilizing resources as it factors incentives and disincentives for climate change, disaster risk management and social impact of infrastructure. As estimated, the cumulative investment in green infrastructure would amount to $36 to $42 trillion between 2012 and 2030. Renewable energy financé is an important category in this regard. The concerns for clean and low-carbon energy are widely felt across all countries of the world. In that sense, green finance is not only an instrument of mobilizing resources but also a channel for inculcating a healthy system of construction, operation and maintenance of infrastructure projects.

Municipal Finance

Urban infrastructure, particularly, investments in utilities like drinking water supply, drainage systems, electricity, roads and flyovers etc needs massive overhauling as most of the countries are experiencing rapid urbanization and demographic transitions. It would require large investments across different sectors of urban infrastructure. Urban administration and municipal governments face tremendous pressure of finances to support this pace of infrastructure building and maintenance. At the same time, the resources at their disposal, which consist of revenues from user charges, land taxes, betterment fees, etc, are barely sufficient to cover financing requirements. The fund crunch is even more acute in developing countries. Municipal bonds are viewed as

an effective means of raising resources for creation and maintenance of various types of urban infrastructure. In developed countries, municipal bonds are well-accepted whereas this asset is not properly explored in developing country municipalities. In India, the Bangalore Municipal Corporation was the first municipal body to issue municipal bonds in 1997. Although the share of municipal bonds in India is negligible at present, its utility as a financing tool would remain significant. Private Sector Participation

Private sector participation is considered the most important element of infrastructure financing. Scarce public resources cannot meet ever-increasing demand for infrastructure development. Infrastructure investments most of which are illiquid and carry higher perceived risks remain unattractive to private investors. However, with state guarantees, private investors may take interest in infrastructure projects. Encouraging trends were observed in private sector participation in infrastructure during 1990-2017 (Table 3). Electricity tops the list in terms of investments through PPP route, followed by ICT, ports and water & sewerage and roads.

Table 3: Private Participation in Different Sectors (1990-2017)

Sector	Countries Participated (No)	Investment in Projects ($ Million)					
		East Asia and Pacific	Europe and Central Asia	Latin America and the Caribbean	Middle East and North Africa	South Asia	Sub-Saharan Africa
Airports	135	7029	48988	37949	2007	5918	1919
Electricity	729	211722	125218	295518	32615	178106	35406
ICT	270	27382	20505	49653	9489	5178	8806
Natural gas	115	9730	24355	36481	4816	1076	2249
Ports	256	23048	5291	25823	5607	12438	12383
Railways	102	43663	5356	55548	343	8037	5119
Roads	219	53804	25944	117834	-	79501	3057
Water and sewerage	250	35236	5340	34790	4109	648	779

Source: Compiled from World Bank, PPI Database.

Public-Private partnerships (PPPs) have received mixed response from policy-makers in different countries. With proper contracts and upfront investments by the implementing agencies, the private participation in financing and development of infrastructure can be dealt with effectively. It would also require enabling provisions on guarantees and dispute settlement mechanisms, particularly currency risk, political risks and governance risks.

As per the Private Participation in Infrastructure database of the World Bank, India is second in the developing world both by the number of PPP projects as well as associated investments. India's success in private participation in infrastructure is built on standardization of contracts, standardized procurement process, scheme of viability gap funding that provides grants to the private sector to a maximum of 20% of project costs, and a robust regulatory structure.

Pooling Foreign Exchange Reserves

Many countries in Asia and Latin America have accumulated significantly higher levels of reserves in 2000s. Some countries, like China, Japan, etc, hold disproportionately higher reserves against widely used benchmarks for reserve adequacy. Moreover, reserve accumulation was followed as a conscious strategy by the central banks in the crisis-affected economies, particularly in East Asia. This wave of competitive accumulation facilitated by net capital inflows prompted the idea of deployment of surplus into high-yielding productive real assets as an alternative to investment in the traditional portfolio US treasury securities. Investment in infrastructure projects has been perceived as a viable option of deploying surpluses (or a fraction of reserves), which potentially have high social desirability. This idea also assumed policy attention in India in the mid-2000s. Korea Investment Corporation (KIC), Temasek Holdings in Singapore, State Administration of Foreign Exchange (SAFE), etc have invested foreign exchange stock of Korea, Singapore and China in high-yielding financial assets. There are other reserve-based Sovereign Wealth Funds (SWFs), which invest in durable infrastructure assets.[12]

Way Forward

In view of the ever-increasing demand for infrastructure development, the need of examining sources and modalities of financing infrastructure projects has become paramount. Besides conventional tools of financing, there is a need for 'out of box' solution in the form of bundling risks and returns. Bank loans although has remained a major traditional source of funding infrastructure projects, mobilization of private capital is given emphasis in the recent years. Capital market solutions are vigorously pushed for consideration by policy-makers and development banks. Tapping the funds parked with the institutional investors such as pension funds, insurance companies, sovereign wealth funds, etc would be critical supplementary sources of funding. In fact, because of strong 'push factor' that operates in the standard portfolios in the post-crisis period in the United States and other advanced economies, institutional investors have shown keen interest in diversifying their lending portfolios. It is also well-recognized that budgetary support would not be adequate to meet the growing financing requirements for infrastructure development. Private investors would perhaps invest in infrastructure provided returns from the assets are higher and also predictable. Certain institutional innovations have occurred in the infrastructure financing landscape in the recent decades. Notable examples include private equity funds, infrastructure bond fund, local currency bond issuance and raising capacity and financing resources of the sub-national or municipal governments. Developing countries whose financial sectors lack depth and liquidity seem to have underscored the importance of formulating appropriate financing mechanisms for infrastructure development.

While the benefits of deep and diversified financial sectors with sophisticated instruments are undoubted, there are some concerns which need to be addressed. For instance, certain sectors and regions are considered highly risky compared to other sectors and regions. Although investment appetite with private investors is still there, investments do not flow to these sectors and regions that easily. This warrants devising suitable incentive structures in contracts in the forms of guarantees against exchange rate volatility, faster resolution of investment-related arbitrations, adequate refinancing and co-financing options, etc. Since the asset-liability structures of institutional investors like pension funds differ drastically relative to commercial banks and financial institutions, proper sequencing of funding plans over different phases of project cycle would help attract these investors to infrastructure projects.

Endnotes

1. See McKinsey (2017).
2. See RIS and Ministry of Finance (2018)
3. Inderst and Stewart (2014)
4. See Levinson and Istrate (2011)
5. See Medda and Modelewska (2011) and Govt. of India (2017)
6. See Govt. of India (2017)
7. See Peterson (2007)
8. See AfDB (2017).
9. See Black Sea Trade and Development Bank (2016)
10. See ADB (2017)
11. See IADB (2017)
12. See Dash (2012).

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Building Resilient and Quality Infrastructure

Assessment of Trends and Patterns

Building resilient and sustainable infrastructure assumes paramount importance in the backdrop of numerous natural disasters, happening world-wide, affecting hundreds of millions of people and causing economic damages worth over a hundred billion dollars every year. Incorporating resilience and sustainability into infrastructure projects is also crucial due to concerns that population growth and increased pace of development in lesser developed economies are contributing to climate change and disasters.

Besides, what is relevant in this context is the requirement that countries meet their targets under the United Nations' Sustainable Development Goals (SDG) and comply with the Paris Agreement on Climate Change. If benefits of connecting people and transporting goods within countries and across national borders through such infrastructure have to outweigh the costs involved, it is critical to ensure global standards and quality in these projects.

Investment Needs

Investment needs for infrastructure globally between 2016 and 2040 is around $94 trillion (or an average of $3.7 trillion annually) -- presenting huge opportunities and challenges at the same time. An extra $3.5 trillion would be required by 2030 to achieve SDGs for drinking water, sanitation and electricity. In India's case, its cumulative spending needs during 2016-2040 are projected to be $4.5 trillion, making the country the world's largest infrastructure market after China ($28 trillion) and the United States ($12 trillion)[1]. As per another estimate, considering that investments to the tune of $90 trillion would be required to build 'sustainable' infrastructure across the world for the period 2015-2030, it would mean that the amount of investments would have to increase significantly from the current estimated annual figure of $3.4 trillion to around $6 trillion per year. What is pertinent to take note of is the projection that 'the global South' will account for around $4 trillion per year (out of that $6 trillion).[2]

Though these whopping investments into infrastructure building would promote growth and development, there are apprehensions that they may not entirely address the resilience and sustainability issues. According to a study, owing to the huge growth in population and the consequent urbanisation, the total global exposure to river and coastal flooding alone are estimated to rise from $46 trillion in 2010 to $158 trillion by 2050.[3] Another study has reported that due to climate change, the value of risk to the entire global stock of manageable assets (in present value terms) ranges anywhere between $4.2 trillion and $43 trillion (between 2015 and 2105).[4]

China, the United States, India, Indonesia and the Philippines were the top five nations most frequently affected by natural disasters during the decade 2006-2015.[5] For cash-strapped lower middle income countries like India, huge economic losses due to natural disasters pull them back by a number of years in terms of development, as that money could otherwise have been utilised for constructive welfare projects and overall economic progress. Therefore, it is imperative to make infrastructure disaster-risk resilient and climate-proof, and also ensure 'green growth' in the process; as in the event of such disasters, poor quality and fragile infrastructure would lead to loss of lives, livelihoods and, in turn, hit economic growth.

SDG 9: Build Resilient Infrastructure

- Develop quality, reliable, sustainable and resilient infrastructure, including regional and trans-border infrastructure to support economic development and human well-being, with a focus on affordable and equitable access for all
- By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities
- Facilitate sustainable and resilient infrastructure development in developing countries through enhanced financial, technological and technical support to African countries, least developed countries, landlocked developing countries and small island developing States

SDG 11: Make Cities Inclusive, Safe, Resilient and Sustainable

- By 2030, ensure access for all to adequate, safe and affordable housing and basic services, and upgrade slums
- By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons
- By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries
- By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations
- By 2030, reduce adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management
- By 2030, provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities
- Support positive economic, social and environmental links between urban, peri-urban and rural areas by strengthening national and regional development planning
- By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels

SDG 13: Take Urgent Action to Combat Climate Change and its Impacts

- Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters
- Integrate climate change measures into national policies, strategies and planning
- Implement the commitment undertaken by developed-country parties to the United Nations Framework Convention on Climate Change to a goal of mobilizing jointly $100 billion annually by 2020 from all sources to address the needs of developing countries in the context of meaningful mitigation actions and transparency on implementation and fully operationalize Green Climate Fund through its capitalization as soon as possible

Countries like India have stated that their development agenda -- including accelerated infrastructure building -- is mirrored in the Sustainable Development Goals (SDGs). The concerned SDGs include SDG 9 (building resilient infrastructure), SDG 11 (making cities resilient and sustainable) and SDG 13 (take urgent action to combat climate change and its impacts). This means, by 2030, India and others would have to endeavour to ensure that their infrastructure (existing and new) is environment-friendly, sustainable, resilient, affordable, accessible and inclusive.

Definitional Issues

The terms 'resilience' and 'sustainability' are not clearly defined as they include economic, monetary, physical, social and environmental aspects, and difficult-to-measure qualitative factors. However, specific drivers in the context of resilience include disaster prevention steps, adaptation to climate change, and sustainable development (as in the SDGs and the 2015 Paris Agreement to combat climate change). Embedding resilience and sustainability into the planning and design of infrastructure projects is critical as it would help de-risk (implying leading to better credit rating, reduced borrowing rates, and therefore lower default risk, in addition to lower insurance premium and faster recovery following a disaster) as well as boost financial performance of such projects; these factors, in turn, would help unlock the capital required to fill the infrastructure gap.[6]

UNISDR Definition of 'Resilience'

Resilience is: "The ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions."

(UN Office for Disaster Risk Reduction (UNISDR), "2009 UNISDR Terminology on Disaster Risk Reduction).

UNEP Definition of 'Sustainable and Resilient Infrastructure'

Sustainable and resilient infrastructure -- *defined as infrastructure that integrates environmental, social and governance (ESG) aspects into a project's planning, building and operating phases while ensuring resilience in the face of climate change or shocks* – is capable of making the difference:- it improves the attractiveness of infrastructure investments by mitigating risks, creating tangible benefits and opportunities as well as reducing emissions and climate risks.

(UN Environment Program Inquiry/GIB Working Paper, June 2016)

Task Force on Climate-related Financial Disclosures

The **concept of climate resilience** involves organizations developing adaptive capacity to respond to climate change to better manage associated risks and seize opportunities, including the ability to respond to transition risks and physical risks.

(https://www.fsb-tcfd.org/wp-content/uploads/2017/06/FINAL-TCFD-Report-062817.pdf)

There have been efforts to help define 'resilience' by fixing reasonable resilience targets -- for instance by ensuring that the Average Annual Loss (or AAL -- expected loss per year linked to the happening of future disasters/hazards) is less than a certain percentage (say below 2 percent) of the capital investment. Also, for example, with respect to infrastructure for flood mitigation, an analysis can be carried out for different levels of resilience – that is, the greater and stronger is the flood defence wall, more would be the cost, but greater would be the AAL reduction. Besides, mainstreaming risk metrics into public and private investment planning systems would also advance the concept of resilience. [7]

Global Frameworks and Discussions

Since investing in resilient infrastructure has long-term benefits, such an approach can be seen in many international pacts; like the Sendai Framework for Disaster Risk Reduction (SFDRR) 2015-2030 – which was the first major agreement of the post-2015 development agenda. The SFDRR identifies 'investing in Disaster Risk Reduction (DRR) for resilience and to build back better in reconstruction as priorities for action towards reducing disaster risk'. In many ways, the SFDRR forms the basis for countries to ensure a network of financing to build resilient and quality infrastructure.

Sendai Framework

This framework recognizes that investment in Disaster Risk Reduction (DRR) cannot only prevent and reduce losses but also build economic, social, health and cultural resilience of the society more broadly. These can generate several developmental co-benefits and be the "drivers of innovation, growth and job creation."

According to the Sendai Framework, investing in DRR for Resilience requires the following:

- Predictable mechanisms at all administrative levels to finance disaster risk reduction strategies, policies and plans;
- Disaster risk transfer and insurance, risk-sharing and retention and financial protection, for both public and private investments;
- Development or revision of building codes and standards, and mechanisms for their enforcement to foster a disaster-resistant built environment;
- Mechanisms to promote disaster-resilient public and private investments, particularly through structural, non-structural and functional disaster risk prevention and reduction measures in critical facilities, in particular schools and hospitals and physical infrastructures;
- Mainstreaming of disaster risk assessment, mapping and management into development planning, natural resources management and preservation of ecosystems;
- Social safety-net mechanisms, including through community involvement, integrated with livelihood enhancement programmes;
- Protection of sites of historical, cultural heritage or religious significance;
- Protection of livelihoods and productive assets, including livestock, working animals, tools and seeds; integration of disaster risk management into business models and practices.

(*Source*: http://www.npdrr2-mha.net.in/technical-session3.php)

The Sendai Framework states that in order to reduce the financial impact of disasters on Governments and societies, in urban and rural areas, efforts should be made to promote mechanisms for disaster risk transfer and insurance, risk-sharing and retention as well as financial protection for public and private investment. On international cooperation and global partnership, the Framework states that it is critically important to ensure financing from a variety of international sources, in addition to transfer of reliable, affordable, appropriate and modern environmentally sound technology on concessional and preferential terms. It also mentions the importance of capacity-building assistance for developing countries. Further, the Framework suggests that "international financial institutions, such as the World Bank and regional development banks, (should) consider the priorities of the present Framework for providing financial support and loans for integrated disaster risk reduction to developing countries."[8] A major factor that drives focus towards making infrastructure disaster-resilient is the increase in hydro-meteorological disasters as a result of climate change. As public infrastructure sectors (including energy, transportation and telecommunication) could attract a majority of investment in developing countries such as India in the near future, it is important to make them resilient also from the point of view of ensuring effective post-disaster response as well.[9]

A detailed assessment of disaster risk is a must to ensure resilience and sustainability of projects as well as their proper financing. As per the takeaways from a discussion held on the sidelines of the New Development Bank Annual Meeting in 2017, short-term and medium-term risks include the risks impacting operation and maintenance. These risks are (i) lesser than expected users of the project, (ii) interest rate fluctuations, (iii) and employee strikes and public protests. Issues related to these risks usually gain more importance than long-term risk components.

The cost of ensuring resilience -- through future-ready design and standards -- may seem to be a big amount during planning stage. However, from a long-term perspective, it would be beneficial to go for disaster resilient infrastructure if planners take into account the costs regarding operation, maintenance and repair over the entire life of the infrastructure.

Importance of Data Collection and Analysis

In order to collect and analyse time-series data, it is crucial to build a system that lays importance not only on the frequency of occurrence and impact of big natural disasters and hazards, but also on the minor ones, as that would help assess risks on the basis of the probability of their occurring in the future. Such an analysis would give investors an additional level of comfort while making huge investments in infrastructure projects. The investors should be given access to this data.

However, lack of reliable data on past hazards and natural disasters is a major concern in this regard. Regarding climate change-influenced disasters (including the hydro-meteorological ones), it is important to carry out analysis of the past hazards as well as the potential dangers in future to be on the safer side in terms of risk assessment. Such an analysis will also help in undertaking recovery and reconstruction measures, and to ensure that the newly built structures and systems are better than the ones destroyed by disasters. To ensure this, the standards for structural design, operation, maintenance and risk assessment as well as concerned regulatory norms and the professionals working in the sector would have to be up-to-date with the latest knowledge on natural disasters and the related innovative technologies. On their part, the lenders should keep regular track of design standards along with disaster risk assessment measures.[10]

Considering that investments in infrastructure have long-term liabilities and relatively high risks, another important factor that is essential for attracting greater investments into the sector is ensuring that institutions are effective, accountable and transparent. Besides, the legal and regulatory environment regarding contract enforcement, dispute settlement and protection of property rights should be credible and stable.

In all, even as development of infrastructure has been identified as a priority area by most nations to meet SDGs, sustainability and resilience criteria should be integrated into infrastructure projects right from the conceptual stage. In addition, developing common standards across countries to assess infrastructure sustainability and resilience may also help address current infrastructure investment barriers.[11]

Finance-Related Innovations

Low-carbon Climate Resilient (LCR) infrastructure development is a challenge that most nations face not only due to enormous funding requirements, but also due to the fact that low-cost public finance needs to play a vital role, particularly in the initial stages usually hampered by several risks. While the political will to adopt stable and credible policies on building resilient and sustainable infrastructure is vital, there is a need to strengthen institutional capacity to develop a pipeline of financially viable project proposals. Developing institutional capacity to negotiate Public Private Partnerships (PPP) on a transparent and win-win basis is also important.

Also crucial is bringing on board private players committed to stay invested on a long-term basis through partnerships with established long-term players such as the Multilateral Development Banks (MDBs), other (national and regional) Development Financial Institutions, pension funds and sovereign wealth funds, to work on various models of innovative financing for resilient and sustainable infrastructure.

Though funding must be substantially augmented, blindly going in for massive investments would not be a panacea to address resilience and sustainability related deficiencies in infrastructure. What can lend a hand would be a resolute action through policy reforms by incorporating environment and sustainable development in the short-term, mid-term and long-term plans as well as budgeting processes. This can be done, for instance (as being already institutionalised and implemented in some countries), through measures such as gradually phasing out wasteful subsidies (in areas such as fossil fuels) and imposition of 'green taxes' that can help boost government revenues. Greater revenues can, in turn, lead to enhanced expenditure towards building resilient and sustainable infrastructure. 'Green taxes' would also help in reducing harm to environment. 'Green tax' or 'environmental tax', as defined by the OECD, is "a tax whose tax base is a physical unit, or a proxy of it, which has a proven specific negative impact on the environment. Four subsets of environmental taxes are distinguished: energy taxes, transport taxes, pollution taxes and resources taxes."

Greening Finance

In addition, incentives should be given to encourage financial system to play its part. To ensure greater investment flow towards building LCR infrastructure, it would also be germane to consider development of 'green banks' (a public entity using limited public capital to bring in private investment into local LCR infrastructure) and 'green bonds' (fixed income, liquid financial instruments used to mobilise funds for climate-adaptation, mitigation and other environment-friendly projects).

The green bond issuance -- aiming to boost environment-friendly projects by bringing down their costs -- is slowly becoming a trend. According to law firm Linklaters, green bond issuance across the globe has touched a new record of $29.64 billion in the first quarter of 2018 -- breaching the previous high of $29.5 billion in the third quarter of 2017. The law firm also found that globally, there was a 64% jump in green bond issuances to $107.4 billion in 2017 from the figures

India's Disaster Management Strategy

India's National Disaster Management Plan (DMP) is in alignment with the Sendai Framework's objectives. The Disaster Management Act, 2005, mentions the requirement of two categories of funds – for disaster response and disaster mitigation. These include a Disaster Response Fund (DRF) as well as a Disaster Mitigation Fund (DMF) each at the national, state and district levels.

According to the National Platform for Disaster Risk Reduction (DRR), the Fourteenth Finance Commission made a recommendation for "development and scientific validation of the Hazard Vulnerability Risk Profiles of States." Presumably, these Profiles would become a basis for risk reduction financing in the future. In the absence of such a mechanism, the DRR is being financed currently through a State's regular finances or through large multi-state programmes, such as the National Cyclone Risk Mitigation Programme. Immediate disaster response is funded through the State DRF and the National DRF, , the National Platform for DRR said. It added that the disbursements from these funds follow norms laid out by the Government of India. These norms specify the kinds of activities – mostly immediate response – that can be supported from

National and State DRFs. "The disasters covered have been specified. States can exercise some flexibility in providing relief for disasters that are not covered. Although long-term recovery and reconstruction is not covered by these norms, there is provision for cash assistance for fully damaged or destroyed houses. After major disaster events, reconstruction and recovery are often funded through external financing." Currently, in order to finance the recovery and reconstruction following a disaster, the state governments rely on the Central government. Therefore, it is important to look at various aspects of risk finance to augment the state government's ability to respond to the financial needs in the wake of a disaster in a cost-effective manner. Also, according to the National Platform for DRR, India's built environment – housing, public buildings, social infrastructure, physical infrastructure -- is changing rapidly. "With regards to disaster risk, this change is characterized by two trends: first, higher rate of growth in hazard prone areas leading to increasing exposure to natural hazards; and second, increasing proportion of the capital stock that is more vulnerable or susceptible to damage from natural hazards. Both these trends do not augur well for the future of disaster risk in the country." Therefore, the built environment needs to be carefully regulated to arrest and reverse this trend. In post-disaster reconstruction, some state governments have accomplished this successfully, the Platform said.

Also, even though as per Section 47 of the Disaster Management Act 2005, the Central Government may constitute a National DMF for projects exclusively for the purpose of mitigation, this Section has not been notified by the Government so far. The Central Government said it feels that currently, there are sufficient schemes to take care of mitigation measures in different projects, and, therefore, the need for creation of separate National DMF has not been felt.

UNESCAP's Concerns and Suggestions

Resilient infrastructure – especially in the form of all-weather rural roads that are built to link these remote areas with the rest of the country – has benefitted from a policy innovation, which is the cess on motor spirit and high speed diesel. Building flood-resilient infrastructure is also crucial for India as the country was among the worst hit by the monsoon rains / floods in 2017; with 30 million Indians being adversely impacted by the rains / floods. The floods "damaged and destroyed homes, schools and health facilities, while many areas became inaccessible due to damage to hundreds of kilometres of roads and railways, as well as bridges and airports. The floods also brought several major cities to a standstill. The total costs of the 2017 monsoon season in South Asia were estimated to be around $1.2 billion," the UNESCAP said. The August 2017 floods in Mumbai, deemed India's financial capital, caused economic losses worth over $500 million. "The need to take comprehensive measures to strengthen Mumbai's preparedness for, and resilience to, future flooding events remains paramount. Stakeholders have stressed the need to look beyond engineering solutions – although these will have a vital role to play – and pursue urban planning that allows for a greater role for green spaces and nature-based solutions," it added. According to the UNESCAP, "Secondary and cascading effects from infrastructure failures often occur: for example, in the aftermath of cyclone Aila in India, access to safe drinking water was substantially reduced. Inadequate infrastructure can also limit access routes for disaster response efforts and evacuations." It further stated that, "Access to high-quality infrastructure is closely linked to the lower impacts from flooding events. Infrastructure can help build the absorptive and adaptive capacities of flood-affected communities. To do so effectively, infrastructure must be planned, designed, constructed and maintained with due consideration of current and future hazards, taking a systems approach."

(***Source:*** *http://www.unescap.org/sites/default/files/publications/SDG_Resilience_Report.pdf*)

of 2016. The leading countries include China, France and the United States. However, in the first quarter of 2018, the leaders were Belgium, Indonesia, Luxembourg, China and Canada.[12] What is also helping expand this market is the Green Finance Taskforce recommending that the United Kingdom Government should issue a green sovereign bond to help finance national green projects such as the United Kingdom's flood defence and resilience.[13] Besides, the European Commission High-Level Expert Group on Sustainable Finance had come up with several suggestions including: (i) a classification system to provide market clarity on what is 'sustainable', (ii) ensuring clarity regarding the duties of investors on ways to achieving a more sustainable financial system, (iii) improvement in disclosure by financial institutions and companies on factoring in sustainability into their decision-making, (iv) an European Union-wide label for green investment funds, (v) making sustainability part of the mandates of the European Supervisory Authorities, and (vi) a European standard for green bonds. [14] Such recommendations could be considered for implementation by countries by fine-tuning them to their respective needs. However, governments need to keep in mind that stakeholders, including investors and environmentalists, are looking at every country's track-record, including commitments and inconsistencies, on green issues and sustainability. This came to the fore when some investment managers opted not to buy into Poland's green bond due to that country's reliance on coal for electricity.[15]

Infrastructure including fossil-fuel-consuming transportation, power plants and buildings account for a majority of the greenhouse gas emissions, and therefore needs to be upgraded to LCR-status. A sizeable portion of the required climate finance would be from the public sector, while private entities would also have to pitch-in with matching amounts. The developing countries, including India, are banking on the commitments made by the developed nations to mobilise $100 billion of climate finance annually until 2020 from various sources (public, private, multilateral, bilateral and alternative sources) towards climate finance to support the developing world to bring down emissions and strengthen resilience to adverse impacts of climate change. The Paris Agreement had said that a fresh and higher target would be fixed by 2025.

To push investments into sustainable and resilient infrastructure projects, it is important to include such projects in the development agenda of each country and then integrate them with their respective Nationally Determined Contribution in line with the Paris Agreement. What can also help is evolution of climate resilient and sustainable designs for infrastructure projects, and assessing impact of each proposal from the point of view of environment and resilience from disasters, besides periodically evaluating climate vulnerability of the projects being developed as well as completed. A risk-transfer concept that can be considered is 'parametric insurance solution' -- which adopts a payout model that enables quicker payment (vis-a-vis traditional insurance), since it does not require loss adjusters following natural disaster. This is being tried out in countries like Brazil.[16] It would also be important to consider disaster risk transfer instruments like catastrophic bonds.[17]

In its activities including in countries such as India, the Japan International Cooperation Agency (or JICA, which is among the world's largest bilateral aid agency supporting socioeconomic development in developing countries) follows the Sendai Framework for DRR 2015-2030. JICA's four-pronged strategy includes understanding disaster risk (improving public awareness and changing mindset of the people involved through training), enhancing disaster risk governance structure to better manage risks, investing in disaster risk reduction for resilience and augmenting preparedness for effective response, as well as the 'Build Back Better' policy in recovery, rehabilitation and reconstruction for ensuring quality infrastructure.[18] JICA has been advocating

that investing in high quality infrastructure – which is stable, sustainable, resilient and benefiting many people -- is itself a risk mitigation solution.

International Platforms

The joint statement brought out by Multilateral Development Banks (MDBs) committing to work with client countries to help them strengthen their governance of sustainable infrastructure, including around planning, prioritizing, budgeting and disclosure is another important initiative to help take coordinated action towards financing sustainable infrastructure as well as harmonising standards. The statement further mentions that efforts to support countries by means of project-preparation facilities and capacity building would be enhanced.[19] In this regard, the MDBs and private players have formed a joint global initiative called SOURCE to "foster the development of sustainable projects that contribute to the implementation of the United Nations 2030 Agenda globally and strengthen cooperation among global infrastructure stakeholders – multilateral development banks, development-financing institutions, investors, consultancy firms, contractors and lenders."[20] This effort is coordinated by the Geneva-based Sustainable Infrastructure Foundation (SIF).[21]

One method that 'shifts the social costs of climate change to the source of the pollution' is carbon pricing. It encourages polluters to bring down emissions and make investments in clean energy and low-carbon growth. This idea is taken forward by Carbon Pricing Leadership Coalition (CPLC) – a voluntary partnership currently comprising 42 national and 25 sub-national jurisdictions, and accounting for about half of the global economy as well as over 22 percent of global emissions. The Coalition, whose secretariat is administered by the World Bank, includes civil society organisations and businesses. The carbon pricing initiatives implemented or scheduled for implementation so far would encompass almost half of global carbon dioxide emissions, as per the CPLC.[22] To take forward the carbon pricing concept, the CPLC would be holding conferences, including in India, to discuss issues such as financing sustainable development with carbon pricing and fiscal aspects of carbon pricing. Already, several companies, including from India, have joined the CPLC and are moving forward with carbon pricing as a climate-risk management tool. These firms are also engaging with stakeholders including the government.[23]

To facilitate global transition to a low carbon economy, over 360 investors managing assets worth over $24 trillion have joined hands to form an online platform called 'the Investor Platform for Climate Actions' to record actions carried out by international investors to tackle climate change. The Platform's action areas include 'measurement' (carbon footprinting of portfolios), 'engagement' (with fossil fuel and energy intensive companies) and 'reallocation' (including investment in low carbon assets and shifting capital from emissions intensive activities).[24] The Platform is encouraging investors to act on policy advocacy as well. Therefore, Governments across the world will have to keep track of these developments and consider proposals from them on a merit basis as inputs for policy making on resilient and sustainable infrastructure.

As per the Task Force on Climate-related Financial Disclosures [or TFCD -- established by the Financial Stability Board (or FSB, an international agency monitoring and bringing out suggestions on the global financial system)], adopting resilience in operations presents many opportunities -- including improving efficiency, designing new production processes and developing new products. Such opportunities, according to the TFCD, are relevant for organizations with long-lived fixed assets or extensive supply or distribution networks -- those that depend critically on utility and infrastructure networks or natural resources in their value chain; and those that may

Sustainable and Resilient Infrastructure: India's Needs and its Efforts to Meet the SDGs

As per the World Bank, about 60 percent of India's landmass is prone to earthquakes of varying intensities; over eight percent is susceptible to floods; almost 5,700 kilometres of the 7,500 kilometres coastline is prone to cyclones and 68 percent of the area is susceptible to drought. The average losses suffered by India annually due to multi-hazard disasters are worth around $9.8 billion, of which the average annual losses due to floods alone are $7.4 billion (i).

It is estimated that India would experience an increase of 1-1.5°C in mean annual air temperature from 2016 to 2045 – a phenomenon that can result in flooding and huge damage to infrastructure. The overall government spending on developing capacity and adaptation to climate change in India was $ 91.8 billion in 2013-14 alone. This spending would have to reach $360 billion (in 2005 prices) by 2030. For India, the adaptation gap, in real terms, could be more than a trillion US$ from now until 2030, and it could increase substantially beyond 2030 (Amit Garg, Vimal Mishra and Hem Dholakia, 2015). As per an International Finance Corporation study, India's overall climate-smart business investment potential is estimated at $2.1 trillion (2016-2030). This includes potential investment in renewable energy of more than $320 billion, and low-carbon, climate-resilient investments in transportation sector (ports, rail, roads, and other critical infrastructure) another $250 billion opportunity by 2030. The green building market in India presents an opportunity of more than $1.4 trillion by 2030 (ii).

According to India's submissions on Intended Nationally Determined Contribution (INDC), the country would require around $206 billion (at 2014-15 prices) between 2015 and 2030 for implementing adaptation actions in agriculture, forestry, fisheries infrastructure, water resources and ecosystems. Besides, there would be additional investments needed for strengthening resilience and disaster management. India's INDC cited an Asian Development Bank study (on assessing the cost of climate change adaptation in South Asia) to state that the approximate adaptation cost for India in energy sector alone would be roughly about $7.7 billion in 2030s. The ADB report projects economic damage and losses in India from climate change to be around 1.8 percent of its GDP annually by 2050. Also, as per India's submission, estimates by NITI Aayog (National Institution for Transforming India) indicate that the mitigation activities for moderate low carbon development would cost around $834 billion till 2030 at 2011 prices (iii).

The submission said the objective of the government's Smart Cities Mission is to develop new generation cities that will provide core infrastructure and a decent quality of life to its citizens by building a clean and sustainable environment. Smart solutions like recycling and reuse of waste, use of renewables, and protection of sensitive natural environment would be incorporated to make these cities climate resilient. Besides, under the Atal Mission for Rejuvenation and Urban Transformation (AMRUT) scheme, adoption of climate resilient and energy efficient policies and regulations has been incorporated. In the endeavor towards a low carbon economy, India is focusing on low carbon infrastructure and public transport systems like Dedicated Freight Corridors and energy efficient railways to reduce their impact on environment. Besides, as part of its 'climate finance' policies, reduction of fossil fuel subsidies, increasing coal cess and introduction of tax free infrastructure bonds for funding of renewable energy projects, have been carried out.

According to India's Voluntary National Review report on the SDG implementation (presented to the High-Level Political Forum on Sustainable Development, New York / July 2017), under the head 'Goal 9: Build resilient infrastructure', it was mentioned that all forms of transportation - roads, railways, civil aviation and waterways - are being rapidly expanded. Road connectivity and electricity are being brought to all villages, it said, adding that thus far, 70 percent of targeted rural habitations without road connectivity have been connected with all-weather roads. Development of 37 national waterways is planned over the next three years, and it will help reduce logistics-related costs and environmental impact. Besides, 8,000 km of pavements and cycle tracks would be laid in 106 cities

over the next five years to promote non-motorized transport and reduce the carbon footprint. Then there is the Bharat Broadband Network initiative with an aim to provide high-speed broadband connectivity to all village councils in the country. Citing a consistent growth in installed electricity generation capacity over the last five years, it points out that the installed capacity in non-fossil-fuel sectors has grown by 51.3 percent, and more than doubled in the renewable energy sector (solar, wind, bio- and small hydro power). The report states that the government has set an investment target of Rs 25 trillion ($390 billion) for infrastructure development during 2016-2019. "Efforts are being made to mobilize additional resources. For instance, the monetization of 75 publicly funded highway projects of value Rs 356 billion ($5.6 billion) *via* the toll-operate-transfer mode, will finance the construction of 2,700 km of roads. Moreover, the Indian Railways is setting up an Rs 350 billion ($5.5 billion) Railways of India Development Fund to serve as an institutional mechanism for raising funds from the market," the report says.

i: https://mha.gov.in/MHA1/Par2017/pdfs/par2015-pdfs/rs-290415/65.pdf
ii: https://www.ifc.org/wps/wcm/connect/51183b2d-c82e-443e-bb9b-68d9572dd48d/3503-IFC-Climate_Investment_Opportunity-Report-Dec-FINAL.pdf?MOD=AJPERES
iii: http://www4.unfccc.int/ndcregistry/PublishedDocuments/India%20First/INDIA%20INDC%20TO%20UNFCCC.pdf

require longer-term financing and investment. Stating that publication of climate-related financial information in mainstream annual financial filings would help ensure that appropriate controls govern production and disclosure of the required information, the TFCD had recommended that organizations should make financial disclosures in accordance with their national disclosure requirements.[25] A May 2018 report by the University of Cambridge Institute for Sustainability Leadership (CISL) found that though around two-thirds of G20 member states were engaged with the TCFD suggestions in some form, others including India, Argentina, Indonesia, South Korea, Russia and Saudi Arabia had no formal engagement with the TFCD. On India, the report said though the capital market regulator Securities and Exchange Board of India (SEBI) had introduced a requirement to bring out business responsibility reports for the top 100 listed entities in 2012, (which was increased to the 500 largest listed companies in 2016), the CISL was not able to find evidence of specific TCFD-compliant initiatives.[26]

Technological Innovations and Standards

Numerous innovations have sprung up as the result of an increased spending on research and development both by the public and private sectors. Catalysing this trend of innovations is SDG 9 bringing greater focus on the resilience aspect of infrastructure related to connectivity, especially the Information and Communications Technologies (ICT) and transport.

Moreover, the Asian Development Bank (ADB) has recommended that countries must go in for climate-change resilient infrastructure, as rise in sea level and extreme weather can damage infrastructure as well as affect its longevity and performance. Therefore, measures including elevating road embankments, relocating upstream water intake and treatment works, and enhancing design and maintenance standards should be adopted. What can also help are embracing innovative processes, as well as new or improved equipment / materials in construction and operations, which would reduce lifecycle cost, increase durability and improve long-term performance (such as more efficient energy and material consumption; the "3Rs" -- reduce,

reuse, recycle).[27] According to the World Bank, protecting road infrastructure from extreme climatic events leads to positive impact on rural areas – that is income to farmers increasing by 20 percent, literacy rate increasing by 10 percent, and there is an improvement in the health of rural communities. This can be done by integrating climate and disaster risk management agenda at stages including strategic planning, operation and delivery. Design innovations in this regard can include climate resilient and environmentally optimized road designs using local and marginal materials, industrial by-products like quarry and mining wastes and fly-ash, sand deposits transported during floods as an alternative to hard stones. Such innovations can lead to economic and environmental benefits (such as savings in construction costs over conventional methods) as well as reduction of consumption of scarce natural aggregates.[28]

While planning to spend huge amounts to build world-class infrastructure, it is important to incorporate global standards on resilience and sustainability. One of the initiatives in this regard that can be studied is SuRe -- the multi-stakeholder, inclusive, transparent, accessible and holistic standard for sustainable and resilient infrastructure -- jointly led by Global Infrastructure Basel (GIB) and Natixis, and supported by multilateral organisations and public sector bodies [OECD, European Investment Bank (EIB), ICLEI, CREAM Europe and FOEN], financiers (Erste Bank Group and Mirova), the IDFC Foundation (Infrastructure Development Finance Company Ltd, India's leading integrated infrastructure financier), non-governmental organizations (NGOs) and civil society (WWF and GIP Pacifico) and consultants (BASE, FIDIC, CAPEC and Quantis Switzerland). The SuRe Standard -- developed as per the norms of the ISEAL Alliance (the umbrella organisation of private sustainability standards) -- will assess environmental, social and governance (ESG) performance and impact of infrastructure projects, and identify those with a positive impact. Verification and certification of infrastructure projects would be carried out by independent experts.[29] Then there is also the World Standards Cooperation -- a high-level collaboration between the IEC (International Electro-technical Commission), ISO (International Organization for Standardization) and ITU (International Telecommunication Union). Besides, there is the UN Office for Disaster Risk Reduction (UNISDR), which incidentally is already collaborating with India's National Disaster Management Authority (NDMA) on activities related to the implementation of the Sendai Framework for the DRR.

Building Climate-Resilient Cities

Infrastructure planning in each country needs to take into account its vulnerability to natural disasters and accordingly incorporate innovative disaster resilience mechanisms during design, implementation and maintenance of such projects. Also worth noting is that the world's population residing in urban areas has gone up to 54.3 percent from 33.5 percent in 1960 (World Bank, 2016). By 2050, an estimated 66 percent of the global population would be urban (UN, 2014) – with people eying greater job opportunities, higher incomes and better delivery of services such as health and education in urban areas. Several countries, including India, are developing or mulling proposals on Smart Cities. City governments in most countries are now concerned about the impact of climate change and are looking at ways to address emerging challenges.

Therefore, it is essential to consider certifications for them on the lines of 'climate-resilient cities' (cities having institutional, structural, social, and economic capacity to withstand the impacts of climate change. Also, these are cities with response mechanisms that have a focus on preparing for extreme climate events such as storm surges, landslides, and floods). Incidentally, several Indian cities are already holding discussions on climate resilience plans. They aim to effectively manage and bring down the adverse impacts of climate change by identifying and understanding risks and vulnerabilities as well as through institutionalisation and mainstreaming of climate resilience

India's Performance and Initiatives on Innovation

Though India was placed 60th overall out of 127 economies in the Global Innovation Index (GII) 2017, it has improved its ranking (up 14 spots to 73rd) in the 'infrastructure' parameter –including Information and Communications Technologies or ICT (where India was 80th), general infrastructure (India – 32nd), and ecological sustainability (India – 103rd). "Good and ecologically friendly communication, transport, and energy infrastructures facilitate the production and exchange of ideas, services, and goods and feed into the innovation system through increased productivity and efficiency, lower transaction costs, better access to markets, and sustainable growth." The ICT sub-pillar included ICT access (India was 106th), ICT use (India – 109th), online service by governments (India – 33rd), and online participation of citizens (India – 27th). The sub-pillar on 'general infrastructure' included the average of electricity output in kWh per capita (India – 94th); a composite indicator on logistics performance (India – 34th); and gross capital formation (India came a strong 12th) comprising outlays on additions to the fixed assets and net inventories of the economy including land improvements (fences, ditches, drains), plant, machinery, and equipment purchases, as well as construction of roads, railways, schools, offices, hospitals, private residential dwellings, and commercial/industrial buildings. The sub-pillar on ecological sustainability included: GDP per unit of energy use (a measure of efficiency in the use of energy) (India was 65th), and the Environmental Performance Index (EPI) – 'ranking countries on 20 performance indicators tracked across policy categories covering both environmental public health and ecosystem vitality. These EPI indicators gauge how close countries are to established environmental policy goals' (on this, India was ranked a poor 103rd), and the number of certificates of conformity with standard ISO 14001 on environmental management systems issued (India – 69th)" (i).

Innovation in disaster resilience is being prioritised by the government. Among the outcomes of the National Platform for Disaster Risk Reduction meeting was that standards, codes and manuals need to keep pace with the state-of-the-art engineering technologies for disaster resilient infrastructure. Also, science and technology applications, Geographical Information Systems, geological-geographical and hydrological research capacities to assist and improve risk and vulnerability assessments as well as mitigation measures of natural hazards need to be promoted. Besides, there should be an integrated approach to disaster risk reduction through technology. Digital platforms have to be robust and resilient to cyber attacks for them to be effective. There was also a suggestion that roads should be built after modelling of flood risks, especially the valley areas and the bridges. In addition, structural as well as non-structural measures should be adopted to ensure infrastructure resilience. Early warning systems based on surface deformation in landslide prone area should be set up, and structural safety of old bridges should be monitored (ii).

Cities including Visakhapatnam and Chennai are gearing up to be smart and resilient cities. For instance, Vishakhapatnam has adopted a strategy to ensure sustainable energy availability and a disaster management system based on the ICT infrastructure including early warning and evacuation systems. Chennai, hit by floods, also has adopted the use of ICT for disaster management systems in addition to a strategy to conserve urban ecology and watershed based drainage management as well as creation of the post of a 'Chief Resilience Officer' to coordinate multi-departmental dialogue and convergence. What would also help other parts of India is the use and involvement of local expertise to generate context specific locally driven solutions (iii).

Another important step in this context is asking developers of economic corridors to submit their findings on climate change and resilient infrastructure to the Government of India, State Governments and the Urban Climate Change Resilience Trust Fund, which has provided a grant of $5 million and technical assistance worth $1 million. Also, State Governments are to adopt an urban resilient infrastructure policy to contain the losses of any natural calamity by 2020. (iv)

i: file:///C:/Users/RISC172/Downloads/gii-full-report-2017.pdf
ii: http://www.ndmindia.nic.in/images/pdf/Second-Meeting-of-National-Platform-for-Disaster-Risk-Reduction.pdf
iii: http://grihaindia.org/grihasummit/tgs2016/presentations/19feb/post-disaster-resettlement/Raina_Singh.pdf
iv: http://niti.gov.in/writereaddata/files/coop/India_ActionAgenda.pdf

strategy and planning by involving communities. What is also helping is the learning from global initiatives such as C40 Cities Climate Leadership Group, ICLEI's Resilient Cities, Global Resilience Partnership, the ACCCRN framework, Asia Pacific Network's CAPaBLE program and the '100 Resilient Cities' pioneered by the Rockefeller Foundation.[30] However, these efforts need to be further strengthened through in-depth and proactive participation from stakeholders, especially from local communities and the government.

Way Forward

Long-term global growth projections present an optimistic scenario. The World Bank (June 2018) has said that "for the first time since 2010, the long-term (10-year-ahead) consensus forecast for global growth appears to have stabilized." [31] Massive infrastructure investment programmes are being planned in many countries to meet the developmental demands. However, considering the concerns on climate change and disasters, it is important to improve vastly efficiencies in resource use while targeting higher economic growth. Higher resource use efficiency can only be achieved through innovations in institutional mechanisms, technology and finance. Detailed criteria on resilience and sustainability should be built into the government procurement procedures for infrastructure projects.[32]

Besides, there should be stakeholder consultations to find out whether infrastructure projects would attract a sense of local ownership. This can be achieved through a process, where the observed and the expressed needs of local communities are taken into account and where opportunities for the local stakeholders are identified. Such a process, in turn, will ensure inclusiveness and sharing of benefits in an equitable manner. Merely focusing on the infrastructure construction component would pose a risk to the sustainability of the project, especially since sustainable and resilient infrastructure calls for integration of environmental, social and governance factors into the planning of projects.

For example, a holistic approach of 'sustainability of outcomes, process and resources' was adopted in the North Eastern Region Community Resource Management Project for Upland Areas (NERCORMP) in India --funded and supported by the International Fund for Agricultural Development (IFAD). Here, it was observed that "infrastructure development such as road construction and maintenance is linked with the expansion of cash crop production and market linkages." The IFAD study reported, "A core strategy in the project extension period has been seeking increased convergence between NERCORMP activities and government initiatives. A major example of this relates to the National Rural Employment Guarantee Scheme, whereby centrally funded infrastructure projects will be planned through Village Employment Councils in line with local priorities..." On the future maintenance and repairs to existing structures, which was identified as a problem area for many development projects, the study pointed out that the "respondents expressed full confidence that these tasks would take place, primarily because the infrastructure installed responded to community priorities for which they invested heavily." [33]

Key Considerations Relating to Infrastructure and Resilience Include:

- A need to focus both on improving resilience of infrastructure itself and how infrastructure would impact community resilience and livelihood;
- Critical infrastructure may include social infrastructure;
- The need for resilient infrastructure is global, but the greatest need tends to be in low-income countries;
- There is a need to engage both men and women, separately if needed, noting that woman's voice in decision-making is often lost / not respected unless measures are introduced to ensure that this does not happen;
- A critical aspect of resilience is how individual structures interact at an infrastructure system scale as well; and
- Infrastructure often lasts a long time, so climate and disaster risks should be considered over the full lifespan, which means infrastructure must be planned as part of the wider climate resilient, low carbon development strategy.

Source: Gallego-Lopez, C.; Essex, J. (with input from DFID) Designing for infrastructure resilience. Evidence on Demand, UK (2016)

Regarding the resilience factor, what can help is a global coalition – on the lines of the Asian coalition proposed by India -- to promote disaster resilient infrastructure. Such a coalition would help "generate knowledge regarding hazard risk assessment, disaster resilient technologies and mechanisms for integrating risk reduction in infrastructure financing." Besides, a globally accepted risk mapping and categorisation of hazards -- including floods, cyclones, chemical hazards and forest fires – should be developed on the lines of what India has done in the case of seismic zones. Such a move would help develop a common understanding of the nature and severity of disaster risks across the world and plan for developing resilient infrastructure.[34] This approach can then be fortified through a 'multi-dimensional' approach (addressing the present and emerging risks, in addition to improving the recovery of infrastructure systems following disasters) as well as a 'multi-disciplinary' strategy with the help of experts from related fields, including disaster risk management, engineering, operation and maintenance, data collection, standards setting, and finance.

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Embedding Innovations in Institutions,Technology and Modalities

Introduction: Financing Innovation for Sustainable Development

Embedding innovations in institutions, technology and modalities has emerged as an overarching paradigm in public policy and governance to mitigate challenges of the 21st century in the areas of development and sustainability. New technologies like Internet-of-Things (IoT) may be used to connect a wide range of devices such as vehicles, mobile devices, sensors, industrial equipments, power generation and manufacturing machines etc. to develop varied smart systems including smart city and smart home, smart grid, smart industry, smart vehicle and also smart health-care, smart agriculture and smart environmental monitoring. For example, the smart grid connects energy source, flow meter, and appliance. The smart grid optimizes energy use (cheaper and greener energy) of businesses, public transport and individuals and rationalises production and distribution of energy.

Resource-intensive economic growth has led to environmental degradation, climate change, pollution and depletion of natural resources. Sustainable practices are being mainstreamed to mitigate these challenges. Physical infrastructure is central to economic growth. Therefore, the infrastructure sector is a key focus for achieving sustainable development. In future, infrastructure would have to be less resource-intensive, energy-saving (and running on renewable energy), resilient and sustainable in facing new environmental challenges. It is imperative that infrastructure caters to all and it should be inclusive. New innovations are believed to be the only way forward for resilient and sustainable infrastructure; and in promoting innovation-driven infrastructure would be crucial in this regard.

While, governments play a major role across countries in creating physical infrastructure, demand for sustainable infrastructure along the lines described above is huge; and governments alone cannot meet these needs. Scope of funding of infrastructure in digital, transport, housing, renewable energy etc. by private players remains underutilized. For example, in the case of telecom infrastructure for mobile connectivity, most investments were largely financed through private funds raised from a variety of players in the market[1]. While, the governments use tax and budgetary transfers for infrastructure financing, private sector might have to rely on capitalization of user fees to cover infrastructure costs and borrowings. Much of this lending comes from multilateral development banks (MDBs), foreign and domestic financial institutions and private equity firms. It also, importantly, includes insurance and pension funds in the case of relatively mature domestic economies. Such funds offer particular advantage of longer term lending.

The Government of India has introduced multiple institutional and financial innovations in the infrastructure sectors in the form of innovative financial vehicles such as Infrastructure Debt Funds, Infrastructure Investment Trusts (InvITs), Real Estate Investment Trusts (REITs), Alternative Investment Funds, and new models of Public Private Partnerships (PPPs). So far as PPPs are concerned, the Government of India has tried out monetization of publicly funded highway projects under Toll-Operate-Transfer (TOT) model and construction and expansion of over 60 highway projects under Hybrid-Annuity-Model (HAM). Under TOT model functions of operation, maintenance and collection of fee is assigned for a 30 year concession period to financial investors and developers against upfront lump sum payment to the Government. The Hybrid-Annuity-Model (HAM) for road construction involves government sharing 40% of construction costs initially with the private sector.

Mitigating climate change: role of technology

The international climate change regime by and large is defined by the norms and procedures of the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol, among others. The international technology oriented agreements to address climate change may fall in the following four categories— 1) knowledge sharing and coordination; 2) research, development and demonstration; 3) technology transfer; and 4) technology deployment mandates, standards, and incentives. The most prominent initiatives in the area of technology transfer are— i) the Multilateral Fund under the Montreal Protocol and ii) Global Environment Facility (GEF). The provisions for technology transfer are driven primarily by a need to help developing countries in following a less GHG-intensive development path through access to climate-friendly technologies and through funding support to cover additional cost.[2] The multilateral technology transfer agreements addresses issues of technology adoption and capacity- building, apart from filling resource gaps in developing countries. Evidence suggests that most technology requirements of developing countries towards climate change mitigation are either in sustainable energy or sustainable agriculture.

The environmental effectiveness of the Montreal Protocol Fund has been substantial in achieving desired level of technological diffusion. Asia, in general (including countries like China and India), and South East Asia and Asia-Pacific in particular have significantly benefitted from the projects under this fund. Also, the performance of the GEF (a joint initiative of the UNDP, UNEP and the World Bank), which operates on a smaller scale, has been satisfactory. The GEF has facilitated developing countries' access to new technologies and project financing at a low cost. The GEF is generally financed from the Official Development Assistance (ODA) flows.

It has been suggested that low carbon technology transfer is at the forefront of international climate negotiations. The promise of access to new technologies is widely recognized as a major incentive for developing nations coming on board in the UNFCCC. However, many countries are not satisfied with the progress in achieving technology transfer so far.[3] A particular area of concern and disagreement between the developed and the developing countries is on the issue of Intellectual Property Rights (IPRs). While developed countries stress on strong IPR protection of new technologies in developing countries; developing countries squarely focus on the question of access. Some experts have identified that with low levels of IPR protection in developing countries, transfer of technologies could be difficult.

Innovation for Resilient and Sustainable Infrastructure: Roads, Urbanization and Mobility

Roads are most important of all connectivity infrastructures, connecting ports, urban centres, regions, and remote areas in difficult terrains. Existing roads have to be widened to accommodate traffic, quality of all roads new and old has to be improved even in remote areas to make them durable; and green codes have to be implemented in construction, maintenance, lighting and traffic mobility. New innovations are effective in this regard. The Prime Minister of India recently inaugurated the Eastern Peripheral Expressway (EPE) connecting highways from the eastern side of Delhi. This is the first Expressway in the country to use solar power on the entire length of 135 km. There are eight solar power plants on this Expressway with a capacity of 4000 KW (4 megawatt) for lighting underpasses and running solar pumps for watering plants. Rainwater harvesting has been installed, and plants are drip irrigated all along the expressway. Rapid urbanization exerts pressure on housing, rehabilitation of slums, fresh water supply, sewage, living environment and public health. Cities are the centres of economic activity with maximum contribution towards national income. Cities that support large populations within limited geographical areas are prone to greater damage due to disasters. Therefore, high quality, resilient and sustainable urban infrastructure, covering public transport systems, waste management, housing, renewable energy, smart technologies for efficient management of cities are proposed as tools of urban management. Efficient management of cities with the use of new-age technologies form the template for 'Smart Cities'. Smart Cities is a promising concept as it places robust integration and efficient distribution as the defining principle.

In the context of urbanisation, it is important to note that along with agglomeration benefits like economies of scale, there could be serious negative externalities in the form of congestion. Technology has enormous scope to guide agglomeration and at the same time minimise congestion to lower social and economic costs. This would be possible through coordinated use of smart devices and big data analytics with precision acumen on demand and supply. Such predictive capacities of advanced computing and interconnected devices and systems would be hugely effective for water supply systems, solid and liquid waste management, transportation and traffic. Application of such technologies are giving visible results. Overall, with the efficient allocation of natural and physical resources in urban spaces, it is likely that resource and carbon footprints of cities would be reduced. Additionally, technology driven early warning and evacuation systems can help cities enhance their disaster management capabilities.

Urban transportation is undergoing rapid transformation across the globe to meet challenges of environmental sustainability and the need for greater connectivity. Transportation is one of the key areas of innovation that has a bearing on a low carbon future and increased well-being of citizens. Multi-modal Mass Rapid Transportation Systems (MRTS) appears to be a promising solution to ever-increasing traffic in major cities of the world. Besides roads, metro rail system, mono rail, rapid metro, high-speed railway (HSR), waterways, amphibious mobility have emerged as new modes of public transportation in many countries of the world. The IoT and host of other digital technologies would be leveraged fully for integrating various modes of transportation and by introducing technology-led solutions like smart cards for seamless movement between different modes of transportation. New technologies like IoT and Artificial Intelligence are expected to provide necessary backbone for integrated transport through autonomous operations and adjustments to peak- traffic requirements.

Inclusive Innovation and opportunities in digitalization

In urban infrastructure, it is important that investments and innovations do not contribute to furthering inequities in accessing basic services and goods. Urban development often leaves out the marginalized sections of the society and their needs are either not addressed or addressed through mechanisms that are market- based. Studies show that access to water, energy and housing on the one hand and access to services like education, health-care on the other hand have an impact on standard of living and well-being. Access is one component, and it is essential that access is equitable and inclusive. Inclusion here means that facilities and services are made available to different categories of users, including physically challenged, the poor and women. Although innovations may appear to be neutral and accessible, they may not be so in reality. On account of factors like high cost, scale and adaptability, certain sections may be excluded from using innovations or accessing them.

In case of infrastructure, there are a number of studies that indicate multiple inequities contributing to unequal access and utilization. Infrastructure needs of poor neighborhood and areas where poor and immigrants are concentrated may not get priority in planning or in adopting innovations. The lack of access to energy can also result in lack of access to energy-efficient lights etc. Similarly in case of health services and education, adoption of innovations may be delayed or simply denied.

Responsible Research and Innovation (RRI) framework, which finds its genesis in the policy debates of the European Union (EU), in relation to science and society interface primarily in the developed world emphasizes on ethics, social relevance, access to scientific information and public engagement. In the Indian context, Access, Equity and Inclusion (AEI) framework has been pursued to evaluate Science and Technology (S&T) policy and outcomes. The significance of these perspectives lie in incorporating and improving discourses on technology-led exclusion, discrimination and socio-economic disparities. The AEI framework should help in understanding how access is linked to innovation and infrastructure and also help in mapping inequities in access, equity and inclusion in the urban areas. More importantly it can be used to sensitize on the need to be aware of factors that exacerbate current inequities.

Digital technologies offer enormous opportunities towards achieving economic inclusion within a shorter time span.[4] The scale of AADHAAR- based intervention in India is much larger than similar efforts elsewhere. The Aadhaar programme has already achieved number of milestones, and is by far the largest biometric based identification system in the world. Aadhaar is used as a unique identification number, and facilitates financial inclusion of the underprivileged and weaker sections of the society, and is therefore a tool of distributive justice and equality. Aadhaar identity platform with its inherent features of Uniqueness, Authentication, Financial Address and e-KYC, enables Government of India to directly reach citizens in delivery of subsidies, benefits and services by using resident's Aadhaar number only. Some of the other key initiatives include India BPO Promotion Scheme, Software Procurement Policy for faster delivery and effective monitoring of services, Tele-law through Common Services Centers (CSCs) to mainstream legal aid in rural India, among others. The CSCs have been effectively used to reach out to the last mile and bridge the gaps between the urban sector and rural sector.

Innovation for Localization – Implication of Technology Regimes

Technological change implies technological learning, improvements in cognitive abilities of the workforce and firm-level adoption and adaptation of technologies leading to productivity gains. Immediate effects in terms of technical change may be in the form of minor innovations which are equally important as the source of productivity improvement as major jumps in the frontier. The IPR regimes greatly facilitate and influence extent of technological learning that a country achieves. For developing countries, appropriate IPR regime would encourage spontaneous technological learning and catch-up. In many of the developed nations, in the initial stages of development a not-so-strong IPR environment helped rampant industrialization.

Evidence indicates that stronger IPR in the South accelerates the rate at which multinational production is transferred to Southern countries.[5] However, this may not be uniformly true for all products/sectors of production.[6] Multinationals are more likely to respond to changes in the IPR regime when products have longer life cycles (e.g. in automobiles) suggesting lagged imitation risks in the South that get further minimized due to stronger intellectual property protection. In segments, where life-cycle of products is short (computers and electronics), imitation risks are low and hence there may not be any perceptible change in the behavior of multinationals in response to changes in the provisions of the IPR laws. This is likely to be to be true for most of the new technologies in the class of Industry 4.0.

The optimum level of patent protection remains a puzzle. It is generally accepted that although patents create incentives for innovations, it could potentially limit chances of innovation through extended monopoly. The patent system needs to be vigilant towards IPRs posing a hindrance to innovation and it should not suppress innovation potential of developing countries. Jeopardizing local innovation capabilities could come at a cost for the developing world and may hamper local supply of knowledge. Hence, a private rights driven model would end up supplying globally sub-optimal level of knowledge. While, Trade Related Intellectual Property Rights (TRIPS) secured an overwhelming mandate for itself, the balance between IP rights, innovation and developmental priorities appear nonetheless elusive.

The fundamental issues around Industry 4.0 going ahead will be capability to produce; ability to connect; and capacity to use. Policy framework ignoring any one of these would result in sub-optimum and even adverse outcomes. It is noted that the trade policy regime in the form of Information Technology Agreement (ITA) might have generated unequal gains across countries and led to reduced production of ICT goods in many countries, including India. China has benefitted most among developing countries. On the other hand, most knowledge underlying Industry 4.0 would eventually be proprietary and would potentially be owned by a few companies based in selected countries. Integration into new age supply chains, information networks, data repository would be critically linked with access to relevant knowledge in other countries and societies. Innovation systems fostering widespread innovation under Industry 4.0, technology pooling and open source models across countries are highly desirable.

SDGs and UN Mechanisms on Technology Transfer

The year 2015 was a milestone in global partnership for development and sustainability. Following the adoption of the much hailed global compact in the form of the Agenda 2030 for Sustainable Development and the underlying Sustainable Development Goals (SDGs), world leaders also agreed on the Paris Climate Agreement. Implementation of the SDGs, which comprise

interconnected goals practically covering all aspects of economic and social development , is slated to be hugely challenging. This essentially suggests that the developed world has to embark on a path of sustainable production and consumption, and the developing countries would have to balance their unmet developmental needs against environmentally sustainable pathways. No doubt, the advanced countries have easier access to resources and technology, the dual means of implementation identified by the Agenda 2030.

Technology holds the key in defining and designing sustainable pathways. To ease difficulties faced by developing countries in this regard, some countries (led by India, Brazil and France) while negotiating the Agenda 2030 came up with a novel idea, which was finally adopted, known as the Technology Facilitation Mechanism (TFM). This new initiative under the auspices of the UN is being developed as a nodal centre that can consolidate similar efforts by other UN agencies, serve as an informational hub of innovations and create a platform of stakeholder engagements. The work on operationalising this facility is in progress and careful audit of conceptual, systemic and institutional challenges are being carried out. Regional assessments, initiatives, models and templates may be used in shaping global technology transfer regimes. The institutional barriers impeding technology transfer has to be overcome through appropriate negotiations and partnerships between countries and stakeholders. New models based on mutual benefit have to be developed. In this context, existing international technology transfer frameworks and the new TFM under the UN are expected to facilitate implementation of the SDGs. The scope of cooperation in strengthening this architecture as well as to devise means to benefit from it is significant.

The UN has undertaken several initiatives over the years to address the challenge of technology gap between developed and developing countries for environmentally sound technologies. Notable among these are the following— The Multilateral Fund under the Montreal Protocol; the Climate Technology Centre and Network of the UNFCCC; National Cleaner Production Centre Initiative; Green Industry Platform; the GEF; and the Green Climate Fund (the GCF). The Green Climate Fund was started in 2011 under the UNFCCC to promote the shift towards low-emissions and climate-resilient development pathways. The GCF secretariat is hosted in South Korea.

Way Forward: Collective role of MDBs in Futuristic Infrastructure and Innovation

Benefits of use of the Industry 4.0 vintage of technologies would be far reaching in terms of infrastructure development towards:

- public health monitoring and prevention;
- efficient management of water supply, irrigation, solid and liquid wastes;
- agriculture, soil health, land planning, cropping pattern, food security and reduction of food waste;
- housing, habitat and transport planning;
- monitored energy consumption and use
- entrepreneurship and innovation;

These point towards centrality of technology and innovation in achieving sustainable development and in fulfilling targets placed under the Agenda 2030 and the Sustainable Development Goals (SDGs).

Industry 4.0 is still in its early phase. There are apprehensions that massive use of technology would replace human labour with significant social impact. However, it is also suggested that immediate employment effects of Industry 4.0 may not be linear given long -term comparative advantages of demography and labour endowment in some countries and disadvantages of ageing population in others. While it is imperative that governments, institutional investors, MDBs and the private sector should strive towards promoting the flow of new technologies; much would depend on specific country contexts and associated technology choices. Therefore, it is also likely that operational feasibility, financial viability, and societal scope of infrastructure development spanning transportation, connectivity, urban amenities etc. would be determined through big-data analytics.

The MDBs have played a very important role in providing concessional finance and technical assistance to developing countries. Yet, development gaps are widespread and economic growth is uneven. Performance of Emerging Economies is impressive but dangers of the 'middle income trap' are real. Infrastructure needs are not static given aspirations of higher economic growth. This is coupled with additional demands of retro-fitting and replacing older infrastructure, new age mobility and urbanization projects that are smart, sustainable and resilient, transition to renewable energy and clean and green industrialisation. Innovation has widened technological options much faster in recent decades. However, access to innovations and capacity to innovate are not uniform across countries and regions.

The MDBs signify collective efforts at resource mobilisation and have sophisticated institutional apparatus to channelize resources to critical sectors which have strong multipliers and interconnections with economic growth, development and sustainability. However, global needs of development finance are much beyond the capacities of MDBs alone, and thus partnerships and collaborations would be important. Nevertheless, the MDBs have higher credit credentials and bigger clout than other institutions to influence resource and knowledge flow. To influence future trajectory of sustainable development, it is not only resources but also knowledge and innovation that would be critical. New innovations are expected be 'cost-saving' either from a static or a dynamic perspective. Such costs include physical costs, environmental and social costs.

It is imperative, therefore, to encourage innovation and knowledge flow. It has been argued that commitments on the access to new technologies are central for developing nations to participate in climate negotiations. However, such commitments to technology transfer are not strictly followed by advanced countries. Perceptions on rights and access over knowledge are divergent between developed and developing countries. Therefore, older regimes and standard approaches need to be re-evaluated when it comes to knowledge- sharing in order to bring down transaction costs in knowledge. The MDBs can collectively influence markets and global regimes to minimise bottlenecks in technology transfer and support innovation ecosystems ,which in turn, would thrive on technology flow, knowledge exchange, innovation networks and knowledge spill-over.

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