Global Economy and Development at BROOKINGS

THE NEW CLIMATE ECONOMY
The Global Commission on the Economy and Climate

Grantham Research Institute on Climate Change and the Environment

# Delivering on SUSTAINABLE INFRASTRUCTURE for Better Development and Better Climate


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DECEMBER 2016

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The Global Commission on the Economy and Climate, and its flagship project The New Climate Economy, were set up to help governments, businesses and society make better-informed decisions on how to achieve economic prosperity and development while also addressing climate change. The project is undertaken by a global partnership of research institutes and a core team led by Programme Director Helen Mountford.

The Grantham Research Institute on Climate Change and the Environment was established in 2008 at the London School of Economics and Political Science. The Institute brings together international expertise on economics, as well as finance, geography, the environment, international development, and political economy to establish a world-leading centre for policy-relevant research, teaching and training in climate change and the environment. It is funded by the Grantham Foundation for the Protection of the Environment, which also funds the Grantham Institute for Climate Change at Imperial College London. More information about the Grantham Research Institute can be found at: http://www.lse.ac.uk/grantham/

## *Acknowledgments*

This paper was produced as a part of and provides a synthesis of findings of the "Better Finance, Better Development, Better Climate" project, a collaborative initiative amongst experts from several organizations (Brookings, Grantham/LSE, McKinsey, WRI, CPI, and ODI) under the umbrella of the New Climate Economy (NCE). The project was co led by Amar Bhattacharya, Jeremy Oppenheim and Nicholas Stern. Josh Meltzer served as the project manager. The paper draws on the following outputs of the project:

Bhattacharya, Amar., Chattopadhyay, Soumya., & Nagrah, Aatika. (forthcoming). *Framework for Assessing the Role of Sustainable Infrastructure*. Washington DC: Brookings Institution.

Bhattacharya, Amar., Oppenheim, Jeremy., & Stern, Nicholas. (2015). Driving Sustainable Development through Better Infrastructure: Key Elements of a Transformation Program. *Global Economy and Development Working Paper* No. 91. Washington, DC: Brookings Institution.

Bielenberg, Aaron., Kerlin, Mike., Roberts, Melissa., & Oppenheim, Jeremy. (2016). *Financing Change: Mobilizing Private Sector Financing for Sustainable Infrastructure*. McKinsey and Company.

Chapman, Sarah., Inouye, Lauren., Smith, James., & Toriello, Carlos. (2016). Infrastructure for sustainable development: Central America renewable energy case study. IWANA.

Delgado, Christopher., Wolosin, Michael., and Purvis, Nigel. (2015). Financing Conservation and Restoration of Degraded Agricultural and Forest Landscapes in Developing Countries. *NCE Working Paper.* New Climate Economy.

Meltzer, Joshua P. (2016). *Financing Low Carbon, Climate Resilient Sustainable Infrastructure: The Role of Climate Finance and Green Financial Systems*. Washington DC: Brookings Institution.

Nakhooda, Smita., Watson, Charlene. (2015). Adaptation finance and the infrastructure agenda. London: Overseas Development Institute.

Qureshi, Zia. (2016). *Meeting the Challenge of Sustainable Infrastructure: The Role of Public Policy*. Washington, DC: Brookings Institution.

Sahoo, Anshuman, Nelson, David., & Goggins, Andrew. (2015). Models for Financing Clean Infrastructure in Middle Income Countries. *CPI Working Paper*. San Francisco: Climate Policy Initiative.

This paper was made possible with support from, among others: UK Aid from the UK government, the government of Norway, the government of Sweden, the Children's Investment Fund Foundation, and Bloomberg Philanthropies. The views expressed here do not necessarily reflect the opinions or official policies of these institutions. Brookings and NCE recognize that the value they provide is in their absolute commitment to quality, independence, and impact. Activities supported by donors reflect this commitment and the analysis and recommendations are not determined or influenced by any donation.

This project contributed to the 2016 work program of the NCE, and in particular a draft of this report was the principal input to the most recent GCEC report *The Sustainable Infrastructure Imperative, Financing for Better Growth and Development*.

In addition to the inputs from the wider NCE team under the direction of Helen Mountford (Programme Director, NCE), we are grateful for the extensive feedback from, and interactions with many, over the course of preparing this report and in the numerous engagements in taking forward the agenda on sustainable infrastructure. We would especially like to acknowledge the support received in the production of the report especially from Aatika Nagrah (Brookings) and Merrell Tuck-Primdahl (Director of Communications, Global Economy and Development, Brookings).

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December 2016

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## *List of Abbreviations*

| | |
|---|---|
| AfDB | African Development Bank |
| AIDC | Africa Infrastructure Country Diagnostic |
| AsDB | Asian Development Bank |
| ASEAN | Association of Southeast Asian Nations |
| AUM | Assets under management |
| BCIE | Central American Bank for Economic Integration |
| BNDES | Brazilian Development Bank |
| BOAD | West African Development Bank |
| CAF | Andean Development Corporation |
| CCS | Carbon Capture and Storage |
| DBSA | Development Bank of South Africa |
| DFIs | Development Financial Institutions |
| EBRD | European Bank for Reconstruction and Development |
| EIB | European Investment Bank |
| EMDCs | Emerging Markets and Developing Countries |
| GCEC | Global Commission on the Economy and Climate |
| GHG | Greenhouse Gas |
| IADB | Inter-American Development Bank |
| ICT | Information, Communications, and Technology |
| INDCs | Intended Nationally Determined Contributions |
| IsDB | Islamic Development Bank |
| KfW | Kreditanstalt fuer Wiederaubau |
| LCR | Low carbon, climate resilient |
| LICs | Low income countries |
| LDCs | Least Developed Countries |
| NCE | New Climate Economy |
| NDBs | National Development Banks |
| NPV | Net Present Value |
| OOFs | Other Official Flows |
| MDBs | Multilateral Development Banks |
| OECD | Organisation for Economic Cooperation and Development |
| PIMA | Public Investment Management Assessment |
| PIM | Public Investment Management |
| PPIAF | Public-Private Infrastructure Advisory Facility |
| PPPs | Public Private Partnerships |
| PPFs | Project Preparation Facilities |
| PTA Bank | Eastern and Southern African Trade and Development Bank |
| SDGs | Sustainable Development Goals |
| SDSN | Sustainable Development Solutions Network |
| TCO | Total Cost of Ownership |
| TFP | Total Factor Productivity |
| WHO | World Health Organization |
| WBG | World Bank Group |

## *The new global agenda and sustainable infrastructure*

2015 was a milestone year in which the world set clear and ambitious objectives through the Third International Conference on Financing for Development in Addis in July; the UN Summit in September that adopted the Sustainable Development Goals and the 2030 development agenda; and the COP21 in Paris in December that resulted in the milestone climate agreement. The three central challenges now facing the global community, as crystallized in 2015, are to reignite global growth, deliver on the sustainable development goals (SDGs), and invest in the future of the planet through strong climate action. At the heart of this new global agenda is the imperative to invest in sustainable infrastructure.

As an essential foundation for achieving inclusive growth, sustainable infrastructure underpins all economic activity. Inadequate infrastructure remains one of the most pervasive impediments to growth and sustainable development, and consequently in tackling poverty. Good infrastructure unshackles and removes constraints on economic growth and helps increase output and productivity. Investment in sustainable infrastructure can help generate employment, boost international trade, industrial growth, and competitiveness while reducing inequalities within and among countries.

Sustainable infrastructure also holds the key to poverty reduction and societal well-being in part because it enhances access to basic services and facilitates access to and knowledge about work opportunities, thus boosting human capital and quality of life. Sustainable infrastructure helps reduce poverty and extreme hunger, improve health and education levels, assist in attainment of gender equality, allows for the provision of clean water and sanitation, and provides access to affordable energy for all.

Sustainable infrastructure promotes sustainable consumption, production, and resource utilization to ensure that habitats and settlements are resilient, and that ecosystems and marine resources are used in a sustainable manner. On the one hand, it enhances food security through more efficient resource use and reduces vulnerability to environmental shocks. On the other, bad infrastructure can and does kill people on a large scale mainly via air and other pollution, and puts pressure on land and natural resources to an extent that may compromise the viability of future generations and create unsustainable economic burdens in the future.

How we undertake the massive investments that are needed will have an enduring impact on climate resilience. The existing stock of infrastructure and its use accounts for more than 60 percent of the world's greenhouse gas (GHG) emissions. The scale of the new investments that must be made offer a unique opportunity for accelerating the transition to an economy based on low-carbon energy, but, if not done well, also pose a great danger of locking in capital, technology, and patterns of economic activity that will last for decades and become progressively unsustainable.

Ramping up ambition as well as spending on sustainable infrastructure is particularly timely, given the global macroeconomic context and the slowdown in growth and declines in investment in all regions, and when other policy instruments are highly constrained. First, monetary policy is reaching its limits. Second, fiscal policy is constrained as well: those with fiscal space seem reluctant to use it and most do not have fiscal room for maneuver. Third, while supply-side structural reforms are important, their effects take time. A fourth means of jumpstarting growth at this juncture is public-private investments in sustainable infrastructure. In the near term, such spending can stimulate demand at a time when many countries have been hit by economic contraction and the commodity slump. In the medium term, investment in sustainable infrastructure can augment and improve the efficiency of energy, mobility and logistics—thereby boosting productivity and competitiveness in all sectors and spurring the domestic

drivers of growth. It can also unlock waves of innovation and creativity. And it underpins the only sustainable long-term growth path on offer.

## *Scale and urgency of the challenge*

The next twenty years are of crucial importance. Massive investments will be needed in energy development, sustainable cities, transport corridors, water and waste management, and telecommunications. There are three key drivers of the projected infrastructure investment needs. First, many advanced economies will require large investments to rehabilitate existing infrastructure that has long been neglected due to under-investment. Accelerating the replacement of aging infrastructure offers an opportunity to improve the sustainability footprint and give greater impetus to the low-carbon transition. Second, there has been a major shift in the global economy with emerging and developing countries (EMDCs) growing at higher rates and now constituting a greater share of the global economy and of global growth. Third, given big infrastructure deficits in most EMDCs and structural changes underway such as rapid urbanization, changes in economic structures, and a rising middle class, investment rates in infrastructure are projected to increase in most parts of the developing world, with the notable exception of China. In particular, the urban population will increase from around 3.5 billion now (50 percent of $7+ billion) to around 6.5 billion by mid-century (70 percent of 9+ billion). This is a once in history transition.

In this paper, we use the conventional definition of core infrastructure, including power, transport, water and waste, and telecommunications. We do not include social infrastructure such as schools and hospitals, nor primary energy production or investments in energy efficiency. Global investment in core infrastructure has increased by US$1 trillion per annum over the past decade to around $3.4 trillion per annum in 2015. The bulk of the increase has been in EMDCs, led by China. Investment in sustainable infrastructure needs to increase even further. Total investment requirements in core infrastructure (for delivery on expected growth and structural change) over next 15 years are estimated to be on the order of $80 trillion (or around $5-$6 trillion on average per annum). This is much more than the current existing stock.[1] The Global Commission on the Economy and Climate (GCEC) 2014 report estimates that an additional $30 trillion or so will be needed over the next 15 years for energy efficiency and primary energy production. One way or the other, most of this infrastructure will get built, but how it is done will have a crucial bearing on outcomes for growth, development, and climate.

Seventy percent of the projected investment needs for sustainable infrastructure will be required in EMDCs, with countries other than China accounting for most of the increase. With rapid population growth, particularly in cities, investment requirements in Africa will grow particularly fast. Power and transport account for 60 percent of the investments needed and are the most important for accelerating the low-carbon transition. Significant investments are also needed in water and sanitation to improve access and adapt to the impacts of climate change. A majority of these investment needs will be accounted for by cities.

An important insight from the GCEC 2014 report is that, while there are upfront costs to ensure sustainability of infrastructure investments to be consistent with the goal of maintaining an upper limit whereby planetary warming is kept to 2 degree Celsius or lower, important offsetting savings will result from such investments as well. This is due to reduced capital expenditure from fossil fuels (power plants),

[1] The GCEC 2014 report had estimated total infrastructure spending between 2015 and 2030 at around $90 trillion including investments in energy efficiency and primary energy. Of this around $57 trillion was for core infrastructure. This study estimates total spending on core infrastructure at around $80 trillion largely because of higher spending requirements in emerging markets and developing countries.

compact cities, and more efficient transmission and distribution. Taken together, according to GCEC 2014, the total incremental infrastructure investment needs are $4.3 trillion for the 2015-2030 period (or around 5 percent of the total investment requirements). However, a low-carbon scenario will entail a major shift in the composition of investments towards low-carbon and climate resilient sectors such as renewable energy, nuclear, Carbon Capture and Storage (CCS), transport, water/sanitation, as well as adaptation infrastructure to better withstand climate change impacts. Altogether around $1 trillion per year is expected to be needed for zero or very low-carbon core infrastructure, mostly for the energy generation and transportation sectors (excluding energy efficiency), representing 18 percent of core infrastructure. Other spending also needs to be reoriented towards greater sustainability and climate resilience.

About 70 percent of the increase in currently projected future emissions will be associated with infrastructure yet to be built. This estimate is based on projected investment trends. If these investments are in line with those made in the past, the 2 degree Celsius target will be out of reach, with grave risk of ecosystem collapse, massive human displacement, unlivable cities, and a plummet in growth.

The Paris Agreement recognizes the need to ramp up ambition. Current pledges for national action as reflected in countries' intended nationally determined contributions (INDCs) would yield emissions of around 55-60 gigatonnes of equivalent carbon dioxide (GtCO2e) per annum in 2030, an improvement on the business-as-usual (BAU) scenario (estimated at 65-68 GtCO2e per annum). However, keeping to 2 degrees Celsius or lower would require GHG emissions of around 40 GtCO2e or less per annum by 2030, depending on the assumed path of emissions thereafter. Recognizing this gap, the Paris Agreement underscores that peak emissions must happen "as soon as possible". It also agreed on conventions for measurement and verification and committed all parties to meet every five years to look at progress towards meeting nationally determined contributions (NDCs) with a view to enhancing levels of ambition.

The window for making these choices is uncomfortably narrow. On the one hand, we cannot underestimate the dangers of delay because of lock-in of dirty and long-lasting infrastructure and the ratchet effect of flow-stock processes, i.e. emissions to concentrations. On the other hand, there is much clearer recognition now, as evidenced in Paris and given the very swift movement from agreement (December 2015) to entry into force of the Paris Agreement (November 2016), of both the immense risks and great attractions and opportunities that lie in low-carbon climate-resilient growth. The time for ramping up actions is opportune. Long-term interest rates are at record lows and there are major untapped sources of finance. Rapid technological change offers prospects for developmental breakthroughs that hold promise for climate-friendly outcomes (for example by building smart cities and scaling up distributed solar power). And there is growing recognition of the importance of decarbonization and new commitments to it by advanced countries as well as developing countries.

The opportunity to shape the new infrastructure provides a unique opportunity to change direction. The next twenty years are decisive in world history: there is deep responsibility as well as great opportunity.

## *Impediments to the delivery of sustainable infrastructure*

Investments in sustainable infrastructure are lagging behind the needs described and those that are being made are not as sustainable as they should be. This is partly because such infrastructure is long-term, requires large upfront investments, and generates cash flows only after many years. Typically, sustainable infrastructure investments are complex, subject to high risks, especially in the initial phases, vulnerable to policy and political risks, and require appropriate regulation. Even if revenues do not cover costs, indirect externalities and social benefits may be large but difficult to measure. Consequently, markets alone cannot provide effective infrastructure services and private investments often cannot be realized without some form of public support.

While these attributes affect investment decisions and outcomes in both developed and developing countries, EMDCs face additional limitations. First, policy and institutional gaps are greater. In particular, many countries lack a coherent and trusted legal and institutional framework, institutional capacities are under- developed, and governance is often weak. Many countries lack effective public private partnership (PPP) frameworks and implementation capacity. Government-induced policy risks both during the implementation and operating phases remain a common impediment to infrastructure investments by the private sector. Second, many countries lack the policies and institutions to set a clear direction for future investments and generate a viable pipeline of projects. Implementation tends to be subject to greater delays and higher costs. Third, EMDCs also face greater difficulties in mobilizing long-term finance and the costs of financing are much higher than what is available in developed countries. Fourth, infrastructure investments worldwide face sustainability gaps. Investment decisions are affected by major price distortions, notably pervasive fossil fuel subsidies, the absence of carbon pricing, and the inadequate regulation or costing of pollution. These price distortions greatly affect the incentives to invest in low-carbon technologies, especially given the low prevailing prices for fossil fuels.

While the broader impediments to infrastructure investment are now better recognized, there is little attention even in the G20 to incorporating sustainability criteria into investment planning and project selection. Higher investment costs, higher financing costs, and higher sustainability costs act as a vicious cycle to impede the quantity and quality of infrastructure investment.

There are five major barriers that inhibit financing going to infrastructure in general, and these are magnified for sustainable infrastructure:

*Lack of transparent and bankable pipelines:* Governments often fail to develop long-term plans, so future infrastructure needs are unknown and there is little to guide potential investors as how the system as a whole might develop. Second, even when long-term plans exist, the pipeline may not be clearly communicated to investors (only half of the G20 countries publish infrastructure pipelines, for example).

*High development and transaction costs:* Inefficient bidding and procurement processes discourage private investment. Many transactions are tailored to each individual project, so standards are often diverse and inconsistent. Transaction and development costs for sustainable infrastructure projects may be even higher, because limited data on financial and risk performance makes deal evaluation more complicated.

*Lack of viable funding models:* A major constraint to attracting investment in infrastructure is funding risk or adequacy and certainty on the ultimate source of revenues for an infrastructure project. One reason for this is that is particularly pertinent in middle- and low-income countries is that users are unwilling or unable to pay high enough charges to allow full cost recovery. Also, investors often expect a higher return because of actual or perceived risks. For sustainable infrastructure projects, the matter is even more complicated. Even when sustainable infrastructure is net present value (NPV)-positive over its lifetime, such projects can have higher upfront costs, and positive externalities such as cleaner air or fewer emissions are difficult to calculate, much less monetize.

*Inadequate risk-adjusted returns:* Many investors do not invest in infrastructure simply because it does not offer competitive risk-adjusted returns, particularly if perceived risks are high. Sustainability complicates the risk-return issue because the technologies and platforms are often new. Also, because sustainable infrastructure often requires more upfront capital, the risk is that much higher.

*Unfavorable regulations and policies:* Regulations on investment limits, capital adequacy, reserve requirements, the valuation of assets and liabilities, and limits on foreign investment can discourage investors from making longer-term and cross-border investments. Uncertainty around tax policies, particularly in middle- and low-income countries, depresses infrastructure investment because it makes it difficult to project long-term net cash flows. In addition, tax policies may not be structured to reward

longer-term investment choices or reflect the lower climate-related risks associated with sustainable and resilient infrastructure.

Tackling these impediments will require concerted and mutually reinforcing actions along four dimensions of policy and finance:

*First*: to **eliminate pervasive fossil fuel subsidies and adopt carbon pricing,** thus improving incentives and generating revenues to enable the investments needed in sustainable infrastructure. **Regulation** can play an important complementary role especially in curbing the use of coal and dealing with air and other pollution.

*Second*: to **provide a stable policy environment and strengthen investment frameworks,** thus helping to deliver a concrete pipeline of viable and sustainable projects, reducing high development and transaction costs and attracting the private sector.

*Third*: to **tackle the gaps in the availability and costs of long-term finance,** both in the upfront and operating phases. Mobilizing both long-term debt finance and the large pool of institutional investor assets can boost confidence. Additionally, the **greening of the financial system** through increased transparency and sharper focus on climate risk can tilt incentives towards sound investments and improve access to financing for more sustainable projects.

*Fourth*: to **strengthen cooperation on technology development and deployment,** especially on clean energy and energy efficiency.

Of critical importance in all of these areas are the credibility, clarity, and consistency of policies. The transition to the low-carbon economy in the context of urban development and technological change presents huge investment opportunities. There is no shortage of world savings, but major obstacles in transforming investment opportunities into real investment demand exist, as do difficulties in bringing forward the right kind and scale of finance at the right time. This requires strong government policy, but as well as the active involvement of multilateral development banks (MDBs) around supporting investment.

## *Tackling fundamental price distortions*

Correcting pervasive distortions in the pricing of natural resources and infrastructure services is essential to improving the public policy environment for sustainable infrastructure. Of critical importance are the distortions from fossil fuel subsidies and the lack of carbon pricing, which strongly bias infrastructure investment towards high-carbon energy sources and leads to huge damage from air and other pollution. Also, such subsidies and distortions discourage the development of cleaner energy technologies, undermine efficiency in energy use, and cause seriously harmful environmental impacts. Tackling these distortions offers huge potential for additional public revenues that can be used for better purposes, including for meeting the large financing needs for sustainable infrastructure and targeted social spending. The IMF has estimated that the total cost of energy subsidies, including the failure to price in negative externalities in terms of pollution and climate change impacts, was $5.3 trillion in 2015, or 6.5 percent of world GDP. Elimination of fossil-fuel subsidies would reduce global CO2 emissions by more than 20 percent, cut premature deaths from air pollution by more than half, and could generate substantial fiscal gains of $2.9 trillion (3.6 percent of world GDP in 2015).

While the removal of fossil-fuel subsidies would have global benefits by reducing carbon emissions, the bulk of the gains would accrue locally through environmental and fiscal benefits. Several countries are taking steps to remove or reduce fossil-fuel subsidies, especially taking advantage of prevailing low petroleum prices. More than 30 countries have taken action to phase-out these subsidies since 2013. This

diverse group of countries includes both some major consumers and producers of fossil fuels, such as Angola, Egypt, Ghana, India, Indonesia, Iran, and Mexico—and most recently Saudi Arabia. However, fossil-fuel pricing reform needs to go much further, not only to remove explicit fiscal subsidies, but also to begin to address implicit subsidies relating to the damages caused by pollution and carbon emissions. The G7 has recently announced their commitment to eliminate all support for fossil fuels within a decade. This can form the basis for more ambitious commitments in the G20 and beyond.

Fundamental to public policy action is to incentivize lower-carbon investment by putting a price on carbon emissions. Doing so would align the price paid by carbon users with the very large social costs of emitting carbon. Pricing carbon also serves as a market mechanism to influence the behavior of producers and consumers. It raises revenues and can reach all sectors. Regulation can also play an important role, such as through instituting environmental standards in energy and transport. Carbon prices in existing arrangements vary considerably, ranging from less than $1 to $130 per ton of CO2 equivalent, but with the majority of emissions priced at less than $10 per tCO2e, well below the price that economic models estimate is needed to meet the goal of keeping to 2 degrees Celsius or lower. A transition to a broad pricing regime with greater coverage of emissions, and at higher prices, will be needed.

Looking ahead, more than 90 countries included some form of carbon-pricing schemes among the actions they intend to take as part of their INDCs submitted in Paris. This is a welcome development. The momentum for mitigation action following the Paris agreement provides an opportunity to develop stronger consensus, support, and coordination across countries on instituting carbon pricing, including progress towards establishing a carbon pricing corridor with a price floor and a rising price over time. The OECD and the World Bank have developed a set of principles that can help guide future carbon pricing arrangements. The Carbon Pricing Leadership Coalition launched at COP21 can help bring together leaders from governments, cities, the private sector and civil society to share lessons and push for more ambitious actions.

Pricing reform is not limited to the energy sector. Distortions are widespread in the pricing of other natural resources and infrastructure services, including for water. Governments should review pricing across sectors to better align them with economic fundamentals. And the equity objectives often offered as argument for subsidized pricing can usually be achieved much more effectively by careful targeting.

## *Strengthening investment frameworks*

The public sector has a central role in guiding infrastructure investments – both because of the extent of direct investment by the public sector and because public policy is essential in setting up the necessary investment framework that can encourage private sector involvement and support from MDBs. The role of public policy in creating a stable and predictable policy and regulatory environment is particularly important to enable a large increase in private sector investment. Even in the presence of a robust private sector, direct public investments will continue to play an important role, such as in rural roads and water management. Also, the public sector will need to provide necessary balance sheet support to meet the viability gap in private investments. Moreover, public policy is needed to create the incentives that direct investors toward sustainable projects instead of toward carbon-intensive projects.

Countries should articulate clear and comprehensive strategies for sustainable infrastructure and embed them in overall strategies for sustainable and inclusive growth and development. National strategies should inform, and be supported by, strategies in key infrastructure sectors and subnational jurisdictions that are important providers of infrastructure. Only such integrated strategic frameworks will ensure coherence across public policy actions and investments, facilitate coordination across sectors and levels of government, and provide the clarity and confidence to private investors so that they will do their part. Sustainable infrastructure plans, to varying degrees, form part of the intended nationally determined contributions (INDCs) countries announced in the lead-up to the Paris meeting. More than 180 countries

submitted such national climate action plans. An important outcome of the Paris meeting is an agreed process to verify progress on implementation and review action plans every five years with a view to strengthening them to achieve the climate goals. It will therefore be important for countries to reflect and integrate their INDCs in overall national growth and development strategies.

Together with improving the environment to mobilize more private investment, public investment will need to be ramped up to meet the projected large growth in infrastructure demand and address the challenge of sustainability. Increased investment will need to be supported by substantial enhancement of public investment management capacities to ensure efficiency and impact and integrate sustainability objectives in investment programs and projects. This presents a particular challenge in EMDCs that will see the largest increases in infrastructure demand but have weaker institutional capacities. In general, priorities for action relate more to the planning stage of the public investment management cycle in countries at a higher level of development, whereas the implementation and delivery stage also needs to be a focus in countries at a lower level of development.

Most countries, but especially EMDCs, would benefit from strengthening institutional capacities to develop, appraise, negotiate, and manage public-private partnerships (PPPs). This would allow them to catalyze more private investment while ensuring value for money and controlling for fiscal risks. Improvements are also needed in fiscal frameworks for accounting for and managing related contingent liabilities. Appropriately structuring PPPs in terms of distribution of risks and returns and supporting regulation is vital to promoting value for money. With increased emphasis on sustainable infrastructure, consistent treatment of climate risk in PPP frameworks will be important, complemented by broader policies.

Governments should develop and implement procurement processes that incorporate sustainability criteria. A number of countries have put in place elements of sustainable procurement; there is a need to develop more systematic and consistent approaches and disseminate good practice. Taking climate risks and sustainability into account in a systematic way magnifies the challenges for investment planning and project development and management. A systematic approach requires: i) incorporating environmental sustainability as an integral, cross-cutting element of government investment programs and policies; ii) systematically capturing environmental externalities in project appraisal and ensuring their proper valuation; and iii) consistently applying environmental safeguards to investments, such as those relating to carbon emissions and pollution or energy efficiency.

In many EMDCs, weak project pipelines are a particularly important (and often binding) constraint to boosting public infrastructure investment and attracting more private participation. Efforts to build capacity for project preparation and investment management will need to reach beyond central government agencies to cover subnational and local-level entities. City-related infrastructure accounts for the bulk of total infrastructure investment, but investment planning and management capacities are often the weakest at municipal levels. Only about 20 percent of the world's largest cities have the basic analytics necessary for low-carbon planning. Also, intergovernmental investment coordination mechanisms and fiscal relations will need more attention.

Governments and their development partners, especially MDBs, will need to scale up investment in building institutional capacities to develop and manage stronger pipelines of infrastructure projects that are both bankable and sustainable.

## *Transforming finance*

The scale of financing requirements for sustainable infrastructure calls for strengthening of resources from all sources. Domestic resources and private flows must provide the bulk of the financing, but official financing can play an important role in helping to close the infrastructure financing gap in EMDCs.

Finding the fiscal space to meet the large sustainable infrastructure needs will require determined efforts on additional resource mobilization through tax and expenditure policies. It will also require better use of government balance sheets. Countries will need to expand fiscal space not only to meet the public sector's own investment financing needs but also to underpin its ability to catalyze private financing.

Of the estimated $5-$6 trillion of needed investment in sustainable infrastructure annually over the next 15 years, a very large proportion will be related to urban areas. Urban finance will thus form a core part of the resource challenge. Strengthening fiscal capacities at local levels to finance and catalyze increased investment in sustainable infrastructure will require action, especially on two fronts. First, local governments need to boost their own-source revenues, which are typically low in developing economies. Own-revenue generation anchors local government finances, including the capacity to borrow, but is also important from the perspective of accountability for investment. It allows local governments to capture some of the returns that accrue to the community as a whole and enhances their ability to borrow against the infrastructure investments. Second, intergovernmental fiscal relations should be reviewed to financially empower cities and local governments commensurate with their central role in meeting the sustainable infrastructure challenge.

Despite ample global savings and record-low long-term interest rates, infrastructure investments in EMDCs are often unable to attract long-term private financing, and the costs of financing are relatively high—in some cases prohibitively so. While the volume of private finance including cross-border finance has grown rapidly over the past two decades, very little of this capital is being directed toward long-term investment, and even less is being made available for infrastructure financing.

Improving access to and reducing the cost of private capital for sustainable infrastructure will require concurrent actions on several fronts.

*Deepen domestic capital markets:* Domestic capital markets will need to provide well over half of all private financing for infrastructure in EMDCs. Countries have taken different approaches to promoting the development of domestic capital markets and infrastructure finance, ranging from centralized approaches involving heavy reliance on large official development banks and direct measures, such as directed and subsidized credit, to more decentralized approaches seeking to foster development of a broader range of public and private capital market institutions. A key lesson of experience is that while capital market structures may differ, success fundamentally depends on a common set of reforms that tackle underlying market, policy, and governance failures. Public policy can help mobilize more private financing in two important ways: by supporting the development of domestic capital markets; and by addressing specific constraints to private financing of infrastructure, and especially sustainable infrastructure, including through promotion of innovative finance.

*Enhance and scale up risk mitigation instruments:* Sound structuring of risks is essential to creating the right incentives for the private sector. This requires carefully constructed contracts that apportion risks that should be borne by the private sector. In addition, risk mitigation instruments and credit enhancements are typically needed, given the very high uncertainties and risks in the early stages of projects and the lack of creditworthiness of project entities. Private investors also often need guarantees against policy and demand risks. Partial risk guarantees are the appropriate means to deal with such risks, but in practice investors often ask for excessive credit or cash flow guarantees. Guarantees are well suited to sustainable infrastructure, because they can be precisely targeted and adapted to policy risks. Guarantees and credit enhancements are particularly important for EMDCs where perceived risks are typically greater than actual risks.

*Develop infrastructure as an asset class:* To better tap the large pools of capital held by institutional investors, infrastructure needs to be better developed and promoted as an asset class. Developing a strong pipeline of sound and bankable projects, standardizing project templates where possible, and improving the flow of information on projects to investors is vital. So are regulatory and institutional frameworks for private investment in infrastructure that provide policy clarity and reduce risk. Success here will provide

institutional investors with long-term inflation protected returns that can help match institutional investors' long-term liabilities – such as payouts by pension funds – with stable income streams.

*Expand the range of financial instruments:* Increasing the flow of private capital into sustainable infrastructure will require developing new and innovative financial instruments that can respond to the requirements and capabilities of different investors. Innovations in financial instruments could expand the range of investment options, improve risk-return profiles, help reach a wider investor base, and channel more resources to sustainable infrastructure. Instruments such as green bonds and YieldCos use familiar financial instruments to enhance capital flows to sustainable infrastructure. Another option is to adapt the funding models. "Land value capture," for example, has long been used to finance railways, metros, and highways. This could also be a powerful way to promote transit-oriented development in urban settings, since transportation infrastructure almost always increases the value of adjacent land. Another challenge is to develop financial instruments that respond to the growing need for small-scale infrastructure. This could include bundling multiple projects to achieve scale and drive down overall costs. Innovation will also be needed to finance a more diverse set of investors in sustainable infrastructure compared to traditional infrastructure, including many smaller and often less creditworthy investors, such as those involved in investing in solar energy.

*Greening of the financial system:* Climate change through its direct impact and through the policy changes that its management requires, can have profound implications across a wide range of balance sheets and for macro-level financial stability. For example, the intensity of severe weather events is rising, threatening many assets, and the necessary policies to manage climate change will cause substantial re-evaluation of assets, particularly those associated with fossil fuels. Thus the G20 has asked the Financial Stability Board (FSB) to consider ways that the financial sector can take account of climate change. In December 2015, the FSB established the Task Force on Climate-related Financial Disclosures to undertake a coordinated assessment of how financial reporting can incorporate climate-related issues that are responsive to the needs of diverse stakeholders including lenders, insurers, investors, and others. The aim of the exercise is to encourage effective climate disclosures that can reduce uncertainties in decision making and thus lower the potential of destabilization of financial markets from corrections in asset values due to climate change and policies to tackle it. A draft FSB Task Force report was issued in April 2016. Several central banks, including those from France, China, Bangladesh, and Indonesia, have developed green or sustainable financial sector regulations that require integration of environmental and social considerations into bank lending decisions. Several voluntary and official initiatives are also underway to ensure that the financial system proactively supports sustainable, low-carbon investments. This includes the adoption of common standards, re-orienting or creating new institutions to support green investments, and the development and promotion of green financial instruments.

While the bulk of financing needed will come from domestic resources and private flows, official financing in support of development and climate action will need to increase. Official concessional assistance is especially important for lower-income countries that have limited access to private financial markets. But a paradigm shift is needed in how development finance is used. Rather than simply filling financing gaps, development finance will need to be used in innovative ways that leverage much larger pools of financing. Even in the best-case scenario, official flows will measure in the hundreds of billions. But the financing requirements measure in the trillions. The key role of development finance will be to support countries in unlocking and catalyzing more financing from all sources. Both traditional official development assistance, and climate finance commitments made in Paris, will have a much larger impact if used in such catalytic ways.

MDBs have a central role to play in scaling up and reorienting investments in sustainable infrastructure. They are well equipped to address both the demand and supply constraints impeding investments in sustainable infrastructure. With their combination of technical and policy support, low-cost long-term financing, and risk mitigation services, these institutions can be instrumental in leveraging substantial increases in flows of private finance to sustainable infrastructure and lowering their cost. The very

presence of MDBs can itself reduce government induced policy risk and bring different parties together. MDBs can also crowd in other sources of finance. This leveraging role will be in high demand, especially in middle-income developing countries, where the financing needs are large and private capital will have to play a major role in meeting those needs. The type of finance provided by the MDBs and their supporting services are well-suited to funding and leveraging investment in sustainable infrastructure. But the capacities of these institutions will need to be substantially expanded to enable them to provide and catalyze finance on the scale needed.

To scale up support for sustainable infrastructure, each MDB should set out explicit assistance strategies for sustainable infrastructure linked to INDC commitments and plans. Towards this end, they should set targets for own lending and for co-financing with other lenders including the private sector. They should enhance de-risking and credit enhancement mechanisms. They should undertake *ex ante* and *ex post* sustainability assessments based on harmonized standards and guidelines. They should provide targeted concessional financing to promote the adoption of innovative technologies. Greater operational attention should be paid to climate resilience and adaptation financing needs. In all of these areas, MDBs should promote enhanced collaboration and common platforms, something that is already occurring. One example is the Global Infrastructure Facility which was established in 2014 by the World Bank as a joint platform with other MDBs to facilitate the preparation of complex infrastructure PPPs so as to mobilize private sector capital, including from institutional investors. MDBs can also help promote and support scalable investment platforms at the country level in partnership with local institutions. The role and purpose of these platforms is to help identify and tackle policy impediments, increase the deal flow of viable and sustainable projects, ensure sound governance and implementation, encourage and support adoption of best available technologies, develop models for proper risk sharing and mitigation, and help mobilize and bring down the costs of financing—both in the early stages and once the project reaches the operating phase.

### *Technology Development and Deployment*

Given the scale of the investments that will need to be made over the next 15-20 years, and the associated lock-in of capital and technology for decades to come, it is vital to deploy the best available technologies to reduce costs and accelerate the adoption of clean and low-carbon technologies. While there have been tremendous technological gains over the past decade, especially in the costs of renewables, there is wide variation across and within countries in adoption of the most relevant and state-of-the-art technologies in relation to their circumstances and the requirements for sustainability. There is also tremendous scope for investing in the development of new technologies in a wide range of areas, including clean energy, energy efficiency, improving urban mobility, and construction methods. Such investments can bring down costs and unleash Schumpeterian waves of innovation that can exploit new growth opportunities.

For innovation and uptake of technologies to accelerate, a number of important challenges will have to be confronted. First, market failures associated with the availability of information will need to be corrected. Emerging economies in particular can benefit from reduced costs of acquiring the expertise for deploying clean energy technologies if knowledge-sharing is encouraged. Second, adequate resources are needed to meet upfront costs to incentivize early high-risk research. Better public support, public-private initiatives, and enhanced international cooperation can help accelerate these and other innovations. Promising efforts include the recently unveiled Mission Innovation initiative started by 19 governments, committing them to a doubling of public investments in basic energy research over the next five years. In the private sector, the Breakthrough Energy Coalition led by Bill Gates brings together 28 major investors from 10 countries with a collective net worth of more than $350 billion. Third, for a wider uptake of renewables, investments in improved networks and system-level innovative technologies are crucial; in particular investments that help reduce variability of renewables and make power systems more flexible, including smart demand-management, connectivity of systems, and storage. Fourth, alignment of price incentives is

crucial. Implicit and explicit fossil fuel subsidies make it harder for clean energy to be competitive. Recently renewed attention to fossil fuel subsidies and reforms currently being considered in a number of countries should be encouraged.

## The way forward

The world is committed to a new, very attractive, inclusive and sustainable growth path. With decisive actions we can shape and deliver on the 21st century growth story. If we do not take the opportunities now, the target of limiting global temperatures to less than 2 degrees Celsius will be out of reach and we will risk reversing development gains, having cities where we cannot move or breathe, or ecosystems that collapse. The gains are potentially great, but so are the risks of delay.

There is a tremendous opportunity to create a virtuous cycle of concerted and mutually reinforcing actions with collaboration and commitment from many parties from countries to cities to the private sector and civil society. There is widespread recognition of the importance of investing in sustainable infrastructure and many countries are scaling up their investments plans. Major economies including China and India are in different ways changing course from past patterns of growth. Cities are increasingly playing a leading role and are learning from each other. And there are impressive examples of leadership and commitment from the private sector. International institutions (UN, G20, IMF, OECD and the MDBs) are now all committed to accelerating the low-carbon transition and building climate resilience. Achieving better infrastructure outcomes will require concerted actions on many fronts. We have to collectively harness the momentum, increase collaboration and implement agreements. It is about working together to incentivize, foster and finance change. But moving from a business-as-usual approach to better infrastructure can dramatically affect global development outcomes and radically reduce the fundamental risks of climate change (Figure 1).

**Figure 1 A commitment to better infrastructure can dramatically improve global outcomes for climate and development**

| From business as usual outcomes | To better infrastructure outcomes |
|---|---|
| **Inadequate investments** in sustainable infrastructure in most countries constrains growth and development | **Scaled investment** in sustainable infrastructure globally leads to improved economic development and growth |
| **Inadequate provision of affordable infrastructure** for poor people, risks reversal in fight for development and poverty reduction | Increased infrastructure **access and affordability** for poor people leads to improved development outcomes |
| **High proportion of high-carbon infrastructure investments** and inefficient use of infrastructure, creates danger of lock-in and irreversible climate change | Increased preference for investments in **low-carbon infrastructure** can mitigate climate change to below 2 degrees |
| **Low resilience** infrastructure creates vulnerability to risks of climate change (especially among poor people) | **More resilient infrastructure** that accounts for climate risks and protects populations most vulnerable to climate change |

# 1. Introduction

The year 2015 has been a milestone year for both the development and climate agendas. Following extensive discussions, the Addis Ababa Action Agenda on Financing for Development was adopted in July at the Third UN Conference on Financing for Development. In September world leaders adopted the new sustainable development goals (SDGs) and with it committed to the 2030 development agenda. At last year's Antalya Summit, G20 leaders committed to the implementation of the SDGs and to taking vigorous actions on climate. And last December in Paris, world leaders adopted an historic agreement on climate change based on more ambitious commitments and a recognition that much more will be need to done to protect the future of the planet.

A central theme emerging from these discussions is that the world needs to overcome poverty and create better lives for all while at the same time responding to climate change. This is especially challenging given anemic global economic recovery and uncertain long-term growth prospects. As the NCE Report of 2014 pointed out, portraying economic growth and development as being in conflict with climate action is a misunderstanding of the opportunities presented by the low-carbon transition and creates an "artificial horse race" between them. On the contrary, fighting climate change can promote development and tackle global poverty, and vice versa. The world needs, therefore, to raise ambitions on both development and climate action, and do so in a mutually reinforcing manner.

Another major theme emerging from the deliberations of the past year is that sustainable infrastructure is key to delivering on both the development and climate agendas. The quantity and quality of sustainable infrastructure will be crucial for the attainment of the SDGs through its impact on inclusive growth, social development, and climate resilience. In particular, the way in which the massive investments in infrastructure are undertaken will have an enduring impact on climate resilience. The scale of new investments required offer a unique opportunity for accelerating the shift to a low-carbon transition, but, if not done well, risk locking in capital, technology, and patterns of economic activity that will last for decades and become progressively unsustainable.

Despite its crucial importance, the world is not delivering on the scale and quality of infrastructure that will be needed to meet the SDGs. This report assesses the constraints that are holding back the scaling of sustainable infrastructure and how to vastly expand infrastructure while avoiding the mistakes of the past. It proposes how to revamp policy and financing frameworks so as to give traction to the implementation of the SDG agenda and to meet the ambitions of the Paris agreement to sharply curb carbon emissions.

## 2. The central role of sustainable infrastructure

The quantity and quality of sustainable infrastructure will be crucial for the attainment of the SDGs, given its impact on inclusive growth, social development and climate resilience (Figure 2). Inadequate infrastructure remains one of the most pervasive impediments against growth and sustainable development, and consequently in tackling poverty. Good infrastructure unshackles and removes constraints on economic growth and helps increase output and productivity. Investment in sustainable infrastructure can help generate employment, boost international trade, industrial growth, and competitiveness while reducing inequalities within and among countries. Implemented well, sustainable infrastructure can be a great equalizer. By contrast, bad infrastructure wastes resources, can and does kill people on a large scale mainly via air and other pollution, and puts pressure on land and natural resources to an extent that may compromise the viability of future generations and create unsustainable economic burdens in the future.

The recognition that infrastructure investments need to be fundamentally different from the past has led to the term "sustainable infrastructure" (Box 1). The G7 in its communiqué issued at the Ise-Shima Summit in May 2016, emphasizes the importance of quality infrastructure investments and sets out principles that accord very closely with the elements of sustainable infrastructure (G7 2016).

**Box 1 What is sustainable infrastructure?**

In this report, following OECD and World Bank, core infrastructure includes power generation and distribution, transport, water and sanitation, and telecommunications. Sustainable infrastructure is socially, economically and environmentally sustainable.

**Socially sustainable.** Sustainable infrastructure is inclusive and respects human rights; it is designed to meet the needs of the poor by increasing access, supporting poverty reduction, and reducing vulnerability to climate change. For example, distributed renewable power in previously un-electrified rural areas can increase household income and improve gender equality by reducing time spent on household chores.

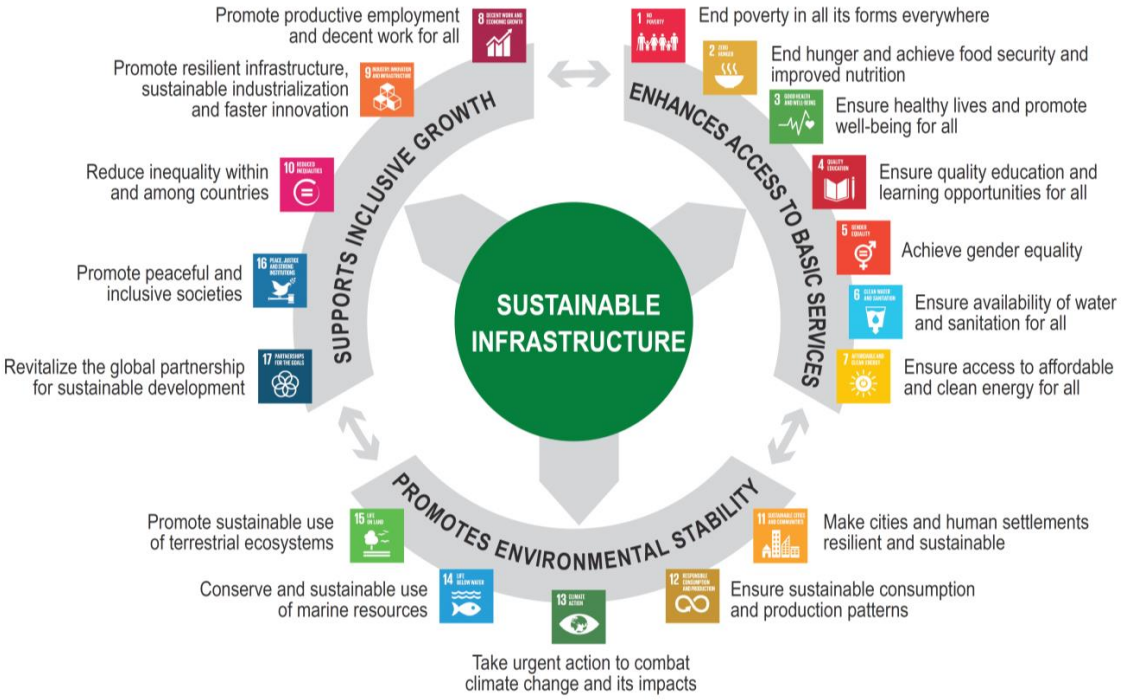
**Economically sustainable.** Economically sustainable infrastructure provides jobs and helps boost GDP. It does not burden governments with unpayable debt or users with painfully-high charges. It also seeks to build the capabilities of local suppliers and developers. Economically sustainable infrastructure may also include opportunities to build local developer capacity.

**Environmentally sustainable.** Environmentally sustainable infrastructure mitigates carbon emissions during construction and operation and contributes to the transition to a lower-carbon economy, for example through high energy-efficiency standards. It is resilient to climate change risks such as sea level rise and increased extreme weather events. It also addresses local environmental challenges, especially around water provision and air quality.

Sustainable infrastructure holds the key to poverty alleviation and societal well-being by enhancing access to basic services. There is now robust evidence that it has a positive influence on livelihoods and standards of living as well as education and health outcomes of poor people. Sustainable infrastructure helps alleviate poverty and extreme hunger, improve health and education levels, assist in attainment of gender equality, allows for the provision of clean water and sanitation, and provides access to affordable energy for all.

Sustainable infrastructure promotes environmental sustainability. It promotes sustainable consumption, production and resource utilization to ensure that habitats and settlements are resilient and sustainable, and that ecosystems and marine resources are used in a sustainable manner. It enhances food security through improvements in resource use efficiency and reduces vulnerability to environmental shocks.

**Figure 2 Sustainable infrastructure and Sustainable Development Goals**




*Source: Bhattacharya, Chattopadhyay and Nagrah (forthcoming)*

How we undertake the massive investments that are needed will have an enduring impact on climate resilience. The existing stock of infrastructure and its use accounts for more than 60 percent of the world's GHG emissions. The scale of necessary new investments offers a unique opportunity for accelerating the shift to a low-carbon transition, but, if not done well, also pose a great danger of locking in capital, technology, and patterns of economic activity that will last for decades and become progressively unsustainable.

## 2.1 Sustainable infrastructure and growth

Sustainable infrastructure – interconnected physical networks in transport, communications, buildings, energy, water and waste management – is an essential for achieving economic growth.

Infrastructure is a crucial determinant of economic growth. Increased investment in stock and flow of infrastructure services can directly raise aggregate output, increase marginal productivity of other outputs, enhance competitiveness, and multiply investments in other sectors. A comprehensive review of the linkages between infrastructure and economic growth has been provided by Calderon and Serven (2014) and Romp and de Haan (2005).

Infrastructure influences economic growth primarily as an input to the aggregate production function, forming the basis of all economic activity. The increased availability of physical capital as well as flow of infrastructure services such as transportation, power supply and use, telecommunications and so on, can help lower production costs and increase productivity (Barro 1990, Aschauer 2000, Torvik 2001, IMF 2014a). Infrastructure also stimulates short run demand and supports economic growth during recessions

(IMF 2014a). To stimulate aggregate demand and growth, infrastructure spending was hiked in both developing and advanced economies in the aftermath of the global crisis of 2007-08. It is estimated that advanced economies spent 21 percent of their fiscal stimulus on infrastructure whereas developing countries spent approximately 40 percent to speed economic recovery (ILO 2011). In China, which implemented the largest stimulus amongst major economies, most of the investment spending was directed to infrastructure.

Infrastructure also influences economic growth by raising total factor productivity (TFP) (Agenor 2012, World Bank 2016a). Improvements in transportation, telecommunications and information, communications and technology (ICT) can help expand the production function by raising TFP (Dugall et al. 1999, Hulten and Schwab 2000). As a result of infrastructure upgrades during the 1950s and 1960s, it is estimated that the U.S. experienced a notable one-time boost in its productivity upon completion of its basic interstate network (Fernald 1999). At the sub-national level, evidence points to inter-regional differences in TFP attributable to infrastructure development (Duggal et al. 1999). In India, nearly half of observed TFP growth in Indian states can be attributed to differences in infrastructure assets in transport and power sectors (ibid). A recent study has found Vietnamese firms that use internet and e-commerce have 3.6 percent higher TFP growth (World Bank 2016a). Similarly, African firms that use internet have been found to have 35 percent higher TFP than their non-user counterparts (ibid).

Sustainable infrastructure, in addition to providing these direct benefits, also helps unlock new patterns of economic activity and growth. It fosters links between sectors and has important scale and network effects. While provision of infrastructure can increase connectivity, both through physical accessibility as well as better integration of services (Schwab and Sala-i-Martín 2015, OECD 2012), sustainable infrastructure creates system-wide inter-linkages that allow economies of scale and reduce transaction costs. For example, integrated transportation infrastructure can not only significantly reduce trade costs and increase access to new markets, but it unlocks opportunities in other sectors in the process. In turn, access to new markets can introduce more efficient management practices, improve information flows between stakeholders, streamline production knowledge, and help secure property rights. Ultimately, this contributes to more efficient resource allocation

Sustainable infrastructure helps raise competitiveness of firms, facilitating intra- and inter-regional trade through physical connectivity as well as through ‘soft’ infrastructure that integrates services across sectors, helping move beyond closed economies (ibid). While increasing physical connectivity is important, it is estimated that physical trade costs account for only 10-30 percent of total productivity costs (Schwab and Sala-i-Martín 2015,). Other factors include the regulatory environment as well as availability of communication services and trade procedures, all of which can benefit from sustainable infrastructure investments. There is significant potential to target sustainable infrastructure investments to improve connectivity in some of the poorest countries in the world. It is estimated that only 11 percent of trade in Africa is intra-regional, with over a third of firms identifying transportation as a major constraint in doing business (World Bank 2015a). Improving connectivity through improved cost-effective, efficient and resilient transportation infrastructure can help lower trade costs for African firms.

Furthermore, by improving the marginal productivity of other inputs and changing their relative payoffs, sustainable infrastructure can have a direct effect on labor as well as on public and private stock of capital, making an economy more competitive. This channel of influence has been documented extensively for traditional infrastructure investments (Calderon et al. 2014, Canning and Pedroni 2008, OECD 2012) and can reasonably be assumed to provide a lower estimate of the effect.

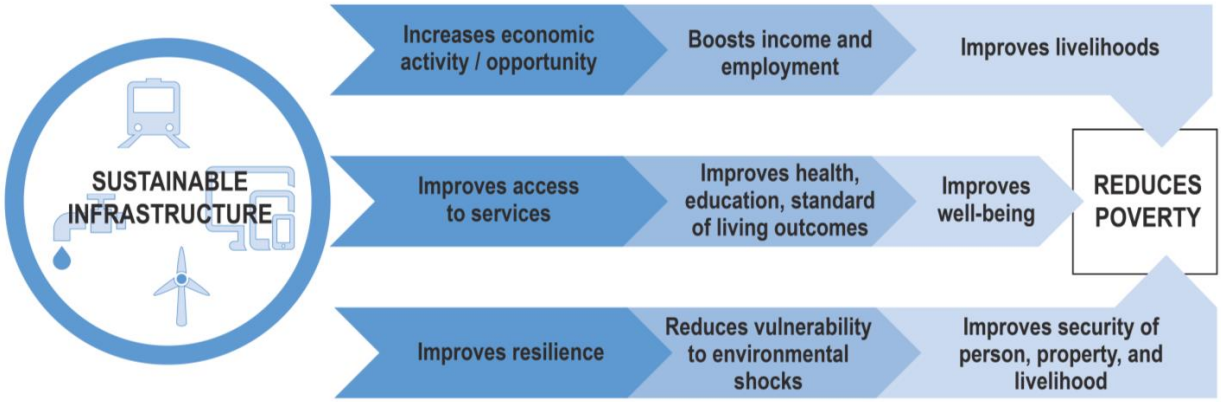
There is evidence that unless infrastructure design takes into account system-wide linkages, sustainable growth objectives will fall short. This is because the role of infrastructure in enhancing marginal productivity of inputs is often subject to threshold and network effects (Estache and Fay 2007, Agenor 2012, Calderon and Serven 2014). For example, unless construction of large scale public infrastructure such as regional highways connecting agricultural markets is complemented with construction of rural

feeder roads, the benefits from increased rural trade will not begin to accrue at the level intended (Agenor 2012). Similarly, benefits from telecommunications in raising output are found to be higher with near universal coverage (Lars-Hendrik and Waverman 2001), in some cases peaking with infrastructure network coverage at full development (Calderon and Serven 2014). This non-linear change in marginal productivity has significant implications for countries with low infrastructure endowments to begin with. It requires achievement of a level of infrastructure accumulation before productivity gains begin to be realized (Agenor 2012). More importantly, it highlights the need for an integrated design that takes into account the inter-linkages and co-benefits from separate infrastructure investments.

## 2.2 Sustainable infrastructure for poverty reduction and social well-being

Poverty means economic deprivation, social exclusion, and lack of access to education, health, housing, employment, as well as greater susceptibility to the negative effects of climate change (UNDP 1997). Sustainable infrastructure is a key driver of poverty reduction, primarily through its impact on economic growth, provision of physical access to basic services, as well as better integration of services and improved flow of information (Brenneman and Kerf 2002, Pouliquen 2000, World Bank 2016a). Sustainable infrastructure that provides integrated services in telecommunications, electricity, transport, clean water and sanitation is essential not just for expanding economic opportunities available to the poor, but also their access to facilities and public services. It can thus help in reducing poverty in all its forms, including alleviating deprivation in the areas of education, health, safe housing, time allocation, energy use, personal security and well-being. Figure 3 provides an illustration of these channels.

**Figure 3 Sustainable infrastructure can reduce poverty**




*Source: Bhattacharya et al. (forthcoming)*

The magnitude of sustainable infrastructure's impact on poverty reduction and social well-being is dependent on elasticity of growth with respect to poverty reduction, which varies widely across countries (Bourguignon 2003, World Bank 2015a). This heterogeneity of effects highlights the lack of one-model-fits-all when it comes to investing in infrastructure to alleviate poverty. Furthermore, badly designed infrastructure can have significant adverse distributional, environmental and health impacts that can worsen poverty levels. Literature is abundant with examples of large-scale infrastructure investments that exacerbated income inequality, resulted in increased mortality and morbidity rates and wrought irreversible ecosystem damage (Stern 2015).

While sustainable infrastructure can make a substantial contribution to poverty alleviation, the achievement of this goal is dependent on two critical factors. First, the degree of inclusiveness in distributing impacts of growth as a result of infrastructure investments, and secondly, the degree of access by the poor to the new infrastructure taking into account location and affordability constraints (Pouliquen 2000). On the one hand, sustainable infrastructure, through targeted provision of services, can help equitably distribute the benefits of economic growth. On the other hand, business as usual (BAU) infrastructure, while potentially contributing to economic growth, can exacerbate income inequality by concentrating benefits for the few. BAU infrastructure is often funded through regressive taxation, plus it fails to account for negative externalities (Barro 2000, Calderon and Serven 2004, Calderon and Serven 2014, Pouliquen 2000).

A second closely related condition relates to accessibility, which includes dimensions of spatial access, economic opportunities, social inclusion, and opportunities for interaction (Song 1996, Geurs and Van Wee 2004). A multi-faceted concept, accessibility is critical for achievement of poverty reduction goals as they relate to infrastructure interventions (Pouliquen 2000, Brenneman and Kerf 2002). A common example is one of denial of access through regressive pricing. Building and maintaining sustainable infrastructure can be expensive, and often user charges that could make such investments viable can be prohibitively high for the poorest. Low-income communities, often located at peripheries of more affluent agglomerations, are at the risk of being overlooked at the time of infrastructure design, in main part due to a lack of influence on policymaking and information (Rodriguez et al. 2016, UN-Habitat 2013, Pouliquen 2000). This can result in policies skewed in favor of those with a voice or technical and financial considerations. Sustainable infrastructure addresses this potential tradeoff between pricing of infrastructure services and accessibility, while avoiding a subsidy trap by using more innovative models of financing and pricing structures (Box 2).

**Box 2 Effectiveness of pro-poor transport subsidies**

Provision of public transportation at affordable cost to poor people while ensuring cost-recovery and financial viability of the service has posed a significant public policy challenge. In Bogota, Colombia, where public transit fares are set closer to cost-recovery levels, the relative cost burden on the poorest households has been disproportionally high. The poorest households spend between 16-27 percent of their income on transportation, compared to approximately 4 percent spent by the richer households. To address this gap in affordability of public transit by the poor, beginning in 2014, the city rolled out a "pro-poor" public transit subsidy to reduce the transportation cost burden on the poorest households. Residents with a poverty index score below a pre-determined threshold of 40 or less were given the option of utilizing a public transit subsidy, through a personalized smartcard. The subsidized fare is equivalent to US$ 0.35 and capped at 40 trips per month. The subsidized fare represents a 50 percent discount for trunk services, and 60 percent discount for feeder services at peak hour.

A quasi-experimental evaluation of the subsidy demonstrates that the subsidy resulted in a significant increase in the hourly earnings of informal workers, which was attributed to increased productivity due to better mobility of the informal workers and access to economic opportunities as opposed to the number of hours worked. The results on other labor market outcomes, such as unemployment, labor participation, hours worked, or formal employment were found to be inconclusive, highlighting the heterogeneity of effects and the need for caution in designing public transit subsidies.

*Source: Rodriguez et al. 2016*

**Sustainable infrastructure and sustainable development:** Sustainable infrastructure investments have been shown to have high financial as well as development returns (Canning and Bennathan 2000). The World Bank estimates economic rates of return for targeted infrastructure investments that include non-monetary benefits associated with sustainable development are substantially high. The economic rates of

return range from 9-18 percent in water and sanitation, 13-22 percent in energy, 19-34 percent in ICT and a larger 22-25 percent in transportation interventions (ibid). It is important to note that the economic rate of returns also compare favorably for both developed and developing countries.

It is estimated that approximately 1.3 billion people lack access to electricity, a form of extreme energy poverty (IEA 2012). A further 1 billion individuals suffer from unreliable access, which constitutes another dimension of energy poverty. Sustainable energy infrastructure can help alleviate poverty through four main channels. First, provision of modern energy ensures efficient supply and use of fuel for cooking without the adverse health outcomes associated with dirty fuels utilized in cooking (Fay et al. 2005, WHO 2016) and frees up time for more productive activities, disproportionately affecting women. It also helps increases food security through increased ability to store food (Frayne and McCordic 2015). Second, equitable access to electricity improves standards of living through better access to appliances, educational, and economic opportunities, as well as information in a fair manner. Third, it serves as a productive agricultural input on which a large segment of world population relies as a means of living, while avoiding the unsustainable agricultural energy consumption witnessed in the past (Pachauri et al. 2013, IEA 2011). Fourth, sustainable energy infrastructure can significantly reduce global carbon emissions, helping thwart a scenario where millions of people are pushed back into poverty in the long run (Granoff et al. 2015).

Similarly, sustainable transportation infrastructure can maximize access to economic opportunities as well as raise value of assets of the poor in both urban and rural contexts. For example, road networks that improve rural connectivity or public transportation in urban areas is both beneficial for reducing carbon footprints and poverty alleviation. In the case of Bangladesh, the International Development Association (IDA) has helped construct 2,500 km of rural roads in 21 districts since 1972 to improve rural connectivity. It is estimated this intervention has helped increase farmers' nonagricultural assets from 25 to 50 percent (World Bank 2015b). In addition, the poverty reduction rate has been found to have doubled in the project areas (ibid). Other studies have found similar gains in poverty reduction and rural market development owing to transportation infrastructure investments (Khandker and Koolwal 2010, Mu and van de Walle 2007). Transportation infrastructure also helps improve returns in other infrastructure sectors. For clinics, hospitals, and schools to deliver their intended services, physical access to these facilities by the poor is critical. Since poor people often live far from key services, their physical access also entails time costs. Transportation infrastructure that is designed to improve access can substantially reduce these costs, as demonstrated in one of the poorest states in Brazil where nearly two-thirds of the rural population lives below the poverty line. Beginning in 2003, the construction of over 100 kilometers of state roads connecting the poorest parts of the region with basic public services resulted in improved all-weather access in the range of 52 to 92 percent in project areas, while also substantially reducing travel time to hospitals (World Bank 2012a).

Furthermore, sustainable infrastructure is critical for ensuring flows of information in our modern economic systems. One of the fundamental conditions for well-functioning markets is availability of information, without which economic agents have limited ability to make sound judgments. In this sense, the joint goal of poverty alleviation and sustainable development through inclusive economic growth is dependent on availability of information. The role modern ICT can play in meeting this fundamental condition cannot be overstated, as also considered in depth in the 2016 World Development Report on Digital Dividends (World Bank 2016a). Information asymmetries can lead not only to price distortions, but also ultimately compromise market efficiency in the long run. ICTs are one means of ensuring the smooth flow of information and keeping transaction costs lower in our increasingly global information- and knowledge-based economy. Ensuring availability of information has become an urgent public policy issue. In particular, the challenge is to ensure that poor communities are connected to the flow of information, more and more of which is primarily available in digital formats (ibid). This is also true for political markets, where success of democratic systems and accountability of governments is dependent on a two-way flow of information (Narayan 1999).

Recent studies have highlighted the role of inexpensive and widely available ICT in connecting underserved and poor segments of the population with markets as well as increasing their participation in the political process (Callen and Long, Ferree et al. 2015). A deeper look at the results indicates that how these tools are used is important in determining their effectiveness (ibid), highlighting the importance of underlying design of the infrastructure intervention and not just its provision. ICTs have also played a transformative role in expanding financial inclusion, land, and labor input productivity as well as in promoting educational and health outcomes (Ogutu et al. 2014, Banerjee et al. 2007, Carrillo et al. 2011).

Sustainable infrastructure in water and sanitation can help connect nearly a billion people who currently lack access to water supply around the world (WHO 2010). This lack of access to basic water and sanitation infrastructure has been linked with poor health outcomes and, by extension, loss of productivity (Pouliquen 2000, Brenneman and Kerf 2002, Zhang 2012). Additionally, it disproportionately affects the productivity of women in developing countries, where they remain generally responsible for household chores (Agenor and Canuto 2015), and has also been linked with conflicts within households (Devoto et al. 2011).A recent study in Brazil considers the tradeoffs available to women in developing countries between competing uses of their time – to allocate between alternatives such as market work, raising children, home production, and human capital accumulation. The study finds that improved access to infrastructure reduces mothers' time allocated to home production and raises time allocated to market work, human capital accumulation, and child rearing (Agenor and Canuto 2015). In addition, increased human capital accumulation raises women's bargaining power, which translates into a higher family preference for girls' education, children's health, an increase in the average share of family income spent on children and a lower preference for current consumption (ibid).

Access to infrastructure and its lack thereof can also ultimately affect educational performance. The degree of access to basic residential infrastructure (electricity, sewage service) as well as educational infrastructure (measured in terms of number of classrooms in a school) has been found to increase probability of student attendance as well as improved scores in mathematics and languages (León and Valdivia 2015). Addressing teacher absenteeism has been a major challenge in many developing countries where a variety of factors contribute to staff's non-compliant behavior. Where research has shown the role of low-payoffs, weak institutional monitoring and accountability as important factors, other studies have shown the role of the physical environment and in particular lack of basic infrastructure such as safe transportation and sanitation facilities at institutions as motivating teachers and students to miss school (Brenneman and Kerf 2002, Alcazar et al. 2006). Similarly, quality of sanitation facilities in schools has also been found to be associated with levels of student absenteeism in many developing countries (Dreibelbis et al. 2013).

Sustainable infrastructure will be critical for meeting the projected reductions in agricultural water supplies around the globe. It is estimated that up to 30 percent of agricultural water demand will remain unmet in Africa, based on current climate change trends (Cervigni et al. 2015). Additionally, variability and uncertainty of water supply is projected to increase with climate change (ibid). Water supply uncertainty has been linked with agricultural productivity losses, with losses in crop productivity from climate change expected in the range of 30 percent in parts of Asia and up to 50 percent in Africa (IPCC 2014). This has serious implications for food security and puts vulnerable poor households at greater risk (Granoff et al. 2015, Cervigni et al. 2015).

However, there is significant scope for designing agricultural water supply infrastructure so that it is sustainable in the long run and resilient to uncertainties arising from unexpected wet and dry seasons. Sustainable infrastructure that enables greater availability, reliability and quality of water supply for agricultural purposes holds immense potential for poverty alleviation, gender equality, food security and building resilience of vulnerable communities to environmental shocks. Sustainable agricultural infrastructure can increase water storage capacity (Cervigni et al. 2015); so can integrated water supply systems that use both surface and groundwater (Pereira et al. 2002, Siderius 2015). Such infrastructure

can provide a buffer against drier seasons through the use of increased storage and allow sufficient aquifer recharging during wetter seasons.

## 2.3 Sustainable infrastructure and environmental sustainability

Sustainable infrastructure is designed with the aim of restricting climate change impacts that are now widely understood to hold adverse implications for poverty outcomes. At the same time, business-as-usual or unsustainable infrastructure exacerbates climate change, skews income distribution, and directly reduces the quality of life for the poorest, particularly in terms of health and physical well-being of present as well as future generations. To ensure equitable distribution of resources within and across generations, it is imperative that voluntary action be undertaken today (Stern 2015). Such action would entail upfront costs as well as the downstream payoffs, though these upfront costs are modest in net terms. However, these upfront costs, as well as sustainability premiums associated with "greening" infrastructure, have been a key concern of developing countries that view them as potentially growth-constraining and therefore as limiting their ability to lift poor populations out of poverty (IPCC 2014, Granoff et al. 2015). There is, however, growing evidence that rather than be in conflict, action on climate and action on development can be mutually reinforcing. The following section provides a summary of the linkages between climate change, poverty, and economic growth.

### 2.3.1 Climate change, poverty, and economic growth

A synthesis of the Intended Nationally Determined Contributions (INDCs) communicated by parties to the Paris climate agreement predicts that, even with full implementation, emissions levels in 2030 most consistent with climate scenarios will limit global average temperature increase to below 3.5°C until 2100. The same synthesis estimate that there is a greater than 66 percent chance that, 84 years from now, global average temperature will rise within a range of 3.0°C to 4.0°C (UNEP 2015a). This trend poses significant challenges to our ability to preserve our threatened ecosystems, build resilience to extreme weather events, protect vulnerable populations, prevent additional economic and biodiversity losses and insure against sudden environmental shocks (IPCC 2014). With an expected 3.5 global average temperature increase, we can expect to have a very high risk of losing vulnerable ecosystems and cultures with limited adaptive capacity. We also face a high risk of losses from extreme events such as heat waves, extreme precipitation, coastal flooding, a high- to very-high risk of unevenly impacting already disadvantaged and vulnerable communities, and high risks of exposure to large-scale loss of biodiversity and ecological systems as well as increased likelihood of abrupt and irreversible damage to our environment.

Climate change can affect poverty in many ways. A recent analysis by the Overseas Development Institute (Granoff et al. 2015) provides an insight into the channels through which climate change can exacerbate poverty and reverse gains made in its alleviation (Box 3).

Furthermore, increased stress on our scarce resources, especially food production systems, will contribute to and exacerbate poverty, further degrade the environment, as well as contribute to increased incidence of human conflict (Hsiang et al. 2013). A recent systematic review finds overwhelming consensus that climatic events are linked to incidence of human conflict across a range of spatial and temporal scales and across all major regions of the world. The review finds that, for each one standard deviation change in climate toward warmer temperatures or more extreme rainfall, the frequency of interpersonal violence rises by 4 percent and the frequency of intergroup conflict rises 14 percent (ibid).

**Box 3 The impact of climate change on poverty**

The success of the ambitious agendas of the SDGs and the Paris Agreement depends on achievement of low-emissions development. It is estimated that, at our current pace of emissions, climate change will push up to 720 million people into extreme poverty due to climate impacts between 2030 and 2050 (Granoff et al. 2015). Hence, the first SDG of ending extreme poverty by 2030, which appears achievable in our current trajectories, is at risk of being reversed. It is projected that climate impacts can undo gains made in poverty reduction through the following pathways between the period 2030-2050:

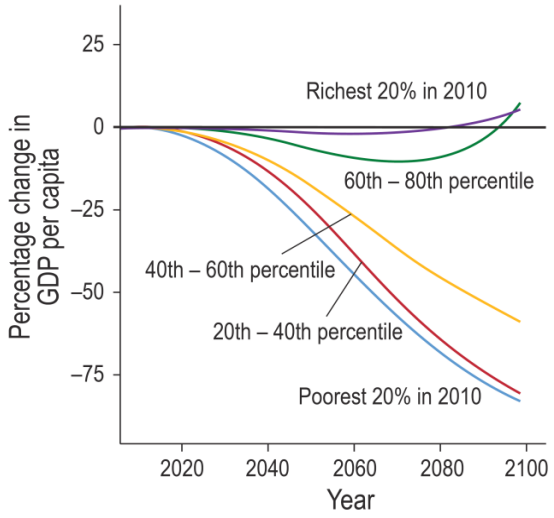
1. **More frequent droughts**
   Nature of the problem: reduced rainfall, lower agricultural output, food insecurity, poor health and inadequate sanitation
   Affected: 200-300 million (mostly rural)
2. **Reduced rural household income owing to declines in primary sector productivity**
   Nature of the problem: increased resource stress, lower agricultural productivity, disproportional dependence on primary sector incomes
   Affected: 120-240 million (mostly rural)
3. **Increased food prices as a result of declines in primary sector productivity**
   Nature of the problem: declining primary sector productivity, reduced food supply
   Affected: 210-420 million (mostly urban)
4. **Increased child malnutrition and stunting as a result of declines in primary sector productivity**
   Nature of the problem: Reduced crop productivity, increased food insecurity
   Affected: 240 million (rural and urban)

*Source: Granoff et al. (2015)*

In addition to direct impacts on absolute poverty levels and food security, climate change will have significant implications for health outcomes of the poor. These adverse health outcomes will be in the form of direct heat-related mortality and morbidity, and secondly, as climate change-induced increased incidence of communicable and vector-borne diseases (Parham and Michael 2010, WHO 2016). The World Health Organization (WHO) estimates that approximately 150,000 deaths per year are attributable to anthropogenic climate change, a figure that is projected to rise to 250,000 deaths per year by 2030 (WHO 2016). Climate change is expected to result in raised average, and extreme temperatures, altered rainfall patterns, sea-level rise, and extreme weather events that in turn serve to increase incidence of communicable and vector-borne diseases, aggravate chronic diseases, including cardiovascular and respiratory diseases and malnutrition, while putting greater pressure on healthcare systems (Friel et al. 2011, IPCC 2014). While developed countries will not be immune to these health effects as witnessed during the European and Russian heat waves of 2003 and 2010, some of the worst outcomes will be felt in the poorest countries (Dole et al. 2011, Haines et al. 2006). It is estimated that over 98 and 90 percent of climate change-induced and carbon economy-related mortality will be in developing countries, respectively. Developing countries are also expected to pick up 80-90 percent of associated costs of worsening health due to climate change. In particularly, Least Developed Countries (LDCs) are expected to suffer about 8 percent of GDP losses, an additional 3 percent due to inequitable access to sustainable development (CVF 2012). In China and India alone, the annual costs due to worsening occupational health and labor productivity losses are estimated at $450 billion in 2030 (ibid).

This strong negative correlation between global temperatures and income growth indicates that warming will likely result in increased global inequality as poor countries suffer the greatest reduction in growth (CVF 2012, Burke et al. 2015). Figure 4 illustrates how average income in the poorest 40 percent of countries declines by three-quarters, while the richest 20 percent avoid such a fate, and on the contrary will even gain from warmer temperatures (ibid).

**Figure 4 Global damage estimates from climate change, mean impacts by 2010 income quintile**




*Source: Burke et al. 2015*

Sustainable infrastructure holds the key to both avoiding extreme climate change as well as adapting to its inevitable impacts, without compromising economic growth. There is increasing evidence that the design of sustainable infrastructure can ensure that additional costs associated with a low carbon development path are not growth-constraining (DDPP 2015, GCEC 2014, Granoff et al. 2015, World Bank 2016a, Dechezleprêtre et al. 2016). The technical feasibility of achieving a transformation to low-carbon economy with a global average growth rate of 3 percent per year through 2050, has been established for 16 countries representing nearly three quarters of global GHG emissions and would result in an 87 percent reduction in average emissions per unit of GDP relative to 2010 (DDPP 2015).

Such fundamental transformation and increased investments in sustainable infrastructure will require additional financing. This has the potential to increase pressure on public coffers and create stress between competing uses. The additional investments needed could burden taxpayers and raise commodity prices. Yet at the same time, such investments present a vital opportunity to find new pathways for collaboration. Public financing complemented with private investments and support from advanced economies, in addition to knowledge-sharing that helps substantially reduce costs of new technologies, can make such investments affordable for cash-strapped economies. A review of the relatively small literature available on the subject indicates that investments in sustainable infrastructure can pay off handsomely. For example, transforming the energy sector and reducing emissions by one-third compared to BAU can enhance GDP in India by 3.9 percent, China by 1.4 percent, Indonesia by 2.4 percent, low-income African countries by 2 percent, and in Association of South East Asian Nations (ASEAN) countries by 1.6 percent (Granoff et al. 2015).

Increasingly businesses have begun to realize that initial investments in low-emissions infrastructure can be beneficial in the long run. For example, energy-efficiency investments have resulted in direct cost-savings and increased profitability while also helping to generate a market for energy-efficiency technologies and products. This has helped increase private interest in emissions reductions targets: businesses are now responsible for a $5.5 trillion global market in low-carbon and environmental technologies and products (GCEC 2014). It is estimated that investments in energy efficiency can increase cumulative economic output by $18 trillion to 2035, equivalent to an increase of 0.25–1.1 percent growth per year (ibid).

### 2.3.2 Undoing damage from the past

The potential role of sustainable infrastructure in ensuring environmental sustainability is not just limited to mitigation of the carbon footprint primarily from energy-related sources, but also in restoration and protection of vulnerable ecosystems damaged from climate change as well as badly designed interventions of the past (World Bank 1994, DFID 2002, Ledec and Quintero 2003). In this sense, employment of sustainable infrastructure is a solution to many of the challenges caused by BAU infrastructure investments.

For example, rapid investments in hydropower in the mid-twentieth century followed a conventional construction process without evaluation of potential harmful environmental impacts in the long-run. As a result, ecosystems and the health of entire river systems were put at risk (Null et al. 2014). Undoing such damage cannot simply be achieved with removal of these structures. Remediation requires a system-wide analysis and additional investments in sustainable infrastructure along with potential removal of low-economic-value structures (ibid). Such an approach considers the economic as well as social costs of removal of harmful infrastructure in addition to potential gains from additional (sustainable) infrastructure investments to rehabilitate harmed ecosystems. Similarly, industrial development, building of new coastal cities, and rapid conversion of marine shorelines into harbors and ports around the globe has accelerated and contributed to losses of marine habitats and ecosystem services. Sustainable marine infrastructure that is designed to protect marine ecosystems can help prevent such losses. Case studies in the U.S. have demonstrated how well-designed marinas with innovative ecological design interventions such as inclusion of openings for fish, rock berms for kelp colonization, and biological manipulation of substrate to support juvenile salmon prey and migration can help move from no-net-loss goals to net-environmental-gain scenarios (Wilson et al. 2015).

**Box 4 Solar power as a remunerative crop**

In India, the Green Revolution in the 1960s ushered in rapid adoption of intensive means of groundwater extraction, mushrooming tube-well infrastructure made cheaper through large power subsidies, partly as a result of which the country has become the largest consumer of groundwater for agricultural purposes (World Bank 2010a). Over 60 percent of Indian agriculture requirements are directly met by groundwater extraction as well as 85 percent of all drinking requirements (ibid). However, studies have estimated groundwater to be depleting at a rate of approximately 0.15 m/year (Moors et al. 2011), due largely to anthropogenic causes, but expected to be further exacerbated by climate change impacts.

In a context where surface water supply is uncertain, groundwater became an attractive substitute. Low-cost, extensive groundwater pumping over the past five decades has resulted in over-exploitation of the reserves to the point of unsustainability. Not only have power subsidies contributed to worsening groundwater exploitation, they have also resulted in significant carbon emissions. Eleven million electric and 9 million diesel tube wells emit approximately 130 MMT of CO2/year. This constitutes approximately six to 10 percent of India's total annual carbon emissions (Shah et al. 2015).

For the past 20 years, the government and civil society have been studying the potential role solar-powered pumps can play in reducing groundwater extraction, reducing power consumption without affecting crop productivity and livelihoods of the poor. Initial introduction of solar-powered pumps to extract and irrigate fields ran into institutional problems as well as saturation of market with sub-par products without few benefits. However, in recent years, innovate efforts such as the IWMI-TATA Solar Power as a Remunerative Crop project have brought government, civil society and private actors together to help reverse the damage to India's groundwater aquifers. The program provides subsidies for farmers to acquire solar pumps, requires them to surrender grid connection, and provides a power purchase guarantee of 7-10 US cents / kWh, making the farmer a net seller of power to the grid. It is estimated that a farmer can make between $500-750 annually by selling power back to the grid (Shah et al. 2015). It is expected that this incentive-based program will make alternative sources of income attractive for groundwater extractors and create an opportunity cost for groundwater use preventing its overexploitation.

### 2.3.3 Towards energy transformation

Infrastructure investments and use have a determining impact on our collective carbon footprint, in particular, on energy-related emissions. Nearly two-thirds of all anthropogenic carbon emissions can be attributed to the energy sector (IEA 2012). These emissions in turn are largely emanating from consumption of fossil fuels in power, transportation, and industrial sectors (ibid). To meet the 2°C or below target, significant reductions are required in primary energy supply, power generation, as well as at the end-use level (mostly from indirect use of power). These reductions will be made possible by through technological innovation across sectors, in particular through development of alternative energy sources, fuel supply, and end-use efficiencies and require substantial investments in sustainable infrastructure (GCEC 2014, IEA 2014, Bhattacharya and Holt forthcoming).

*Power.* Electricity generation, including transmission and distribution, make up nearly a third of total GHGs (IEA 2012). Technological innovations in the power sector can lead to significant reductions in projected emissions. Investments in power generation efficiency, fuel switching, nuclear power development, renewables, and Carbon Capture and Storage (CCS) can help reduce total emissions in the sector from between 40 to 50 percent (ibid). Furthermore, hydropower and thermoelectric power currently constitute nearly all (98 percent) of the global electricity generation capacity (van Vliet et al. 2016) and, as water resources are projected to come under increasing stress due to climate change, the uncertainty associated with power generation is expected to rise significantly. Recent research has highlighted that the loss of usable capacity in hydropower and thermoelectric power could be in the range of 61-74 percent and 81-86 percent, respectively in the next 50 years (ibid).

Investments in sustainable infrastructure such as increasing plant efficiencies, fuel switching, and development of alternative sources of fuel can help reduce exposure to climate impacts in addition to the emissions-reduction potential they hold. Deployment of these technologies on a wider scale holds great promise given the pace of decline in their costs, as in the case of solar photovoltaics in the past decade as well as expansion in energy storage capacity. The cost of solar has dropped by nearly 80 percent, with comparable cost reductions in wind and LED lights at 60 and 90 percent, respectively (Nelson et al. 2014, Nemet 2006).

*Buildings.* Emissions from buildings (commercial and residential) make up a fifth of the total global energy-related emissions (IEA 2012). Infrastructure investments in more energy efficient building envelopes, heat, venting and cooling (HVAC) systems, lighting and appliances can help reduce total emissions in half by 2050 (ibid).

*Transportation.* Fossil fuel consumption in transportation is responsible for nearly one fifth of global carbon emissions (IEA 2012). It is estimated that investments in increasing end-use fuel and electricity efficiency in transportation use can help cut emissions in the sector by nearly 30 percent by 2050. For example, switching to electric vehicles holds immense potential in reducing carbon footprint of personal transportation (ibid). In the US alone, this would reduce personal transportation emissions by nearly a third and reduce petroleum consumption in half (Pandit et al. 2015).

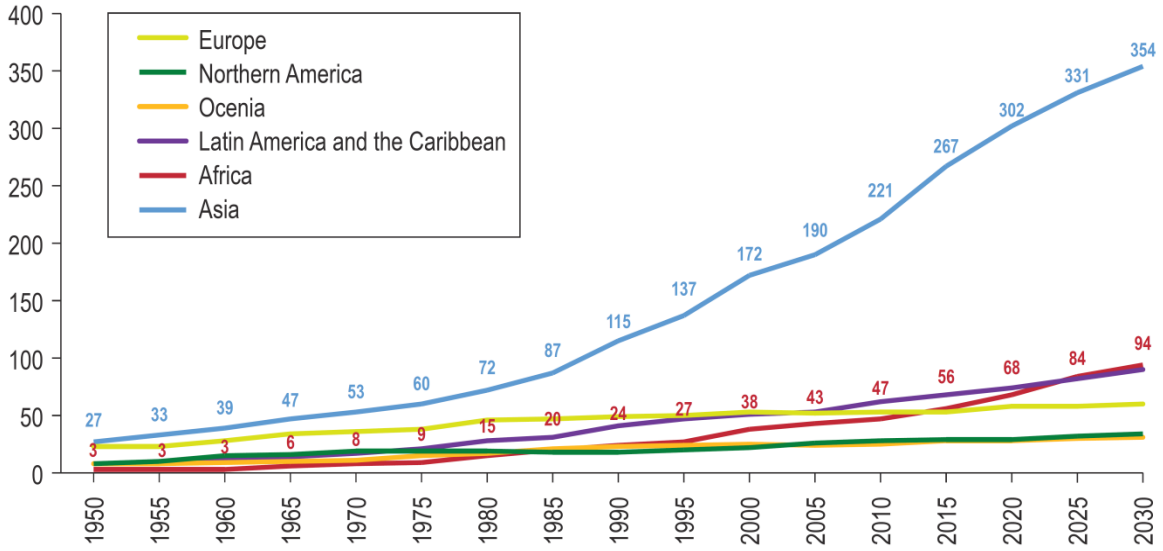
Sustainable infrastructure solutions will inevitably require a reorganization of resources toward alternative uses. It is important that this investment is done in a manner that takes into account what researchers have called the "*synergistic effects of infrastructural symbiosis*" or the interrelations that exist in terms of flows between the different interconnected capitals in urban infrastructure systems (Pandit et al. 2015). For example, switching to electric vehicles in the U.S. could lead to a substantial increase in water demand comparable to the current U.S. domestic demand, with serious implications for scarcity in other, competitive uses (ibid). A sustainable, integrated approach to infrastructure development would be required to take into account system-wide resource (re)allocation issues.

### 2.3.4 Building sustainable cities

The world is facing the most rapid pace of urbanization in its history. In 1950, approximately 185 million people lived in cities with more than 1 million inhabitants, making up 25 percent of all urban dwellers (UNDESA 2014; see Figure 5). In 2030, this number is projected to rise to over 2 billion individuals, making up nearly half of all urban dwellers (ibid). The trend indicates not just a greater pace of urbanization, but also increases in average city population size. At the same time, cities, a large percentage of which are located on coastlines (UNEP 2016a), face major environmental challenges emanating from incremental climate change as well as extreme climate events (Hallegatte et al. 2013). Potential effects include major setbacks to the social and economic infrastructure of cities, including basic public services affecting millions. Exposure to extreme climate events may affect some of the most vulnerable inhabitants disproportionally (McAdam 2011, Dasgupta et al. 2007, UNHabitat 2013). Additionally, urban migration of rural populations as well as internally displaced climate refugees will put pressure on basic urban infrastructure. In particular, urban authorities in developing countries will be confronted with increased housing crises and the growth of informal settlements and slums, with implications for health, educational and poverty outcomes.

These trends will put additional pressures on city infrastructure, in particular on basic services. In light of these projections, it is estimated that nearly 70 percent of global infrastructure demand in the next 15 years will originate from urban centers (CCFLA 2015). As cities are major contributors to GHG emissions, accounting for nearly two-thirds of global emissions (Stern 2015), reducing urban carbon footprints through sustainable urban infrastructure can reduce the risks of exposure to climate change, build environmental resilience as well as reduce the overall demand for sustainable infrastructure.

**Figure 5 Number of urban agglomerations with 1 million or more inhabitants**




*Source: UNDESA 2014*

Increased concentration of economic activity in urban areas will require greater investments in transportation and public-services infrastructure with a surge in urban construction activity (Bhattacharya

and Holt 2015). Sustainable infrastructure, with its emphasis on maximizing coverage, connectivity and integration of services, can help cities meet these immense challenges.

There is strong evidence that cities have so far lead the way in climate action in areas where national governments have found it hard to generate the necessary consensus (McCright et al. 2014 ). In the United States, a recent survey has revealed significant progress in voluntary city-level commitments by mayor-led governments to commit to some form of climate-related action (USCOM 2014). These actions range from strict regulatory guidelines on building codes, transport and energy efficiency standards to more general commitments.

Globally, the rise in sustainable infrastructure demand for urban areas raises the challenge of providing adequate and complimentary planning and financing support at national, regional and local levels. The following sections discuss the scope and scale of these urban infrastructure needs in more detail.

**Box 5 The role of natural infrastructure in the water, energy and food nexus**

The public and private sector are increasingly recognizing that investing in natural systems to complement, substitute or safeguard traditional, concrete-and-steel infrastructure can reduce costs, enhance environmental benefits, and help create more resilient cities under climate change (Ozment, et al. 2015). Strategically managed natural systems, or "green infrastructure", can effectively purify water, reduce the impact of floods, control stream temperature, and sequester carbon, amongst other functions (UNEP 2014). Importantly, natural infrastructure simultaneously provides a suite of additional cross-sector social and environmental benefits.

From municipalities to private companies and countrywide programs, public and private sector champions have initiated promising efforts to protect and enhance natural infrastructure across the globe. To date, managing watersheds for specific water services represents the largest portion of natural infrastructure investments, as illustrated by the following examples:

- **Water purification.** Municipalities such as Beijing (China), Quito (Ecuador), and Portland (Maine) have invested in restoring and protecting forested watersheds to achieve water quality benefits at rates lower than the cost of treatment plants or other grey infrastructure alone. For example, in Ecuador, a Water Conservation Fund (FONAG) funds watershed management projects that will protect one of Quito's water sources for the long term. FONAG now disburses almost $1 million a year for conservation projects, using fees collected from water users, including: Quito Municipal Water and Sewage Company, Quito Electric Company and private companies, such as Andean Brewery and Tesalia Springs water bottling, (TNC 2012).
- **Reduction of reservoir sedimentation.** Deforestation and other land use changes increase soil erosion, which can fill reservoirs and lower their capacity to store water and generate power. To combat the sedimentation process and avoid costly reservoir dredging, the power company Enel, in partnership with the Costa Rican government, is helping finance reforestation efforts upstream of its hydropower reservoirs. In addition to increasing efficiency and extending the lifespan of Enel's power facilities, the restoration efforts have provided more reliable streamflow, reduced greenhouse gases, and rewarded sustainable agricultural practices through payments to landowners (Hanson, et al. 2011).
- **Regulation of water flow.** Several communities and corporations have invested in restoring the key role forests play in regulating aquifer and stream recharge. For example, faced with critical water shortages at its tea plantations related to the clearing of surrounding forests for fuel wood and grazing, Unilever Tea Kenya (UTK) committed to improving water stewardship and protecting regional water supplies by donating native tree seedlings to surrounding farmers and communities for reforestation (Unilver 2009).

Similarly, as part of a PPP between the Sao Paulo water utility in Brazil, The Nature Conservancy (TNC), private companies, such as AB-InBev and others, landowners in Sao Paulo's watershed are paid $95 per hectare to protect or restore forests. Conserving the target 14,300 hectares of hydrologically sensitive land around Sao Paulo is projected to save $2.5 million by improving water quality and quantity, reducing sedimentation, and increasing

the longevity of the Cantareira reservoir system (TNC 2012a). By providing landowners a sustainable income stream, the program also helps alleviate poverty.

The benefits of natural infrastructure extend far beyond forested watersheds. Mangroves play a key role in mitigating coastal flood damage, while supporting aquaculture and fisheries (Rönnbäck, 1999); riparian areas can shade and regulate stream temperatures at a lower cost than cooling towers (Rutberg 2013); and floodplains can reduce downstream flood risk, while providing rich agricultural land and valuable habitat for fish and bird species (Sommer et al. 2001). For example, a partnership between China Three Gorges Corporation (CTG) and TNC found that restoring and managing the function of floodplains on the Yangtze River, in combination with improving dikes and other downstream grey infrastructure, would reduce flood risk more effectively and at a lower cost than upstream dams alone could. Under the proposed strategy, CTG could increase hydropower production valued at up to $350 million per year by maintaining higher water levels in the reservoirs, while also releasing a more natural flow at the benefit of a downstream fish reserve (TNC, CTG, Goldman Sachs Group, & et al 2011).

In the face of uncertain climate and water futures, natural infrastructure also provides unique advantages for planning infrastructure systems. Often, natural infrastructure strategies provide benefits and make economic sense under a wide range of climatic conditions, making them more likely to sustain benefits in the midst of uncertainty and increased variability (Ozment et al. 2015). For example, many forests reduce peak stream flows, decreasing downstream flood risk during wet periods, and these same forests also store water and maintain snowpack to provide an essential slow release of cool groundwater into streams during dry periods (Gartner, et al. 2014). Further, the ability to adjust and adaptively manage natural infrastructure provides the flexibility that is necessary to cope with changing conditions. This is in contrast to large concrete infrastructure, which is often socially and economically difficult to reverse or remove once it is built (Garcia et al. 2014). More effectively recognizing and emphasizing the climate mitigation and adaptation benefits of natural infrastructure has the potential to increase access to dedicated climate financing.

Although mainstreaming nature into infrastructure planning, decision-making, and operations faces unique challenges, the success of existing natural infrastructure projects demonstrates it can be done. To increase investment and harness the potential of natural infrastructure, government, private sector, civil society, financial institutions, and academia need to focus on three key priorities:

1. Completion of robust business and financial analysis to better understand the true cost savings provided by natural infrastructure, both in capital costs and long-term operations and maintenance costs;
2. Ensuring that the full benefits and costs of green infrastructure strategies are incorporated into impact assessments, now and under future climate conditions, which in addition to demonstrating the business case for green infrastructure, could also help leverage new financing streams, including climate finance; and
3. Ensuring that lessons learned from early and emerging natural infrastructure projects are effectively integrated into future projects, increasing success rates and reducing transaction costs.

Making progress in these areas will increase the role of nature in infrastructure system design, regulation, and investment plans, leading to more sustainable, climate-resilient infrastructure and cities for the future.

*Source: Kara DiFrancesco[1] and Todd Gartner[2], based on the Nexus Dialogue Synthesis Paper (Ozment, et al. 2015)*

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## 2.4 Implications for adaptation

Investments in sustainable infrastructure are a necessary condition for successful adaptation to the inevitable impacts of climate change. At the same time, adaptation remains inextricably linked and

endogenous to sustainable development. Adaptation can be viewed as an adjustment, process or outcome in natural or human systems in response to actual or expected climatic stimuli or their effects (IPCC 2014). Climate change will not only result in extreme events that necessitate protective adaptation measures, but it will also manifest in gradually altering temperatures, sea-levels as well as rainfall patterns. Such climate change impacts will require adaptation through sustainable infrastructure that helps build resilience of vulnerable communities and provides protection against exposure to extreme climate events, as well as helps devise long term sustainable development pathways.

Adaptation approaches can either be incremental or transformational in nature, with different implications for long term development pathways. For example, transformational adaption seeks to overhaul threatened systems, moving them to fundamentally new patterns, dynamics, and or locations (IPCC 2014). On the one hand, sustainable infrastructure solutions to help realize this transformative adaptation would rely heavily on stimulating innovation, unlocking new opportunities in the process, and consequently altering current patterns of consumption and production. On the other, incremental adaptation requires tweaking existing systems to make them resilient to climate change. For example, improved telecommunications and upgraded physical infrastructure can help improve information flows particularly with regard to extreme climate events, reduce uncertainty associated with climate change as well as provide physical security for the vulnerable.

The difference in adaptation needs between and within different regions around the world means that adaptation measures will involve a combination of incremental and transformational sustainable infrastructure investments. In regions where climate-induced sea level rise is expected to inundate large swathes of land, protection and resettlement of millions of people will require transformation of BAU infrastructure investments with renewed emphasis on smart cities and integrated service provision. Similarly, in regions where water resources are projected to become increasingly scarce, protection of agriculture-dependent livelihoods will require investments in climate smart agricultural infrastructure. The following table summarizes potential infrastructure interventions for adaptation (Table 1).

As climate change impacts are projected to vary across the globe, exposing some communities to greater risk than others, so will the adaptation of infrastructure needs and management responses. Furthermore, the differences in preexisting levels of infrastructure vary greatly between and within developed and developing countries. This will require different adaptation approaches even when responding to similar exposures. For example, climate change is expected to increase uncertainty and variability in water supply across the globe with some regions expected to witness increased supplies whereas others will experience a drastic reduction. This high variability-uncertainty scenario has significant implications for agricultural, industrial, as well as domestic water uses. To moderate expected impact requires adaptation measures. Research indicates that most of the adaptation costs in the water supply sector (83-90 percent) will be incurred in developing countries over the period 2010–2050 (Ward et al. 2010). Given the disproportionately greater exposure of the poorest communities to climate change impacts (IPCC 2014, Granoff et al. 2015, Burke et al. 2015, Nakhooda and Watson 2015), sustainable infrastructure investments in adaptation are crucial for preventing a reversal of the development gains made thus far. Furthermore, such diversity in climate change impacts highlights the importance of targeting adaptation infrastructure investments where needs are more urgent and potential gains high.

Significant progress has already been made in investing in infrastructure services that provide a basis for policymakers to make climate-adapted decisions, particularly in resource-constrained environments. For example, information systems that provide accurate and timely meteorological data enable improved and integrated resource management in areas with higher climate variability and exposure (World Bank 2016b).

**Table 1 Managing climate risk: Potential sustainable infrastructure inputs**

| Climate risk management response | Potential adaptation measures | Potential sustainable infrastructure inputs |
|---|---|---|
| **Avoid.** Bypass the risk | ▪ Retrofit existing investments<br>▪ Land use planning to restrict investment and settlement in high-risk areas<br>▪ Introduce or change regulations and standards<br>▪ Introduce licenses, user fees and labeling<br>▪ Introduce incentives for re-location to less climate vulnerable areas | ▪ Technological innovation<br>▪ Integration of ICT<br>▪ Upgradation of physical structures |
| **Reduce.** Decrease the exposure, potential impact or likelihood of an event | ▪ Invest in research and utilization of more drought and flood tolerant crops<br>▪ Improve water use efficiency and build water storage capacity<br>▪ Stabilize and protect ecosystems, such as mangroves, forests and wetlands<br>▪ Design and implement early warning systems<br>▪ Enhance public health programs for vector borne disease spread<br>▪ Build dykes, sea walls and other flood mitigation measures<br>▪ Build knowledge, capacity and diversify livelihoods<br>▪ Set aside land corridors for movement of wildlife<br>▪ Extend social protection systems for those most affected, particularly after climate shocks<br>▪ Public awareness campaigns and other educational and informational initiatives<br>▪ Switch activity or resource use to one better suited to climate change | Investments in:<br>▪ water (e.g. harvesting, storage, management, distribution, treatment and recycling)<br>▪ energy (generation, storage & distribution)<br>▪ solid waste (including collection, distribution, recycling & storage)<br>▪ transportation (including pedestrian, bicycle, vehicular, rail, air transport.)<br>▪ communication networks (including telephone, cellular and data)<br>▪ social infrastructure (education, healthcare, recreation, public services)<br>▪ food systems (including production, storage, processing and distribution)<br>▪ Protective infrastructure (floods, droughts) |
| **Accept and share.** Accept and plan for if the risk is realized | ▪ Plan early response measures<br>▪ Identify evacuation routes and plans<br>▪ Make formal or informal savings to respond to impact<br>▪ Identify access to debt for response<br>▪ Repair, reconstruct assets and build back better<br>▪ Mutual and reserve funds | ▪ Early warning systems<br>▪ Early response systems<br>▪ Protection / shelter (land, housing and property)<br>▪ Reconstruction of damaged infrastructure |
| Transfer the burden of climate impacts | ▪ Seek and provide access to insurance, e.g. from crop failure<br>▪ Seek reinsurance<br>▪ Build social safety nets<br>▪ Build social networks and informal risk pooling | |

*Source: Modified from Nakhooda and Watson 2015*

Similarly, climate-proofing future infrastructure investments at inception can be both cost-effective and timely. Further investments in sustainable infrastructure to ensure long-term food security, protection of human habitats and entire ecosystems are needed and should be undertaken in a holistic manner. This requires considering how each investment affects poverty, growth, and sustainable development. Sustainable infrastructure that promotes climate-smart land use can help achieve adaptation goals as well as sustainable food production and rural development while contributing towards climate change mitigation (GEF 2016). Investments to protect high-carbon stock forests, improve land management, and spur efficient agricultural production practices are key components of climate-smart land use and can help

offset emissions from fossil fuels (ibid). Such an integrated strategy can prevent the possibility of maladaptation where even small miscalculations at planning stages can lock the world into unsustainable long-term development pathways (Nakhooda and Watson 2015). Fortunately, the processes involved in undertaking infrastructure investments are conducive to considering and embedding adaptation requirements in their design at an early stage (ibid).

The following sections discuss in greater depth the estimated needs and means for sourcing such greening of infrastructure.

# 3. Assessment of current spending and future investment needs

Assessments of the magnitude of infrastructure investments required are inherently difficult due to a paucity of comparable, high-quality data. Systematic monitoring of spending at the national level occurs in only a few countries; consistent, comparable data on infrastructure stocks is non-existent. Estimates of current spending and projections of future needs are hampered because of differences in what is counted as infrastructure, which sectors are included, and whether capital investments and/or operations and maintenance are covered.

In its latest report, the U.S. Council of Economic Advisors defines infrastructure as "fixed capital assets that are consumed jointly in various production processes that facilitate and support economic activity, with "core" infrastructure referring to roads and other transportation facilities, power generation facilities and distribution networks, and water and sewer systems." The NCE includes all of these sectors as well as telecommunications but also includes primary energy generation and investments in energy use. In this report, as noted earlier, we follow the OECD and the World Bank, with core infrastructure defined as including power generation and distribution, transport, water and sanitation and telecommunications.

## 3.1 Past trends and estimates of current spending

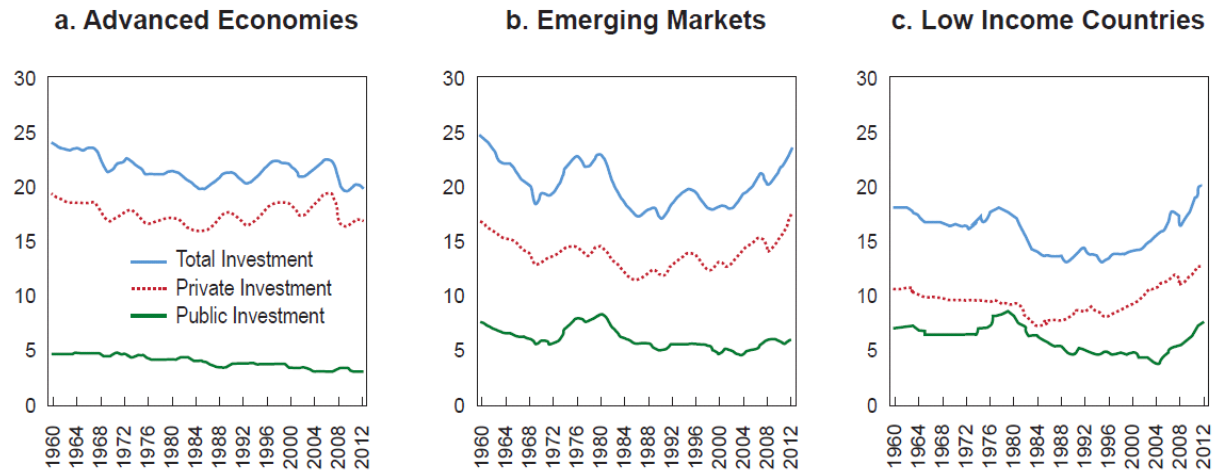
Since systematic and comparable data on public infrastructure investment are scarce, aggregate public investment is often used as a proxy to assess public infrastructure investment trends. A significant component of the public capital stock in most countries consists of infrastructure, with the public sector typically the main provider (IMF 2014a: Chapter 3).

Overall public investment rates have been declining in most economies for much of the past three decades. In advanced economies, public investment has fallen steadily from a high of just under 5 percent of GDP in the late 1960s to a historic low of just over 3 percent of GDP in 2012. In emerging markets economies, public investment peaked at over 8 percent of GDP in the late 1970s and early 1980s, then dropped to around 4-5 percent of GDP in the mid-2000s. It has since recovered partially to 6-7 percent of GDP. Low income countries (LICs) are the only group of countries where public investment rates have steadily and appreciably risen, from about 4 percent in 2004 to 8 percent in 2012 (Figure 6).

With infrastructure forming a major part of public investment, this decline in public investment rates has resulted in growing infrastructure financing gaps. Over the past three decades, the stock of public capital relative to GDP across advanced and emerging economies declined by an average of around 15 percent, as accumulation of capital stock has lagged behind growth in economic activity. Even in those economies where measures of the quantity of infrastructure appear relatively high, deficiencies in quality have increased (Qureshi 2016).

Data on actual infrastructure investments are fragmentary and subject to the definitional and data limitations noted above. Nevertheless, there are a multitude of data and studies on infrastructure spending for individual countries, regions and major sectors. It is possible to piece together from this disparate data a reasonably comprehensive dataset on spending, particularly for major countries and for regional and global aggregates. Building on the prior work of Bhattacharya and Holt (2015), we compiled the available information on "core" infrastructure spending to assess recent trends and to construct a baseline for infrastructure spending in 2015 by major countries, regions and sectors (Bhattacharya et al forthcoming).

**Figure 6 Trends in public investment by country income categories, 1960-2012, Percent of GDP**




*Source: IMF (2015)-1*

The data confirm the decline in infrastructure spending in the 1980s and the 1990s. Infrastructure investment as a share of GDP declined in much of the developing world during the 1980s and 1990s following the debt crisis of the early 1980s. A series of factors drove this trend. Widespread fiscal retrenchment and corresponding cutbacks in public investment was most evident in Latin America and Africa, just as there was a significant rollback in infrastructure investment in many countries in East Asia following the financial crisis of 1997. Another factor was the optimistic view about the extent to which the private sector would fill the gap. In Latin America where such expectations were especially high, with the exception of Chile, the increases in private investment were quite modest compared to the large rollbacks in public investment, with the result being a net shortfall of investments. A third factor underlying the declines in infrastructure investment was the withdrawal of traditional donors as well as multilateral development banks from infrastructure financing as large infrastructure projects fell out of favor over concerns about their environmental and social impacts.

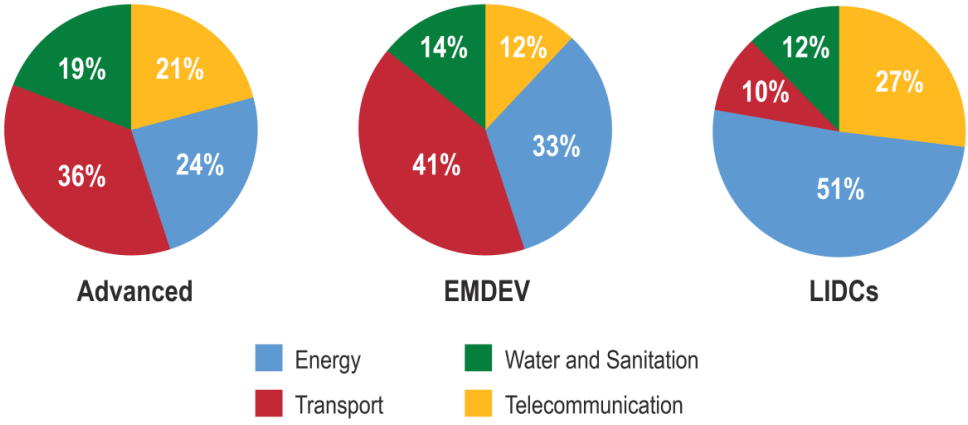
Starting with the early 2000s, there was a significant recovery in public investment in the emerging markets and developing economies; real investment in these countries collectively rose sharply – from 7.5 percent of GDP in 2004 to 9.5 percent of GDP by 2011. China has accounted for the largest share of this increase; but spending also increased substantially in India, Russia and the oil-rich countries of the Middle East. Infrastructure spending also rose significantly in sub-Saharan Africa, but with wide variations. On the other hand, spending increased only modestly in Latin America and Southeast Asia. Amongst advanced economies, Australia, New Zealand and Canada have had robust growth in infrastructure spending; United States and Japan had modest growth; whereas investment rates in the European Union have declined during and since the prolonged economic slowdown that began in 2009. More recently, many emerging economies are also now also affected by the slowdown and facing fiscal pressures, which may constrain their infrastructure spending.

Overall infrastructure investment has increased by around $1 trillion over the past decade to an estimated $3.4 trillion in 2014. Of this $2.2 trillion is accounted for by emerging markets and developing countries. This is substantially higher than what has been previously estimated. China alone accounts for $1.3 trillion, which is not only larger than all other developing countries, but also larger than all developed countries combined.

An assessment of sectoral trends suggests significant differences in investment emphasis across country groups. Overall, transport and power sector spending have dominated the infrastructure investment portfolio. The transport sector accounts for about 40 percent and power sector constitutes another 30 percent of the total investment. However, there are significant differences across country income groups (Figure 7) even in the short span of 2010-2012.

Transport has been a dominant sector for infrastructure investment in advanced economies, attracting about 36 percent of investment, followed by the power sector at 24 percent. In the emerging markets and developing countries too, transport (41 percent) and power sector (33 percent) were the two most dominant destinations of investment. In low income developing countries, the power sector dominates the demand for investment (51 percent of the total) followed by telecommunication (27 percent). Water supply and sanitation projects attract less than 20 percent of investments across all country income groups. Within the transport sector, road projects investments account for more than 60 percent of the total, dwarfing the share of spending on airports, railways, and seaports projects.

**Figure 7 Sectoral distribution of infrastructure financing, 2010-2012, percent**




*Source: Bielenberg et al. (2016)*
*Note: Based on a sample of 75 countries.*

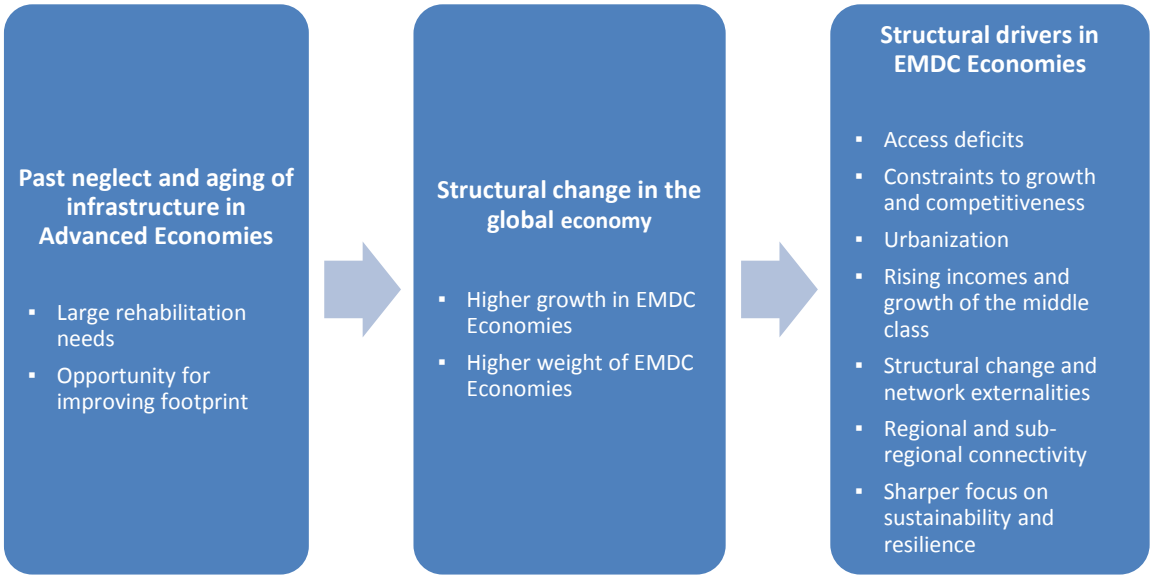
## 3.2 Drivers of infrastructure investment needs

Massive investments will be needed over the next two decades in energy development, sustainable cities, transport corridors, and water and waste management. There are three key drivers of the projected infrastructure investment needs in the next 15-20 years (Figure 8). First, many advanced economies will require large investments to rehabilitate existing infrastructure that has been run down due to neglect and insufficient investments over time. Accelerating the replacement of aging infrastructure offers an opportunity to improve the sustainability footprint and give greater impetus to the low-carbon transition. Second, the global economy is undergoing fundamental structural changes. Emerging and developing economies have had persistent high growth rates until recently and now constitute a higher share of the global economy. The major source of infrastructure demand will originate from these countries given their development needs and ongoing structural shifts.

EMDCs will constitute the largest infrastructure needs in the decades ahead, given their large and growing share of the world economy. In addition, the pace of economic growth in these EMDCs will significantly exceed that of the advanced economies from now until 2030. The share of EMDCs in global

GDP already exceeds 55 percent in purchasing power parity terms and EMDCs are projected to account for 70 percent of global growth between 2015 and 2030. Growth and rising incomes will generate more demand for infrastructure services than in the past – both in terms of quantity and quality. Past demand suppression associated with low income levels is being replaced by manifest increases in demand for infrastructure services and stock accumulation required to meet evolving consumer preferences as well as growing commercial and industrial demands (Bhattacharya and Holt 2015).

**Figure 8 Drivers of Projected Infrastructure Demand**




*Source: Authors' framework*

Since most of these developing countries suffer from large access deficits and poor quality infrastructure (Schwab and Sala-i-Martín 2015), with the exception of China, there will be greater need and imperative for these countries to spend larger shares of their GDP on infrastructure so as to meet their growth and development objectives. In addition, there are structural shifts occurring in the developing economies, amplifying the need for increased infrastructure investment. As developing countries grow, their secondary/manufacturing and tertiary/services sectors are gaining prominence. These sectors require more and higher quality infrastructural support to function effectively and are much more infrastructure-intensive than the agriculture-oriented economies.

Significant demographic shifts in EMDCs are another factor determining future infrastructure needs. By 2030, 79 percent of the world's middle class will be in the developing world (Kharas and Gertz 2010). In addition, the population in the developing countries will be much younger than the aging, and in some cases shrinking, populations of the advanced economies. This large cohort of relatively young middle-class consumers in many EMDCs, with rising incomes and aspirations, will add to the overall demand for infrastructure services.

Rapid urbanization in particular will have profound effects on infrastructure needs in developing countries in the coming decades. Between now and 2050, world population is set to increase by 2.3 billion, from 7.0 to 9.3 billion. The population living in urban areas is expected to grow by 2.6 billion, from 3.6 billion to 6.2 billion. Almost all of the increase in the global population between 2030 and 2050 is expected to come from developing countries and regions. Most of this growth will be concentrated in Asia and Africa.

The migration of the rural population into cities in search of better-paid jobs puts pressure on basic urban infrastructure. This phenomenon impacts infrastructure through a number of mechanisms:

- A shift from low-energy intensity agricultural production to the production of high-energy intensive, specialized commodities;
- A need for additional transport-related infrastructure to meet the increasing level of motorized traffic;
- A significant boost in construction and development required by urban concentration of economic activity.

Advanced economies too will require large investments to rehabilitate existing decrepit or neglected infrastructure. As discussed in the previous section, infrastructure spending in the advanced economies has been declining since the mid-1990s as indicated by the secular decline in public investment rates (IMF 2014a). This has resulted in declining quantity and quality of the public capital stock, and thereby in per capita stock of infrastructure. For instance, the American Society of Civil Engineers (ASCE) rated U.S. infrastructure quality in 2013 as poor, and estimated that $3.6 trillion was needed by 2020 to just update and upgrade existing facilities (ASCE 2013). OECD reports that "For OECD countries as a whole, investment requirements in electricity transmission and distribution are expected to more than double through to 2025/30, in road construction almost to double, and to increase by almost 50 percent in the water supply and treatment sector" (OECD 2014a). Countries in the European Union will need to augment recent spending levels that have been severely restrained since the economic crisis of 2008/09. Such spending is particularly needed in the new member countries of the European Union; accelerated investment will be critical to mitigate the existing infrastructural imbalance for better integration within the region, as well as to meet the priority of transitioning to a low-carbon economy (EC 2014).

## 3.3 Assessing future needs

Assessing the infrastructure needs of the developing world is, at best, a difficult task, given the absence of quality and comparable data. Infrastructure requirements differ by geography, demography, income level, growth, structural factors and political exigencies, among others. Despite the diversity of demand-side considerations, numerous attempts have been made to quantify and aggregate infrastructure investment requirements. Nonetheless, most existing estimates are based on a handful of original studies. Evaluating the conclusions and methodological approaches of these studies can provide insight into the current understanding of investment needs.

A multitude of factors influence the magnitude and nature of needs estimated in existing studies. These include, among others:

- The time horizon under evaluation
- The methodology employed (top-down vs. bottom-up, macroeconomic vs. microeconomic)
- The definition of infrastructure and inclusion/exclusion of particular sectors and sub-sectors
- The availability of data and specific countries from which it was gathered
- The type of investment (capital expenditure vs. operational expenditure)
- The underlying assumptions (development paths, GDP growth, existing spending, etc.)

Notwithstanding these differences, most needs estimates can be broadly divided into distinct categories, based on methodology:

- **Basic/universal access assessment:** Estimating the needs to meet a benchmark for basic infrastructure level and quantity in each sector (UN Sustainable Development Solutions Network 2015).

- **Sectoral needs assessment:** Estimating spending and needs according to anticipated demand or requirements for access across different sectors (McKinsey Global Institute 2013, OECD 2006, Foster & Briceño-Garmedia 2009, UN Sustainable Development Solutions Network 2015).
- **Cross-country econometric modeling:** Projecting needs based on historical demand patterns and estimates of sector-specific provision costs (Fay & Yepes 2003, Yepes 2008).
- **Macroeconomic modeling:** Estimating infrastructure investment needs as a percentage of GDP, based on growth projections (Fay, Toman, Benitez & Csordas 2010, Yepes, 2008).
- **Cross-country benchmarking:** Determining investment levels (percent of GDP) required to attain comparable infrastructures levels to other, more developed countries (Perriotti & Sanchez 2011).
- **Evaluation of development and enhanced sustainability targets:** Assessing spending requirements based on explicit domestic political targets or global development goals (GCEC 2014, McKinsey Global Institute 2013, McKinsey 2015).

Simple macroeconomic modeling based on historical patterns of expenditure and physical stock accumulation has been the most common method for estimating current spending and anticipated needs. This methodology was outlined in the 2003 needs study by Fay and Yepes (2003), which serves as the basis for many current estimates. Fay and Yepes used a macroeconomic model to estimate future infrastructure needs based on a link between per capita income growth and projected consumer and producer demand for services. Using lagged dependent variables, sector-specific demand assumptions and approximation of unit costs, Fay and Yepes aggregated regional estimates to value the world's infrastructure stock in 2003 at $15 trillion. Investment needs for developing countries were projected at $233 billion annually between 2005 and 2010, amounting to 2.7 percent of developing country GDP (though variation was projected by region and income-level). The inclusion of operations and maintenance needs brought the total to 5.47 percent of GDP.

Another approach to projecting infrastructure demand was utilized by the OECD in 2006, involving analysis of sectoral investments in a set of countries and utilizing econometric modeling to project aggregate spending needs. It was estimated that $53 trillion in total global investment would be required between 2000 and 2030, with the figure later increased to $64 trillion, based on a more detailed assessment of the transportation sector. The study projected that more than half of this investment would be required in developed countries, with spending on operations and maintenance constituting a substantial proportion of total financing. The McKinsey Global Institute (2013) employed a similar methodology as part of its global infrastructure needs projections, estimating that a total of $57 trillion would be required between 2013 and 2030, while assuming that efficiency gains achieved by following best practices would significantly decrease the total investment requirement.

In contrast, the Africa Infrastructure Country Diagnostic (AICD), undertaken by Foster and Briceño-Garmedia (2009) for the World Bank used detailed data collected at the local level to perform microeconomic modeling and spatial analysis, informed by supply-side considerations and country-level development targets. In what is probably the most thorough assessment to date, the AICD estimated that sub-Saharan African countries would need to spend approximately $93 billion annually on infrastructure between 2006 and 2015 to meet growth and development goals. This amounted to 15 percent of the region's 2008 GDP, 10 percent of which was for new investment. Existing investment was quantified at $45.3 billion per year (based on averages for 2001-2006).

A top-down, macroeconomic modeling approach was used by Fay et al. (2010) to make new estimates of infrastructure spending requirements. Assuming GDP growth of 4 percent among EMDCs, spending needs were projected at 5-6 percent of GDP by 2013, equating to $1.3 trillion to $1.5 trillion in annual investment. Existing infrastructure financing was estimated at $0.8 trillion to $1.1 trillion (in 2008 dollars). An assessment by the G20 Working Group on Infrastructure used a similar method to project slightly higher needs in 2011. Based on aggregation of various regional EMDC estimates, the report found that, on average, developing countries will need to invest 7 percent of GDP to meet basic needs and

support rapid growth. This amounted to $1 - $1.5 trillion in 2011. This approach tends to underestimate projections of future demand, since they are based on infrastructure needs during past growth spells, which means rising aspirations for sustainability and the infrastructure intensity that accompanies economic growth are discounted.

More recently, an evaluation by the World Bank (2013) in *Financing for Development* suggested that developing countries will require $1 trillion in annual investment until 2030 to meet infrastructure needs, with an additional with an additional $200 - $300 billion per year to ensure climate resilience. From a sectoral perspective, telecommunications accounted for the largest share, followed by power and transportation. Water and sanitation constitute an exceptionally small portion of the projected needs.

The Sustainable Development Solutions Network (SDSN) has estimated infrastructure needs based on achieving minimum quantitative benchmarks for infrastructure stocks and services commensurate with attaining the SDGs (attainment of specific goals, the financing of operations and maintenance costs as well as the financing needs required to finance the compositional change required in the shift away from capital investments in unsustainable technologies (such as high-carbon) towards sustainable infrastructure). Their analysis synthesizes other previous estimates on a sectoral basis while also accounting for the additional needs of middle and low-income countries that have a poor infrastructure base and would need larger proportions of GDP as investments to fulfill benchmark SDG standards. By their estimates, the incremental investment needs for 2015-2030 amount to almost $1.28 trillion to $1.36 trillion (in 2013 constant US$). About 46 percent of the investment needs are estimated to be in the transport sector, 27 percent in the power sector and 24 percent in the telecommunications sector, with water sector needs assessed at about 3.6 percent.

The New Climate Economy Global Commission on the Economy and Climate report (2014) adopted a detailed sectoral analysis estimating global investment needs for sustainable infrastructure between 2015 and 2030. Complementary studies by OECD (2006 and 2012), IEA (2012), and the Climate Policy Initiative (CPI) are used in the NCE assessment. The NCE study employs a broad definition of infrastructure as inclusive of investments in primary energy production (coal, oil) and investments in energy efficiency. Using existing technologies and investment patterns as the BAU scenario, the study projects that a total cumulative investment of $88.61 trillion will be needed between 2015 and 2030, which then rises to $93 trillion on a net basis when adopting a low-carbon investment strategy. This low-carbon investment path includes higher capital expenditure required upfront for newer but costly technology to improve energy efficiency in buildings and power generation; it also incorporates anticipated efficiency gains and savings from transitioning to more energy-efficient urban developments, from reducing fossil-fuel subsidies and from taking other initiatives for adopting sustainable infrastructure. By these projections, the power sector will require the greatest share of investment (35 percent), followed by water supply and sanitation (33 percent) and transport (21 percent). The NCE methodology assumes a global growth rate of 3 percent per year; it does not consider rationing, productivity gains, or the additional upfront capital costs to pay for climate resilience. The base-case estimate assumes infrastructure expansion that keeps pace with growth but will potentially lead to a 6-degree Celsius rise in temperatures above pre-industrial levels. The sustainable scenario meets the same infrastructure demand consistent with a 2 degree pathway.

McKinsey (2015) builds on the McKinsey (2013) and NCE (2014) estimates with a sectoral and country-by-country assessment of past investment trends (covering 2007-2012). The McKinsey 2015 analysis extrapolates past investment trends to estimate the allocation of NCE's projected overall investment levels between sectors and categorizes economies based on the World Bank's country income classification. They also opt for the NCE estimates for cost projection as "they provide a more comprehensive picture of the energy sector and include the cost of investing in sustainable infrastructure". The difference between the McKinsey (2013) and NCE (2014) estimates is explained by the difference in definitions of what is included in infrastructure, and differences in energy and water supply and sanitation sectors; the NCE energy estimates accounts for the full upstream investments needed to generate power,

such as upstream and refining infrastructure investments for oil and gas, and infrastructure investments for coal mining; NCE estimates include irrigation for agriculture in their water sector estimates, while McKinsey (2013) does not.

According to these estimates, 52 percent of investment demand for sustainable infrastructure will originate in the middle-income countries, 46 percent in the high-income countries, and only 2 percent in the low-income countries.[1] In terms of sectoral distribution, energy sector demand will constitute 43 percent ($40 trillion), followed by transport sector (29 percent or $27 trillion) and water supply and sanitation (21 percent or $19 trillion). Using the same projection methodology and comparing it with the investment rates of the recent past (2007-2012), the study identifies the investment gaps by sector and country income groups that are most likely to emerge if the current levels and quality of investment continue on the BAU path. The largest gaps would emerge in the middle income countries ($32 trillion), and the most in the power sector ($28 trillion), followed the transport ($11 trillion) and the water supply and sanitation sector ($12 trillion).

**Table 2 Comparative assessment of infrastructure needs, 2015-2030, US$ trillions (2015 US$)**

| Source | Coverage | Energy | Transport | Water Supply & Sanitation | Telecom | Total |
|---|---|---|---|---|---|---|
| OECD (2006) | Global except for water sector.[1] Needs are additions and renewals. | 3.9 | 6.0 | 17.0 | 5.9 | **32.8** |
| OECD (2012) | Transport sector only. | | 9.6 | | | |
| Boston Consulting Group (2010) | Global, using OECD and World Bank estimates. | 4.0 | 7.0 | 14.3 | 9.2 | **34.5** |
| McKinsey Global Institute (2013) | 84 countries that account for more than 90 percent of global GDP. | 13.2 | 25.8 | 12.7 | 10.3 | **62.0** |
| World Bank (2013) | Developing countries only. | 4.0 | 4.1 | 3.2 | 2.8 | **14.1** |
| International Energy Agency (2014) | Global energy needs only.[2] | 37.6 | | | | |
| NCE, 2014 (Total Needs - BAU) | Global | 50.4 | 14.8 | 23.1 | 7.7 | **96.1** |
| NCE, 2014 (Total Needs - Low Carbon) | Global | | | | | **101.6** |
| *NCE (Core Infrastructure BAU)* | Global | *11.0* | *14.8* | *23.1* | *7.7* | ***56.7*** |
| *NCE (Core Infrastructure - Low Carbon)* | Global | *-1.1* | | | | ***55.6*** |
| *NCE (Energy - Primary Generation and Use)* | Global | *39.4* | *0.0* | *0.0* | *0.0* | ***39.4*** |
| UNCTAD (2014) | Global | 9.5 - 14.4 | 5.3 - 11.7 | 6.2 | 3.5 - 6.7 | **24.5 - 38.9** |
| UN Sustainable Development Solutions Network (2015) | Global, meta-analysis of other studies.[3] | 5.3 - 5.4 | 9.5 | 0.03 | 5.0 | **19.8 - 19.9** |
| Brookings (2016) | Global | 20.5 - 23.9 | 27.2 - 31.4 | 12.7 - 14.7 | 16.6 - 15.5 | **74.7 - 86.6** |

***Notes***
All estimates are in US$ 2015, and adjusted for the 15 year period, 2015-2030.
1: Water sector projections include OECD and Brazil, China, India, and Russia.
2: Energy needs include energy supply (fossil fuel extraction, power generation, transmission and distribution) and energy efficiency needs.
3: Needs are adjusted for overlaps; Water sector estimates are for universal basic service coverage.

*Source: Bhattacharya et al. (forthcoming)*

Table 2 summarizes the estimates of projected needs from the studies reviewed above. They have been adjusted to allow for comparability. First, all estimates have been converted to 2015 dollars. Second, NCE estimates are shown separately for "core" infrastructure (since that is the definition that is used conventionally) in addition to one including primary energy generation and energy efficiency. Thus the NCE (2014) estimate for "core" infrastructure investment needs between 2015 and 2030 under a BAU scenario is $56.7 trillion (in 2015 dollars). This compares with the $62 trillion for McKinsey Global Institute. All other estimates in Table 2 for projected investment needs are much lower.

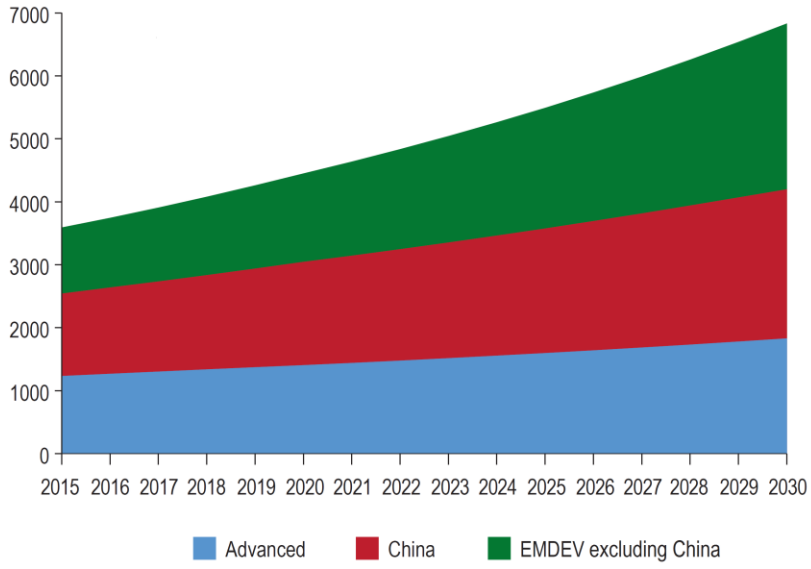
One reason existing estimates are low is because they do not capture the increases in infrastructure spending over the past decade, particularly in EMDCs. This is true even for the NCE and McKinsey estimates. As noted earlier, global infrastructure spending in 2015 is estimated at $3.4 trillion, much higher than previous estimates. The sector based methodology used by most of the studies also fails to capture the structural changes that are underway in the global economy and that are driving the increases in infrastructure investment spending.

Consequently our study uses a different methodology to assess the magnitude and structure of projected infrastructure investments. We calculate an updated baseline of investment spending for 2015 for major countries, then project investment requirements on assumptions of growth and investment rates that are based on assessments of investment plans and identified gaps across major economies and regions. The projections recognize the uncertainties both with regard to growth and investments as well as with respect to policies and financing. A significant limitation of the robustness of the estimates is that few countries have consistent estimates or projections for infrastructure investments based on assessments of needs. An exception is India which has undertaken regular assessments of infrastructure spending and needs. A recent comprehensive assessment prepared by the National Transport Development Policy Committee provides consistent estimates of infrastructure investment from the past and macroeconomic consistent projections until 2032 (NTDPC 2016). Despite the inherent limitations, the assessment carried out for this study provides a reasonable guide of projected trends and shifts.

Using this methodology, we estimate total infrastructure requirements over the next 15 years will be on the order of $75 - $86 trillion, much more than the current estimated stock of $50 trillion. These estimates are even larger than what had been estimated in NCE 2015, since $89 trillion ($96 trillion in 2015 dollars) includes investments in primary energy generation and energy efficiency in addition to core infrastructure. The equivalent figure for core infrastructure in the NCE report of 2014 is $57 trillion.

Around 70 percent of the projected investment needs ($3.5 - $4.0 trillion on average) will be required in EMDCs (except China), accounting for most of the increase. With rapidly growing populations and urbanization, investment requirements in Africa will grow most rapidly. But investment rates are projected to increase significantly in all developing regions with the notable exception of China (Figure 9).

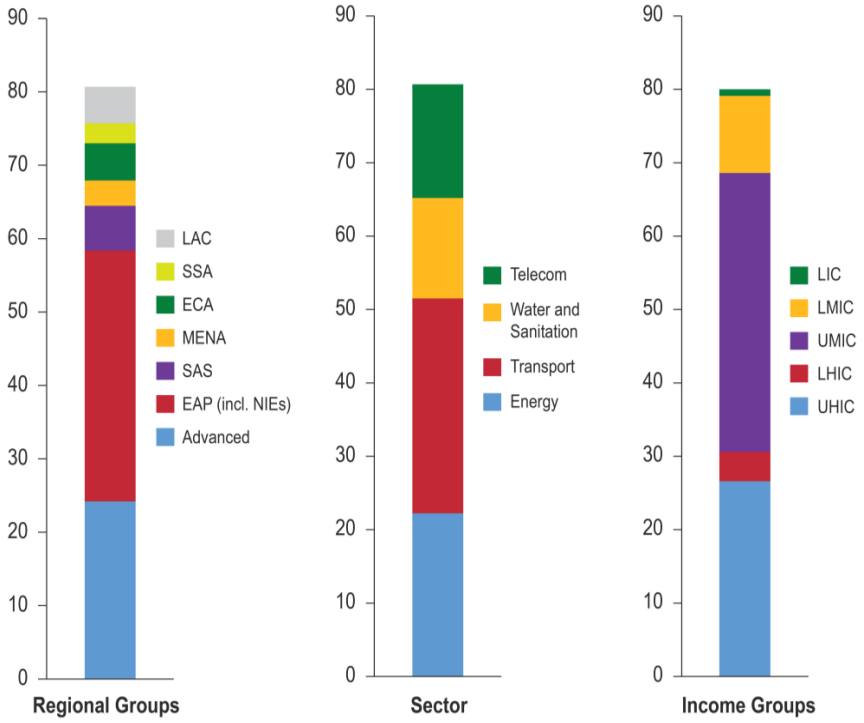
**Figure 9 Projected Annual Infrastructure Investment Trends, US$ billions (2014 US$)**




*Source: Bhattacharya et al. (forthcoming)*

As shown in Figure 10, power and transport account for 60 percent of the investments needed and are the most important for accelerating the low-carbon transition. Significant investments are also needed in water and sanitation to improve access and adapt to the impacts of climate change.

**Figure 10 Projected cumulative infrastructure demand by regional groups, sector and income groups 2015-2030, US$ billions (2014 US$)**




*Source: Bhattacharya et al. (forthcoming)*
*Note: Projections based on mid-point of range estimates. Excludes fossil fuel extraction and use, expenditure to enhance energy use efficiency, and operation and maintenance costs.*

In terms of income groups, the bulk of the requirements are accounted for by middle income countries, with the upper middle income countries accounting for the dominant share because of China. The absolute share of low income countries is small in part because of the diminished size of the group. Relative to GDP, low- and lower-middle income countries will see the highest investment rates.

## 3.4 Enhancing sustainability and resilience

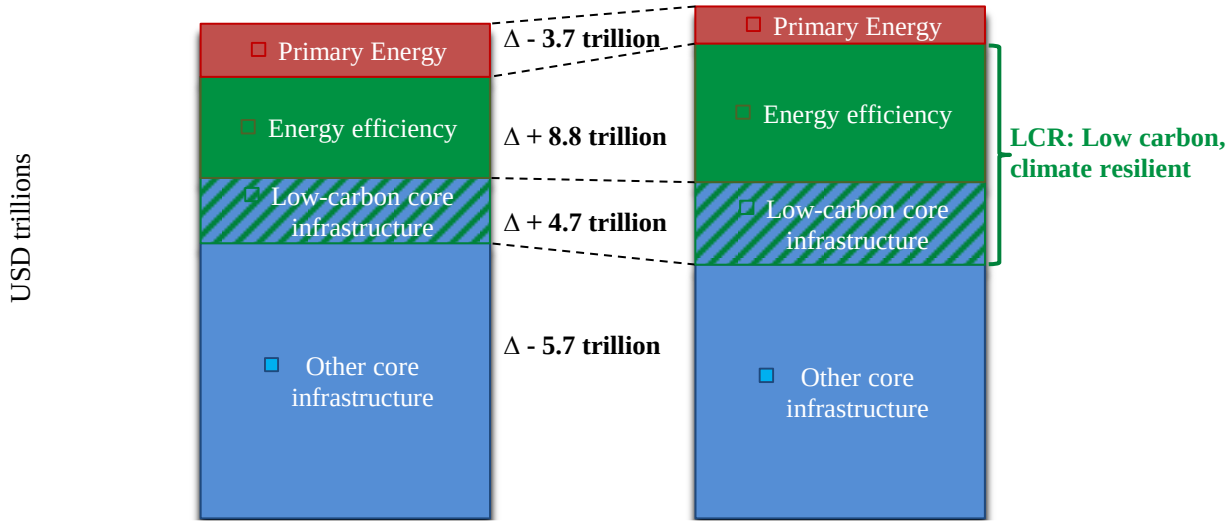
An important insight from the GCEC 2014 report is that, while there are upfront costs to ensure sustainability of infrastructure investments consistent with the 2 degree Celsius scenario, there are important offsetting savings as well. The additional costs are approximately $13.5 trillion, attributable to energy efficiency ($8.8 trillion) and low carbon technologies ($4.7 trillion). Associated with these costs are offsetting savings of approximately $5.7 trillion realized from reduced capital expenditure from fossil fuels (power plants), compact cities and transmission and distribution. The GCEC report also provides estimates for costs associated with primary energy (such as upstream costs for oil, gas and coal) at $12.52 trillion and offsetting savings of $3.7 trillion by 2030. Taken together, according to GCEC 2014, the total incremental infrastructure investment needs are $4.3 trillion.

Only a part of the NCE estimates is core infrastructure, which is now estimated to be higher. Based on the definition of core infrastructure, it is possible to further disaggregate incremental infrastructure needs into two components. First is low-carbon, climate resilient (LCR), and second is other, non-climate related core infrastructure. This is important, as core infrastructure accounts for approximately two thirds of GHG emissions, and demarking LCR infrastructure will be needed for targeted investments if the world is to achieve its climate goal and adapt to climate change.

LCR includes energy efficiency as well as low-carbon core infrastructure i.e. low-carbon renewable energy, nuclear, Carbon Capture and Storage (CCS), transport, water/sanitation as well as adaptation infrastructure to better withstand climate change impacts. Figure 11 shows that, between 2015-2030, $13.5 trillion, or approximately $1 trillion per year of low-carbon core infrastructure is expected to be built mostly for the energy and transportation sectors, representing 18 percent of core infrastructure. On top of low-carbon core infrastructure investments, energy efficiency investments are expected at approximately $24 trillion on top of core infrastructure investments. The total LCR requirements stand at approximately $39 trillion for the 15 year period.

Figure 11 also shows the LCR infrastructure needs consistent with a 2 degree climate goal. In this case, additional low-carbon core infrastructure investments of $4.7 trillion, or $313 billion per year, are needed. This includes additional investments in low carbon energy and transport, water/sanitation and adaptation. In addition, $8.8 trillion is required for improving the energy efficiency of buildings, industry and transportation, at approximately $586 billion per year. This raises total LCR infrastructure investment needs for climate change to US$52 trillion or US$3.5 trillion per year under a 2 degrees Celsius scenario. This increased need for LCR infrastructure does not factor in expected reduced operating expenses from low carbon technologies such as renewables, as well as upstream primary energy estimates mentioned above.

**Figure 11 Cumulative infrastructure investment needs, 2015-2030 (2014 US$ Trillions)**




Primary Energy: Oil, gas and coal
Energy efficiency: buildings, energy and transportation
Low carbon, core infrastructure: renewable energy, nuclear, CCS, transport, water/sanitation & adaptation
Other core infrastructure: non-climate related water/sanitation, transport, energy and telecommunications

*Source: Meltzer (2016)*
*Note: Computed estimates and projections based on information in GCEC 2014, IEA 2012, OECD/IEA 2013, UNEP 2016a, WRI 2015 and CPI 2015a.*

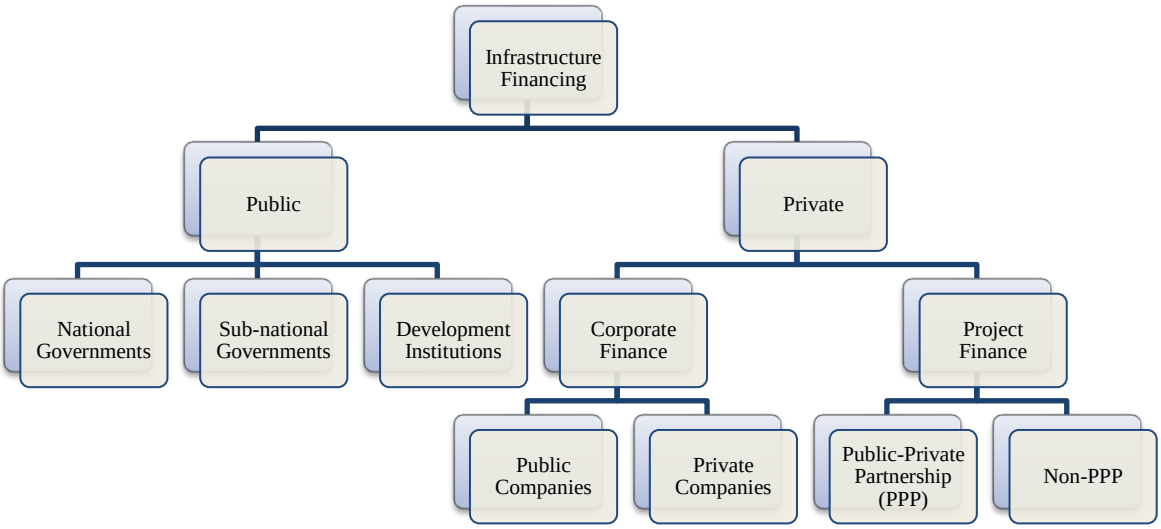
### 3.4.1 Adaptation costs

Calculating the costs of climate-proofing present and future infrastructure investments has proven to be a difficult task given the range of uncertainties involved with climate risk exposure as well as in finding common definition of adaptation needs. Adaptation infrastructure investments broadly fall under two categories: 1) protective infrastructure as well as infrastructure built to a higher standard that can withstand climate impacts such as coastal seawalls, flooding barriers and climate-resilient reinforced roads, and 2) preventive infrastructure that reduces uncertainty arising due to climate change such as efficient irrigation systems, high yield crops, low-carbon integrated energy systems etc. The complexity of often overlapping needs and the changes in long-term projections due to various investments scenarios undertaken today has resulted in a wide-range of estimates for adaptation needs, ranging from $4100 billion per year (Nakhooda and Watson 2015). The latest UNEP report on adaptation finance gaps forecasts the number to grow by between $140 billion to $300 billion by 2030, and between $280 billion and $500 billion by 2050 (UNEP 2016b). As a more precise picture of infrastructure investments needs emerges over time, the projected adaptation needs will likely be significantly higher than previous estimates (ibid).

# 4. Changing sources and channels of infrastructure finance

There are multiple sources of financing infrastructure as shown in Figure 12.

**Figure 12 Sources of Infrastructure Finance**




*Source: Inderst (2016)*

Revenue resources from national budgets have historically been a major source for infrastructure financing, particularly in developing countries. Lately, however, sub-national and local governments have grown in significance as they have been able to raise revenue finances of their own, and in some instances have successfully issued infrastructure bonds. Development institutions include the MDBs as well as national development banks (NDBs) are another important source of funds, with MDBs having been a critical source of funding for those developing countries with limited access to other sources of capital. MDBs continue to be a key source of infrastructure finance as well as a source of knowledge of best practices and technical expertise. NDBs are financial intermediaries established with government support (and most often with some form of government financing) that offer long-term capital finance and typically pursue specific mandates set by their respective governments. Consequently, they play a crucial role in supporting infrastructure planning, development, and financing, but in only few countries and through select NDBs.

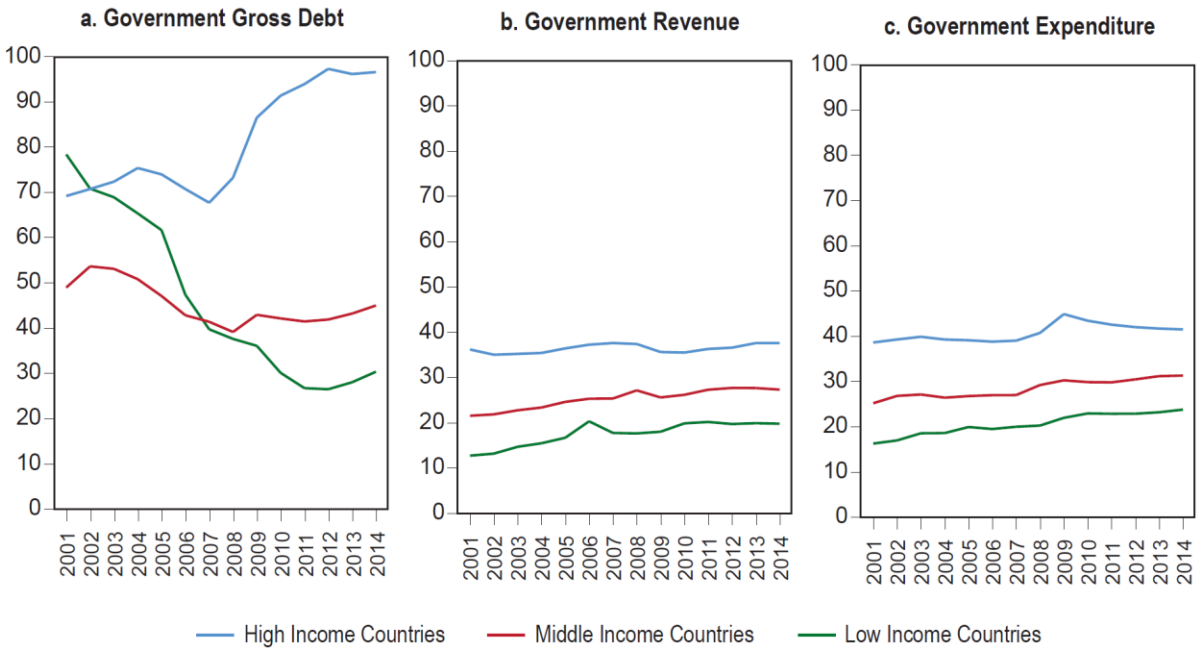
Corporate finance is the biggest source of privately financed infrastructure. In cases of corporate or on-balance sheet finance, a private operator may fund some of the capital investment for a project and obtain funding based on the balance sheet of the private operator rather than the project itself. Alternatively, project finance is a contractual financing arrangement specifically for infrastructure. Project finance is "the financing of long-term infrastructure, industrial, extractive, environmental and other projects/public services (including social, sports and entertainment PPPs based upon limited recourse financial structure where project debt and equity used to finance the project are paid back from the cash flow generated by the project, typically a special purpose vehicle (SPV)" (Inderst, 2016). Both corporate and project finance rely predominantly on debt financing through syndicated bank loans to finance infrastructure projects. Corporate bonds and new equity are other sources of private finance, but they have typically not contributed significantly to infrastructure financing.

## 4.1 Public finance

Direct budgetary contributions from public sector sources have been the main source of financing infrastructure investment in developing countries. In advanced economies, this share is lower; nevertheless it contributes to about 40 percent of infrastructure financing.

Efforts to further increase public infrastructure investment have been impeded by shrinking fiscal space. According to OECD (2015b), in advanced economies, where public investments account for about 40 percent of total infrastructure investments, the recent economic crisis resulted in an appreciable decline of their investment to GDP ratio in 2009 and 2010 (Figure 13). It has recovered to pre-crisis levels since then. But despite the fiscal consolidation since then, the residual effect of high public debt/GDP ratios that accrued during the global financial crisis along with tepid growth in these countries (and prolonged recession in others) has limited the prospect of significant growth in investment ratios in the foreseeable future. The investment to GDP ratio from 2015 to 2018 is rise to rise, by about 1 percentage point in most G20 countries, reaching 26.4 percent in 2018. This projection is boosted by non-OECD G20 member countries that have a higher investment rate than traditional OECD member countries. The variance ranges from about 17 percent in Argentina, Italy, and the UK to 46 percent in China.[2]

**Figure 13 Trends in government gross debt, revenue, and expenditure, 2006-2014, Percent of GDP**



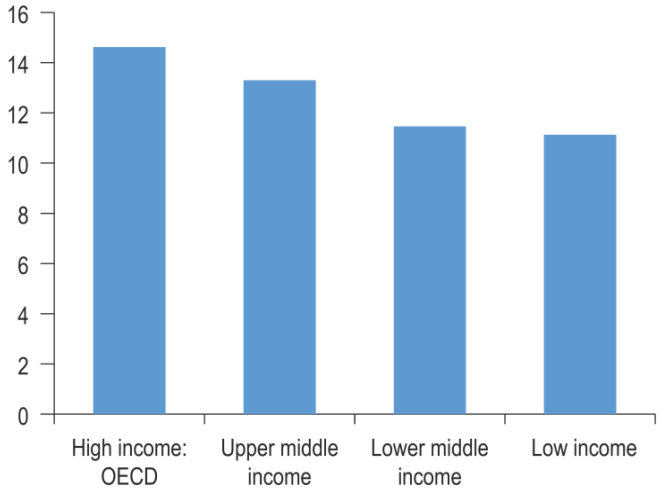

*Source: Qureshi (2016)*

In EMDCs, the share of revenue-financed public investment is even higher – at 60-65 percent of the total – and this remains a dominant and critical driver of their infrastructure investment (Ahmad 2015). However, the levels of public investments have been low in most developing countries, with a few notable exceptions such as China. Structural bottlenecks, rather than the lack of economic growth, have been the main constraints to expanding the fiscal space in these countries. Government revenue in developing countries have been significantly lower than the 18 percent of GDP estimated to be required to meet globally agreed development goals (Figure 14). And since these countries have higher infrastructure

investment needs as well as insufficient fiscal space, increasing public investments will require raising additional government revenues through improvements in tax administration and broadening the tax base (World Bank 2013b, Ahmad 2015, Qureshi 2016).

Domestic public finance is only one component of aggregate public investment. In LICs, aggregate public investments have also benefitted from increased external borrowing and growing official development assistance (ODA) that have together enlarged the fiscal space for domestic governments, in addition to some increase in domestic revenue generation. We discuss ODA trends in a subsequent section.

**Figure 14 Average Tax revenue, 2014, Percent of GDP**




*Source: World Bank 2015c*

## 4.2 National development banks

National Development Banks (NDBs) have grown in number over the past two decades, and so has their asset portfolio. In select countries, they play a crucial role in supporting infrastructure planning, development, and financing.

As financial intermediaries, NDBs offer long-term capital finance to projects that generate positive externalities and hence are underfunded by private creditors (UNDESA 2006). The NDBs have helped diversify domestic economies in the countries where they operate, boosting competitiveness and encouraging investment activity in line with specific regional development and reform priorities (OECD 2015b). These priorities have included infrastructure in certain periods and in certain countries. In EMDCs, NDBs have been a source of long-term credit, loan guarantees, and other financial services in the infrastructure, housing and agriculture sectors. In addition to financing, they have provided technical assistance for a range of infrastructure projects. Even in some advanced economies with well-developed private financial institutions and capital markets, NDBs such as the Kreditanstalt fuer Wiederaufbau (KfW) in Germany, Japan Development Bank, and Business Development Bank of Canada have played an active role in providing financial services to strategic sectors of the economy (Luna-Martínez and Vicente 2012).

However, the importance of NDB infrastructure financing should not be overstated; only some NDBs in a few countries focus primarily on infrastructure investment. Since World War II, several newly independent countries addressed their chronic lack of long-term financing of investment projects by

creating development finance companies, development funds, and NDBs. OECD estimated that there were about 340 development banks in some 80 developing countries in the mid-1960s (Chandrasekhar 2007).

While countries had different motivations in setting up NDBs, their emphasis in the 1960s was on industrialization and import substitution. During this period, NDBs invested in infrastructure projects as part of the core objective of industrialization. The 1980s and 1990s saw a shift in focus toward social development, export promotion, support to small and medium sized enterprises, and other core national development priorities (UNDESA 2006). This coincided with two trends. First, there was a wave of privatization of state-owned NDBs starting in mid-1980s that diminished the significance of these institutions in financing long-term capital projects (Luna-Martínez and Vicente 2012). Second, the late 1990s and early 2000s was a period when MDBs and prominently the World Bank, provided financial support to many of the NDBs, deemphasizing "brick and mortar" infrastructure investments. For instance, World Bank infrastructure lending went from about 40 to 50 percent of total lending between 1987 and 1998to less than 30 percent between 1999 to 2003 (World Bank 2006).

The importance of infrastructure investment and the prominence of NDBs in its financing re-emerged only during late 1990s and early 2000s when infrastructure projects began to be decentralized and there was a need to crowd-in funding from additional sources.

While data on the magnitude of NDB assets or loans and their sectoral allocation are scarce, the number of NDBs and their overall asset portfolios grew rapidly over the past two decades. By 2005, there were over 550 development banks worldwide, of which 32 were international, regional and sub-regional development banks, and about 520 were NDBs. These were spread across 185 countries, or an average of about 2.8 per country (Bruck 2005). Latin America and the Caribbean had the largest number of NDBs (152), followed by Africa (147), Asia and the Pacific (121), Europe (49) and West Asia (47).

Luna-Martínez and Vicente (2012) also report that the overall combined loan portfolio of NDBs increased from $1.16 trillion to $1.58 trillion dollars between 2007 and 2009 – a 36 percent nominal increase in just three years, far exceeding the 10 percent increase in private bank credit for the countries they surveyed during the same period. With 60 percent of NDBs recording up to 50 percent growth in loans, and another 24 percent growing by more than 50 percent, the NDBs were thus able to perform "a countercyclical role by increasing the supply of credit to private firms in their jurisdictions to partially mitigate the credit crunch associated with the global financial crisis".

However this growth in NDBs has benefitted infrastructure investment in only a few countries. From a survey of 90 NDBs across 61 countries, Luna-Martínez and Vicente (2012) find that only 53 percent of these NDBs have specific mandates, and only four percent have an infrastructure targeted mandate. As a consequence, only a few NDBs in China, Brazil, South Africa and Algeria (among the developing countries) and Germany have made significant infrastructure financing commitments (Table 3).

NDBs differ widely in their structure, financing, portfolios of assets and liabilities – which in turn dictates the nature of their engagement and operations. In terms of ownership, Luna-Martínez and Vicente (2012) find that in their sample of 90 NDBs, 74 percent were fully owned, funded, and administered by the government, and another 21 percent had the government as their majority shareholder. Hence the private sector only participates in the management of only 26 percent of NDBs.

Some of these NDBs have international operations. The German KfW and the China Development Bank have substantial international investments. BNDES now has presence in Montevideo, Uruguay and Johannesburg, South Africa (BNDES Africa). Conversely, Development Bank of Southern Africa (DBSA), although wholly owned by the government of South Africa, has operations in 14 countries spanning Southern Africa.

**Table 3 Diversity in the size and infrastructure contribution of prominent NDBs**

| Country | NDB | Total Assets USD billions | Total Loans USD billions | GDP 2014 USD billions | Total Assets Percent of GDP | Total Loans Percent of GDP | Infrastructure financing priority |
|---|---|---|---|---|---|---|---|
| China | China Development Bank | 1664 | 1281 | 10357 | 16.07% | 12.37% | Limited; 9% of loans |
| Brazil | BNDES | 373 | 80 | 2347 | 15.89% | 3.40% | Yes; 36.7% of loans |
| India | IFCI Limited | 6 | 3 | 2051 | 0.27% | 0.17% | Yes |
| | Industrial Credit and Investment Corporation of India (ICICI) | 106 | 31 | 2051 | 5.15% | 1.49% | No |
| | Industrial Development Bank of India (IDBI) | 58 | 20 | 2051 | 2.84% | 0.96% | No |
| | Infrastructure Development Finance Company (IDFC) | 14 | 8 | 2051 | .69% | 0.38% | Yes; > 85% of loans |
| | India Infrastructure Finance Company Limited (IIFCL) | 6 | 4 | 2051 | 0.31% | 0.22% | Yes; 100% of loans |
| | Total 5 (for India) | 190 | 66 | 2051 | 9.27% | 3.21% | |
| South Africa | Industrial Development Corporation (IDC) | 10 | 2 | 350 | 2.86% | 0.51% | Yes; 34% of new loans |
| | Development Bank of Southern Africa (DBSA) | 6 | 5 | 350 | 1.66% | 1.40% | Yes; > 90% of loans |
| Korea | Korea Development Bank | 263 | 136 | 1410 | 18.67% | 9.66% | No |
| Germany | KW | 650 | 585 | 3 874 | 16.77% | 15.10% | Limited; through KW-IPEX Bank |
| Algeria | Algeria Fonds National d'Investtissement | 9 | 7 | 214 | 4.33% | 3.22% | Yes; > 90% of loans |
| Angola | Angola Banco de Poupannca e Credito | 2 | 1 | 129 | 1.78% | 0.73% | No |
| Nigeria | Bank of Industry | 3 | 3 | 574 | 0.59% | 0.52% | Limited to Telecommunications secor |

*Source: Bhattacharya et al. (forthcoming)*

Sahoo et al. (2015) examine Brazil's and India's disparate approach to managing NDBs (see Box 15 for a full description). They conclude that competing engagement strategies offer different benefits and drawbacks in either approach—both in their theoretical potential, as well as that based on the actual implementation. Theoretically, a centralized system such as Brazil's could generate greater financial and administrative efficiency, better coordinate to achieve multiple policy objectives, and improve liquidity in the overall financial system; a decentralized system could instead spur greater financial innovation, increase participation by a wider array of financial institutions and private investors, reduce government interference, and allow smoother integration of international development finance. But in reality, they conclude that the differences in outcomes in infrastructure finance between the two countries were smaller than that anticipated; the differences were guided more by policies in implementation than by their financing models. While centralized model such as in Brazil generated a higher volume of financing and met broader government objectives, it had scope to improve.

A Taskforce on Development Banks and Sustainable Development convened by Boston University's Global Economic Governance Initiative and the Brookings Institution's Global Economy and Development program found on the basis of a number of case studies that national development banks are overlooked but essential players that could play an important leadership role, but that infrastructure is largely not a priority for the vast majority of NDBs (Studart and Gallagher 2016). In order to realize their

full potential as platforms to foster sustainable infrastructure finance, NDBs will need: prioritization from governments of sustainable infrastructure in their mandates; create platforms for blending instruments and co-financing; help develop, strengthen and scale up sustainable infrastructure projects; and engage with the broader regional and international development finance community.

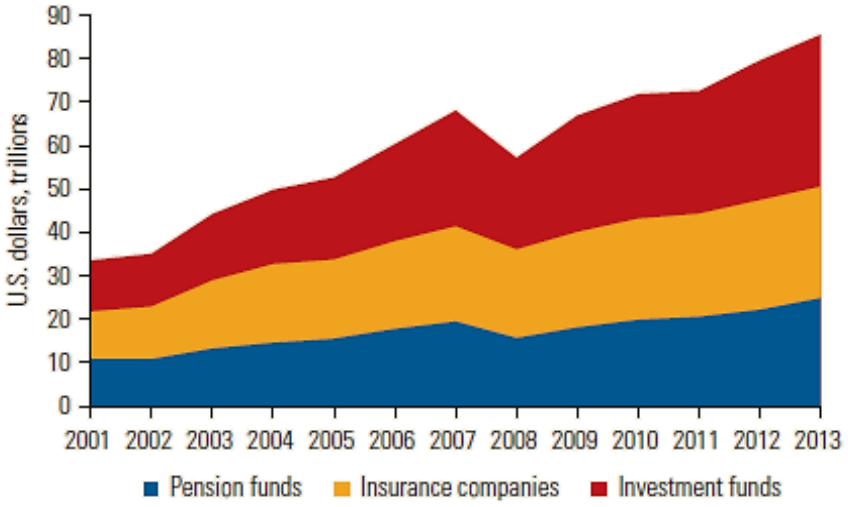
## 4.3 Private finance

### 4.3.1 Growing pool of private finance

The overall volume of private finance has grown rapidly over the past two decades. This includes growth in pools of private savings that can potentially finance long-term investments, including infrastructure. Despite this expansion in private finance, very little of this capital is being directed toward long-term investment, and even less is being made available for infrastructure financing.

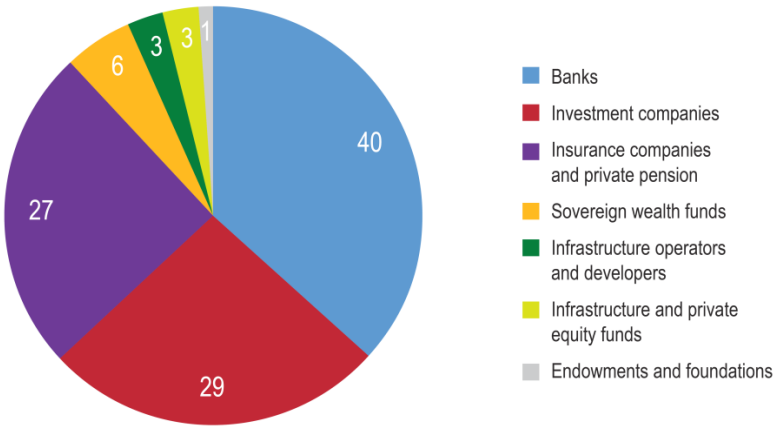
The magnitude of total private finance can be estimated from the trend of assets under management (AUM) held by private investors through banks, pension funds, insurance companies and investment funds over the past 20 years. The World Bank (2015c) estimates that, other than a brief decline during the global financial crisis, the stock of AUM under private management has maintained a robust growth trajectory (Figure 15). Bielenberg et al. (2016) use Preqin Global Database (2015) to estimate that private and institutional investors currently control approximately $120 trillion of AUM, with a majority of it in the advanced economies. And AUM in private control is anticipated to continue growing at a compound annual growth rate of around 6 per cent until at least 2020 (PwC 2015). This reveals the magnitude of existing private finance that can potentially be harnessed to long-term investment, and in particular, to finance infrastructure projects.

**Figure 15 Assets under Management of Non-Bank Institutional Investors, 2001-2013**




*Source: World Bank (2015)*
*Note: The figure above excludes the contribution of private banks that in 2015 accounted for an additional US$40.2 trillion in asset holdings.*

**Figure 16 Private Institutional Investors and their Asset Base, 2014, US$ trillions**




*Source: Bielenberg et al. (2016) using Preqin Global Database.*
*Note: The figure above excludes the contribution of public pension funds (about $11 trillion) and hence the total amounts to $ 109 trillion.*

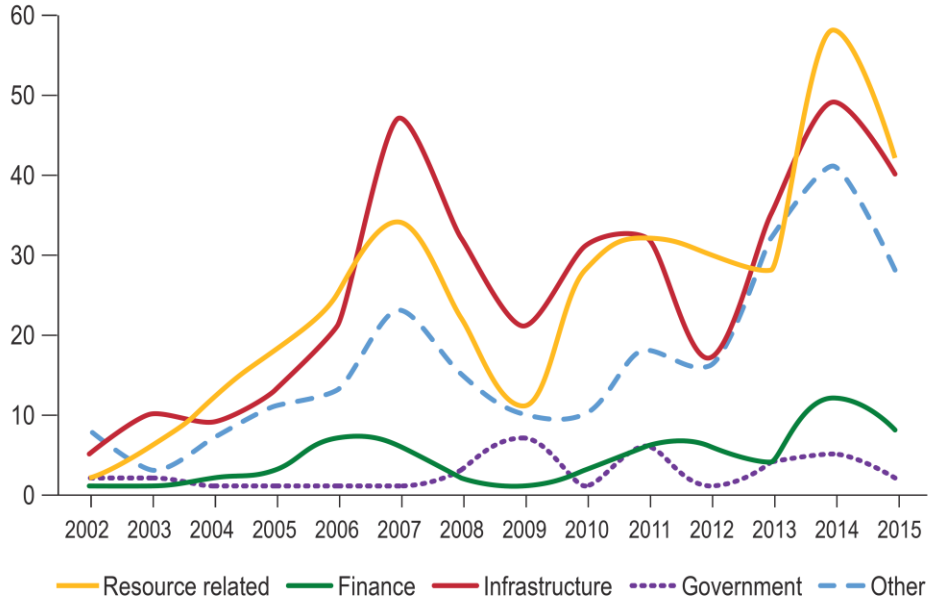
However, only a small fraction of this growing investible pool of capital is being channeled to finance long-term projects (World Bank, 2015c). The same World Bank report finds many households and firms across developed and developing countries face greater difficulty in accessing long-term financing in the wake of the global financial crisis. The G20 and Group of Thirty have also expressed concerns about the detrimental effects of a potentially constrained supply of long-term finance in meeting infrastructure investment needs. While investment allocations of institutional investors are difficult to specify due to cross-investments, an OECD report suggests that a large proportion of traditional and non-traditional investors appear to invest primarily in government bonds and other fixed income securities (Çelik and Isaksson 2013).

Infrastructure projects attract less than 10 percent of private equity AUM (Prequin 2015). In comparison to the total volume of private sector assets of $120 trillion, our estimates of current infrastructure investments of approximately $3.4 billion annually reveals the scope for such private savings to finance infrastructure projects if those natural impediments could be overcome. There is, nonetheless, some evidence that the share of non-bank private investment targeted at infrastructure projects is growing modestly, "reflecting the growing realization among long-term investors that infrastructure assets are a natural habitat for their investments" (Arezki et al. 2016).

Debt financing through syndicated bank loans, corporate bonds and the issue of new equity are a major source of private finance for infrastructure. Among them, syndicated bank loans have been the preferred instrument for private financing of infrastructure. In the early stages of infrastructure projects, banks are able to provide closer monitoring and scrutiny of projects as well as provide specialized expertise. This results in more successful implementation of plans in the critical first steps of project planning and construction that are typically more complex and riskier than the subsequent phase of operation. Closer monitoring by banks also help provide both project developers and financiers greater flexibility and more timely interventions when needed – particularly through gradual disbursement of funds, and in renegotiating and restructuring loans when facing unforeseen developments (Ehlers 2014). Cortina et al. (2015) also find that the average maturity period for syndicated loans in construction and transportation sectors in developing countries during 1991-2013 was about 12 years, which was higher than other sectors in developing countries as well as higher than for developed countries. This suggests yet another motivation for greater preference of syndicated bank lending for private infrastructure financing.

Despite this suitability of long-term syndicated loans for financing infrastructure, only a small proportion of total corporate finance contributes to infrastructure investment. Even at its peak in 2014, bank lending devoted to infrastructure was $50 billion out of a total volume of $165 billion (Figure 17).

**Figure 17 Unstable Recovery of Long-term Syndicated Bank Lending for Infrastructure, 2002-2015, US$ billions**



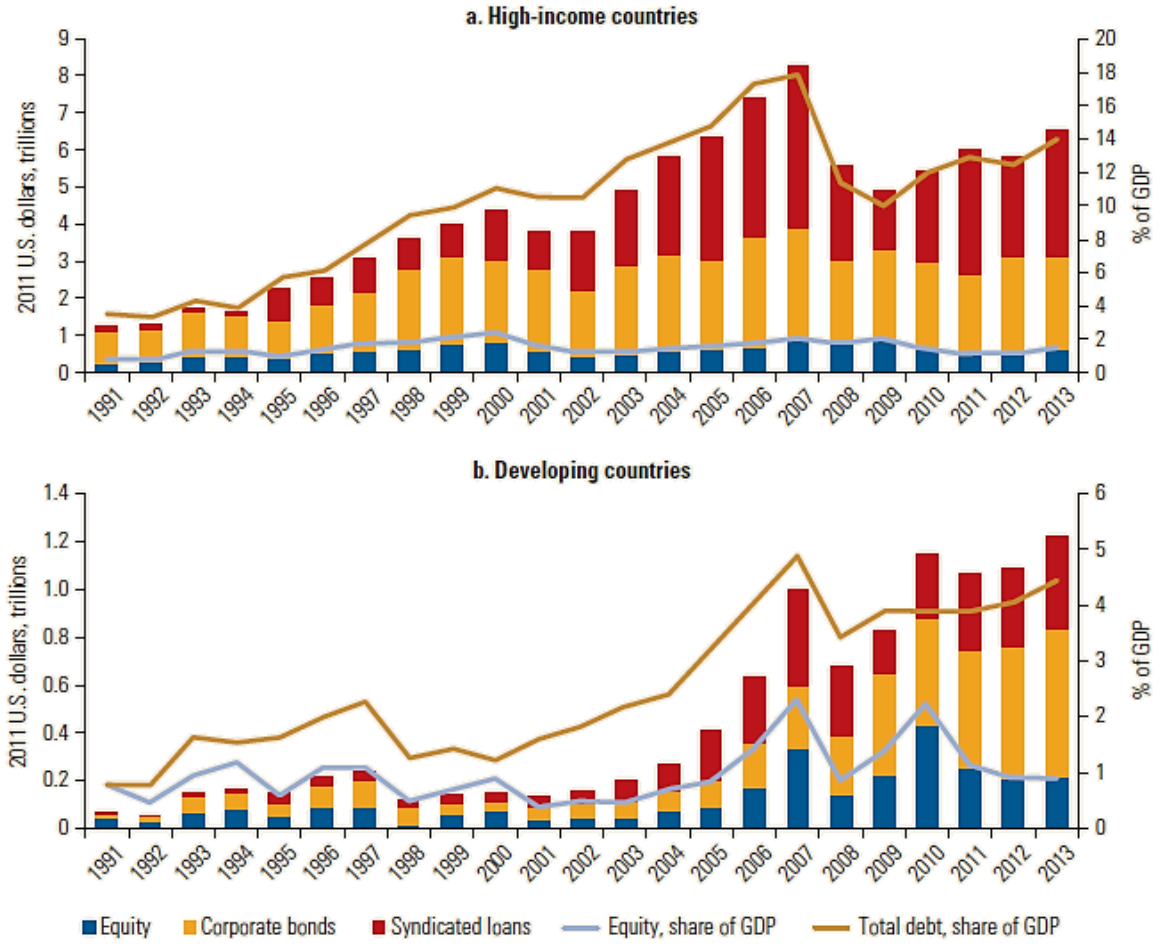

*Source: Dealogic and World Bank*

Bond finance is not a perfect substitute for syndicated bank loans; they are not well suited for the early stages of project finance, but can be used to bolster financing for well-established sponsors and for refinancing once projects reach their operational phase. The potential for bond financing is enormous once projects reach an operational stage and when stable underlying cash flows make infrastructure projects akin to fixed income securities (Ehlers 2014). Syndicated bank loans exceed infrastructure bonds in terms of the volume of private capital flows raised through debt financing for infrastructure in all regions except China. So, while corporate bonds have boomed since 2009, the share of infrastructure project bonds have grown primarily on account of China.

### 4.3.2 Comparing sources between developed and developing countries

A recent analysis by Cortina, Didier and Schmukler (2015) used a new dataset that includes 41 developed countries and 39 developing countries. It sheds important insights into the volume, channels and trends of private financing, both domestic and international, and in developed as well as developing countries over the period 1991-2013. They find that markets for private financing expanded rapidly since the 1990s – both in high-income as well as in developing countries. The total volume of private financing, which peaked in 2007 at over $9 trillion, recovered partially to nearly $8 trillion by 2013 (Figure 18). This growth was driven primarily by an increase in debt financing that far outpaced GDP growth rates during the period. Between 1991 and 2007, debt markets grew from 4 to 18 percent of GDP in developed countries, and from 1 percent to nearly 5 percent of GDP in the developing countries.

**Figure 18 Volume of equity, corporate bonds and syndicated loans, 1991-2013. 2011 US$ trillions, and percent of GDP**



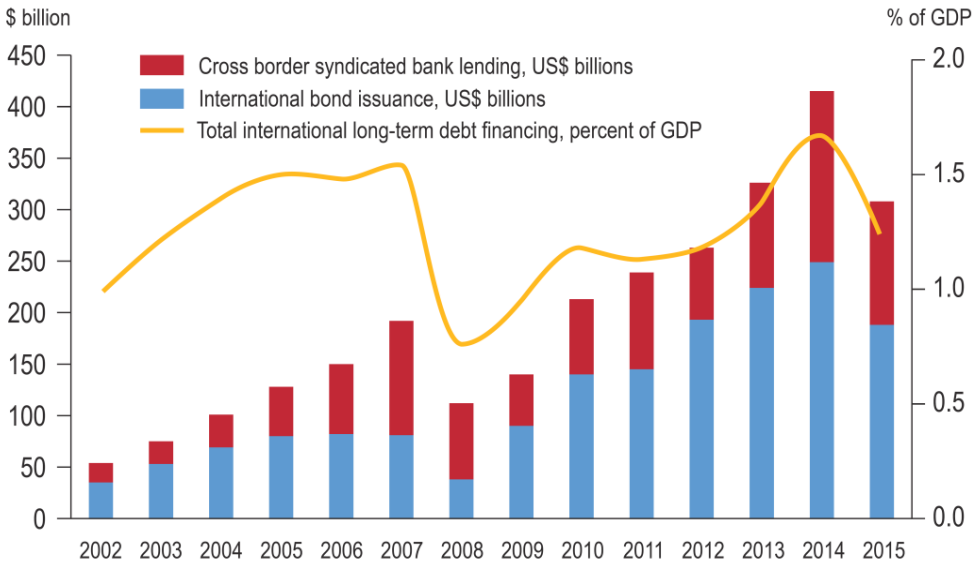

*Source: Cortina, Didier, and Schumukler 2015*

In developing countries, approximately 60 percent of all infrastructure investment is financed through private banks, and that proportion is higher than for developed countries (Bhattacharya, Oppenheim, and Stern 2015). Indeed, project finance accounts for 25 percent of syndicated loans in developing countries, as compared to less than 5 percent in developed countries (Cortina et al. 2015).

Cortina et al. (2015) find that the global financial crisis led to a global decline in the volume of debt financing market. Developed countries suffered more than a 45 percent decline in debt markets, whereas developing countries underwent a 15 percent decline. During the crisis, high-income countries experienced a proportional dampening in all forms of debt, reflecting the combination of both supply and demand decline in debt finance. The distribution between corporate bonds and syndicated bank loans has remained stable in the post-crisis recovery, although the aggregate levels are yet to reach the pre-crisis level.

In developing countries, the markets for private finance have been volatile over the past 10 years. There was an overall decline in aggregate private financing between 2008 and 2009, followed by a rapid recovery from 2010 onwards (Figure 19). While syndicated bank loans have only had a modest recovery that began in 2014, a sharp and sustained increase in corporate bond issuance since 2009 has offset the decline in syndicated bank loans, so much so that aggregate levels of private finance and debt finance have both surpassed pre-crisis levels. Corporate bond issuance is now the largest component of market for private finance. However, this boom in corporate bonds in developing countries since the crisis has not done much to stimulate infrastructure finance, as little of it is used for infrastructure, aside from China (Ehlers, 2014). Issuance of new equity has had spurts of growth, but it remains a small proportion, accounting for less than 20 percent of total market for private finance in developing countries.

**Figure 19 Long-term debt financing for developing countries, 2002-2015. US$ billions, and percent of GDP**




*Source: Dealogic and World Bank*

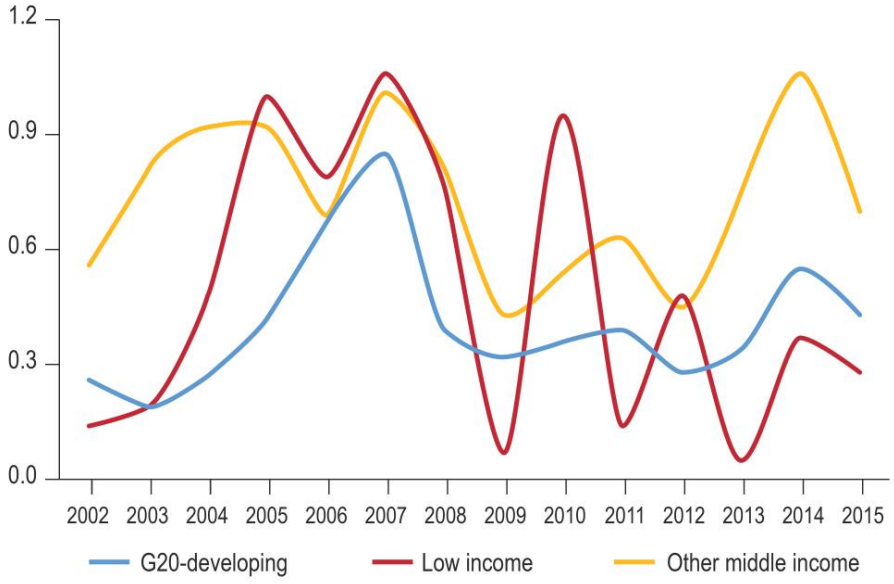
In developed countries between 2002 and 2015, the proportion of domestic channels of private financing surpassed international channels. In contrast, developing countries relied much more on international channels for private financing prior to the crisis – the proportion of domestic financing was much smaller, particularly in the market for syndicate bank loans. However, since the crisis, domestic markets have become more prominent in both syndicated loans and corporate bonds markets for these countries.

Domestic syndicated loans have grown steadily in developing countries since early 2000s, in contrast to the volatile swings in international channels of such private finance. International bank lending took off in the mid-2000s, only to decline by almost 75 percent in just two years between 2007 and 2009. This sharp decline was most likely a consequence of the combined impact of supply and demand side constraints. On the supply side, Western European banks that were leading financiers of international syndicated bank lending to the developing countries, were severely restrained by both deleveraging pressures as well as tightening banking regulations imposed through the new Basel III stipulations that sought to restrict long-term borrowing (World Bank, 2015). On the demand side, the global recession dampened the demand for new investment with foreign currency exposure. International bank lending has made an anemic recovery from its large decline and is far from reaching its pre-crisis high level. Meanwhile, domestic sources of

financing have become more prominent and have grown to such an extent that they offset the decline in international sources such that overall aggregate levels of syndicated bank loans in developing countries have remained stable. Cortina et al. (2015) estimate that, in these countries, 58 percent of domestic bank loans are used for infrastructure finance, as opposed to only 20 percent of foreign bank loans. So the steady growth of domestic syndicated bank loans ought to have mitigated some of the decline in infrastructure finance. Meanwhile, there has also been an increase in cross-border lending between developing economies, helping reduce the impact of a decline in syndicated bank loans from developed to developing countries targeted for project finance.

Even among developing countries, the recovery of long-term syndicated bank lending has been uneven (Figure 20). By 2014, in large developing middle-income countries (that are members of G20)[3] as well as in the remaining middle income countries, the volume of such loans recovered and surpassed their pre-crisis 2007 levels. However this rebound has lagged behind GDP growth, especially in large middle income countries. Meanwhile, low income countries attract only about $1 billion in syndicated loans annually, an amount that is marginal both in absolute and relative terms.

**Figure 20 Long-term syndicated bank lending for developing countries, 2002-2015. Percent of GDP**

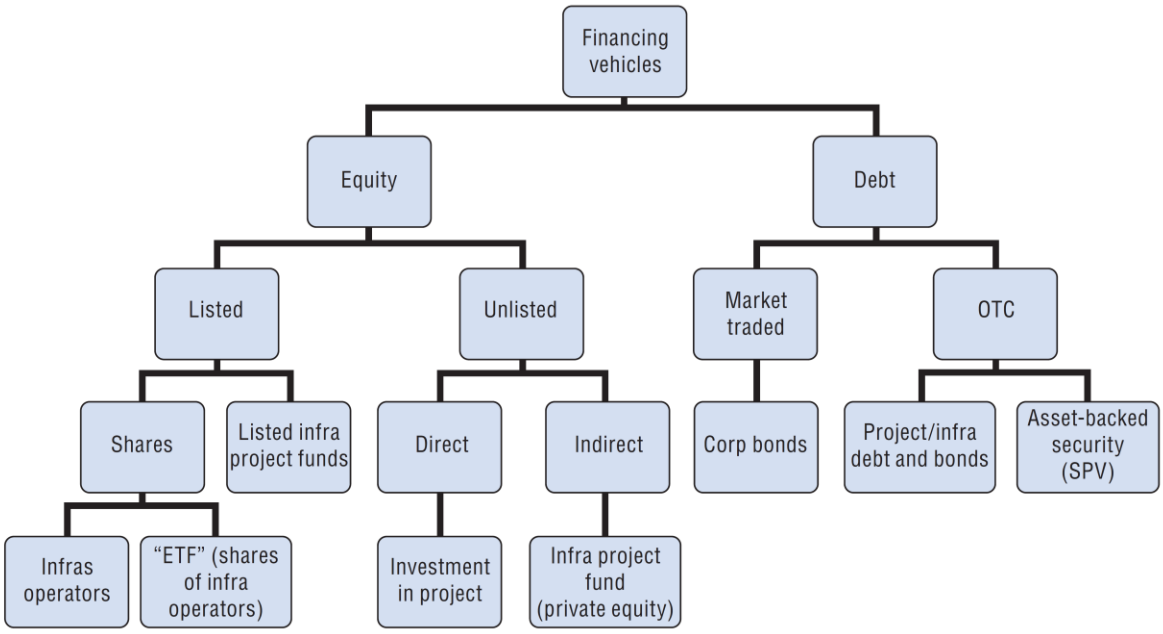



*Source: Dealogic and World Bank*

### 4.3.3 Evolving channels and instruments for private infrastructure finance

In principle, there are multiple channels available to the private sector to exploit the pool of capital for infrastructure (Figure 21).

**Figure 21 Channels and instruments for private investment in infrastructure**




*Source: Della Croce and Gatti (2014)*

There has been a growth in the structure of instruments for private investments in infrastructure, but so far, only a few advanced economies have been able to exploit these opportunities. The range of available channels and instruments for mobilizing private financing of infrastructure have become more sophisticated; each instrument has its unique set of characteristics and therefore implications for lending or investment portfolios. But they have been used primarily in the advanced economies where institutional asset money is beginning to grow and more long-term institutional investment is being channeled to finance infrastructure.

These sophisticated instruments have evolved over time, each with its unique set of characteristics and therefore implications for lending or investment portfolios. OECD (2015f) has developed a taxonomy of financial instruments that details both their variety and also their suitability for different asset categories (Table 4).

The variety and specificity of different modes and instruments of private financing (both corporate and project finance) offers a menu of channels that link the pools of capital to asset types results. It thereby greatly assists in overcoming some of the typical bottlenecks that have traditionally prevented private financing from being attracted to infrastructure investment. However, the use of these instruments has been limited so far, and has been predominantly localized in the advanced economies (OECD 2015f).

**Table 4 Taxonomy of instruments and vehicles for private infrastructure financing**

| Modes | | Infrastructure Finance Instruments | | Market Vehicles |
|---|---|---|---|---|
| Asset Category | Instrument | Infrastructure Project | Corporate Balance Sheet / Other Entities | Capital Pool |
| Fixed Income | Bonds | Project Bonds | Corporate Bonds, Green Bonds | Bond Indices, Bond Funds, ETFs |
| | | Municipal, Sub-sovereign bonds | | |
| | | Green Bonds, Sukuk | Subordinated Bonds | |
| | Loans | Direct/Co-Investment lending to Infrastructure project, Syndicated Project Loans | Direct/Co-investment lending to infrastructure corporate | Debt Funds (GPs) |
| | | | Syndicated Loans, Securitized Loans (ABS), CLOs | Loan Indices, Loan Funds |
| Mixed | Hybrid | Subordinated Loans/Bonds, Mezzanine Finance | Subordinated Bonds, Convertible Bonds, Preferred Stock | Mezzanine Debt Funds (GPs), Hybrid Debt Funds |
| Equity | Listed | YieldCos | Listed infrastructure & utilities stocks, Closed-end Funds, REITs, IITs, MLPs | Listed Infrastructure Equity Funds, Indices, trusts, ETFs |
| | Unlisted | Direct/Co-Investment in infrastructure project equity, PPP | Direct/Co-Investment in infrastructure corporate equity | Unlisted Infrastructure Funds |

*Source: OECD (2015f)*

## 4.4 Multilateral development banks

### 4.4.1 The importance of MDB financing

MDB financing has helped address the main constraints holding back the implementation and financing of sustainable infrastructure in emerging markets and developing countries. This stream of financing has been very appealing for multiple reasons. Infrastructure has been proven to be critical for economic growth and development. Thus, financing these key sectors in developing countries that typically have large unfulfilled infrastructure needs matches well with the prime mandate of the MDBs.

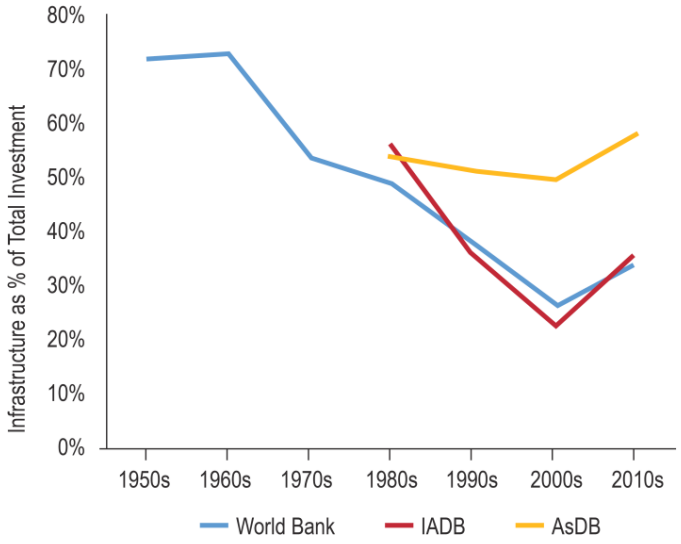
MDBs have been a critical source for augmenting investment capital in developing countries where there are few alternatives – both in terms of quantity of financing and in terms of financing costs. While public financing has always been the primary source of finance in developing countries, as discussed above, these countries typically lack the fiscal space to generate adequate resources to match the level of needs. These countries also face impediments in accessing private financial markets that could have otherwise been a source of investment finance. First, very few developing countries have access to private capital markets; World Bank (2013b) estimates that only 20 middle income countries do, leaving the remaining 84 middle income and 31 low income countries cut off from this stream of financing. Second, infrastructure projects typically have long gestation periods, so even if the countries are able to gain access, the cost of capital proves too high for scarce long-term capital that can finance them. MDB financing helps overcome market failures and achieves greater investment through concessional financing than otherwise possible. And finally, the MDBs have "an unparalleled ability to transmit best practices

via technical assistance and project preparation to realize these gains in developing country infrastructure projects" (Humphrey 2015). Another argument in favor of MDB involvement is that efficiency gains from utilizing best practices in infrastructure design and implementation can amount to 30 percent to 40 percent of project costs (McKinsey 2013).

### 4.4.2 Trends in MDB financing

MDBs have historically been among the most prominent financiers of infrastructure investment, particularly in developing countries, and continue to be so. While the 1990s and early 2000s were a period that witnessed a shift in MDBs' emphasis away from "brick and mortar" infrastructure project financing and toward policy lending and human development, financing infrastructure projects has regrown in importance and prominence since then (Figure 22).

**Figure 22 Share of infrastructure in total investment commitment, select MDBs, decade average, percent**




*Source: Humphrey (2015)*
*Note: World Bank includes IBRD and IDA only. Includes only investment in new or rehabilitated physical infrastructure; does not include sectoral reorganization, policy reform, or privatization operations. "2010s" refers to 2010–2013.*

MDB financing of infrastructure has nearly doubled between 2004 and 2013, although the data suggest that this is driven more by the growth in the overall financing portfolio of the MDBs than by any dramatic increase in the prioritization of project financing. The apparent growth in infrastructure investment, from $20 billion a year in 2004 to about $54 billion in 2013, appears to mirror the expansion of the overall MDB financing portfolio for the period. During the same period, total annual MDB loans, guarantees and commitments grew from $60 billion in 2004 to over $140 billion in 2010.

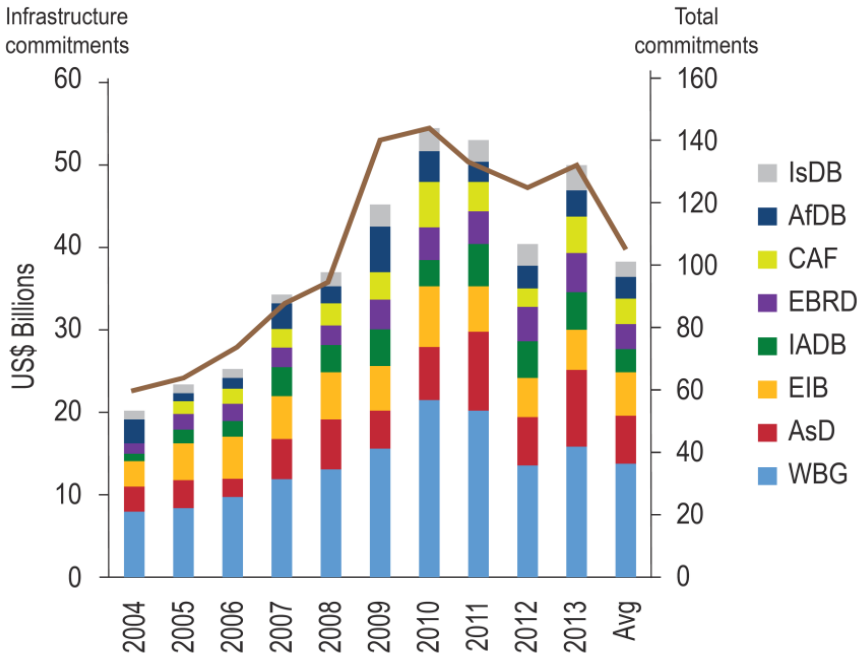
MDB infrastructure investment financing, while catalytically important, is a small component of the overall infrastructure spending in EMDEV countries of nearly $2.4 trillion per year. World Bank (2012b) estimates suggest that MDBs invested about $55 billion a year on infrastructure (in 2013, and thereafter) which seems to overstate their direct support for infrastructure investments. An independent assessment by Humphrey (2015) estimates that while the MDBs' average annual financing was more than $100 billion per year for 2004-2013 and for the same period, their average annual infrastructure financing was about $38 billion per year (Figure 23). This reinforces the conclusion that the share of infrastructure in

MDB investment still remains below 40 percent – and much lower than the levels during the decades of the 1950s through 1980s. OECD (2013) estimates seem to support this notion; they estimate that Development Assistance Committee members provided $136.7 billion of ODA in 2010 (also cited by World Bank (2015d) in their joint submission to the G20). But of this amount, multilateral ODA from MDBs amounted to $37.6 billion; multi-bilateral non-core ODA of $16.7 billion and purely bilateral ODA of $82.4 billion accounted for the balance (OECD 2013).

In terms of composition among MDB members and the type of financing they offer, the World Bank is the dominant contributor among MDBs; its lending commitments of about $31.5 billion in 2013 was more than double that of the Inter-American Development Bank ($15.5 billion) and the Asian Development Bank ($14.3 billion). A significant part of World Bank financing however is for non-project lending. The World Bank also dominates in concessional financing ($ 16.3 billion; 57.75 percent of its total). Only the African Development Bank has a higher proportion of concessional funding.

Transportation and energy have been the two most strongly supported sectors in the past decade, constituting over 70 percent of infrastructure lending for all eight MDBs (and over 75 percent for the World Bank and four main regional MDBs). There are, however, differences among the MDBs, and notable in those differences are the large share of water sector investments by the Inter-American Development Bank (IADB), European Investment Bank (EIB), and the Islamic Development Bank (IsDB); (Figure 24).

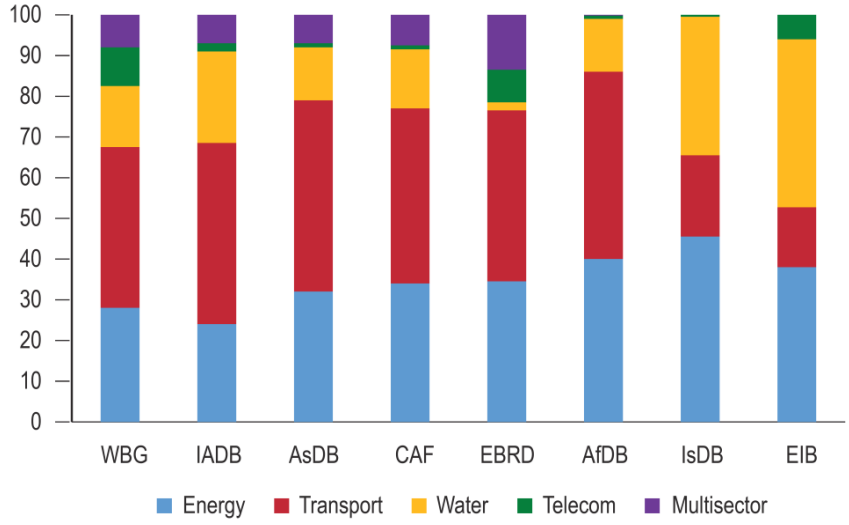
**Figure 23 Infrastructure investment commitments by MDBs, 2004–2013, US$ billions**




*Source: Humphrey (2015)*

*Note: Left axis: Infrastructure loan, guarantee and equity commitments (denoted as histogram bars). Right axis: Total MDB loan, guarantee and equity commitments (denoted by red trend line).*
*Both sovereign and non-sovereign guaranteed projects as well as concessional, non-concessional, and grant financing included. Includes only investment in new or rehabilitated physical infrastructure; excludes sector reorganization, policy reform, and privatization operations.*

**Figure 24 Sectoral composition of infrastructure investment commitments, 2003–2014, Percent of total**



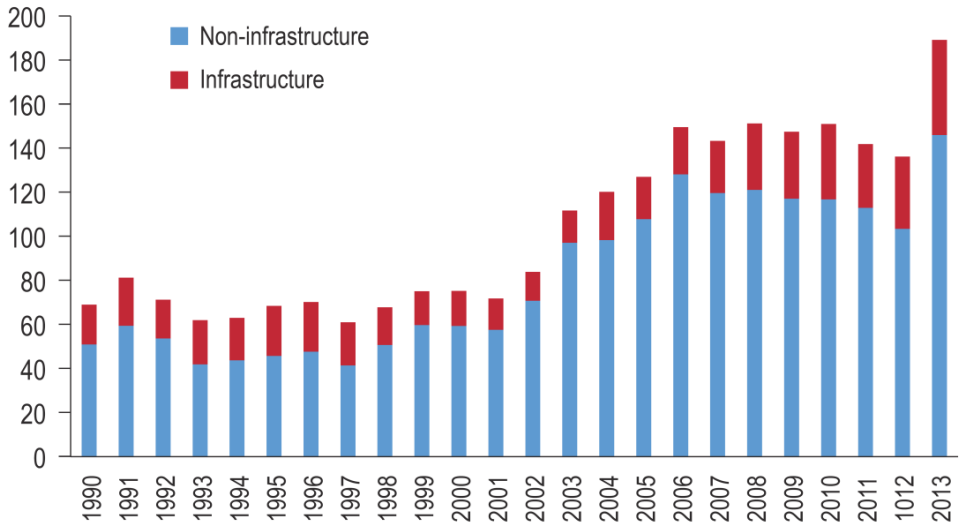

*Source: Humphrey (2015)*

## 4.5 Official development assistance

ODA, which includes concessional development assistance in form of grants and loans, has grown rapidly since mid-2000s (OECD 2008). In 2002, total ODA grants and loans amounted to $65.6 billion; by 2013, this total had risen to $186.1 billion – a growth of 183 percent over 12 years. The growth trend was temporarily upset in 2011 and 2012 as a result of the prolonged recession in ODA DAC member countries (OECD 2016). But the growth trajectory seems to have been restored, with ODA levels recovering to reach a new high in 2013.

*While infrastructure constitutes a smaller part of total ODA investment, its share has been rebounding and it remains a significant contributor to the overall pool of infrastructure investment* (Figure 25). Of total concessional financing, the share of infrastructure investment was between 20 and 30 percent during the 1990s. The shift in emphasis of the World Bank in the late 1990s and early 2000s away from infrastructure projects towards policy lending and human development funding resulted in the share of infrastructure falling below 20 percent during 2001 and 2009. That downward trend ended around 2005. With greater recognition then of the importance of infrastructure to growth and poverty alleviation, the role of multilateral assistance began to be considered essential (Gutman, Sy, and Chattopadhyay 2015). Since 2004, infrastructure spending in ODA has gradually recovered to more than 22 percent of the total. In proportional terms that may not seem to be a sizeable increase. But in nominal terms, ODA for infrastructure projects has grown from $11.7 billion in 2003 to $42.5 billion in 2013, a 264 percent increase – reflecting the renewed focus within multilateral institutions on ODA for infrastructure.

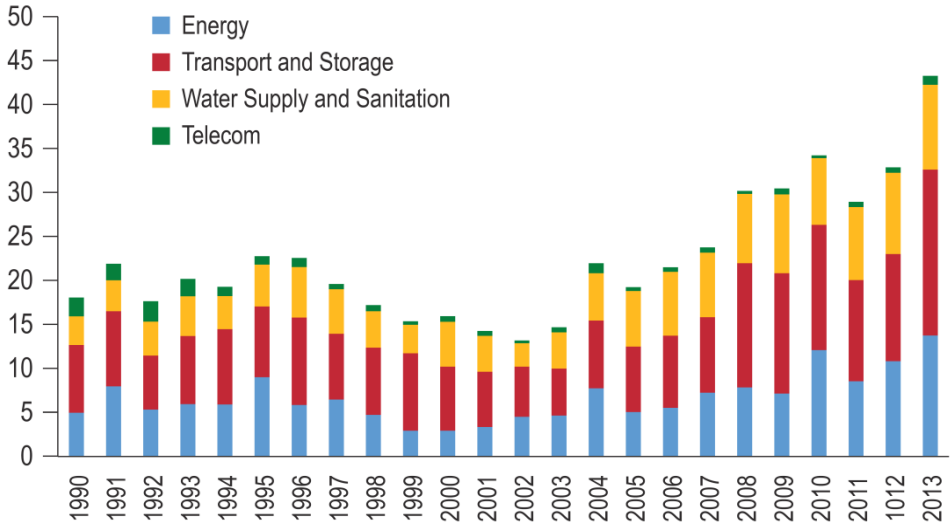
**Figure 25 ODA Grants and Loans, current US$ billions**




*Source: Authors' computations using OECD CRS (2014) database.*

Within ODA infrastructure investment, ODA loans have persistently been double in magnitude to ODA grants. When combined, over the ten-year period 2004-2013, the main sectoral destinations of ODA have been transport sector (about 40 percent), energy sector (30 percent) and water supply and sanitation sector (27 percent). Telecommunication sector projects have typically been financed through non-concessional market finance, and continue to be so (Figure 26).

**Figure 26 ODA Grants and Loans by Sectors, current US$ billions**

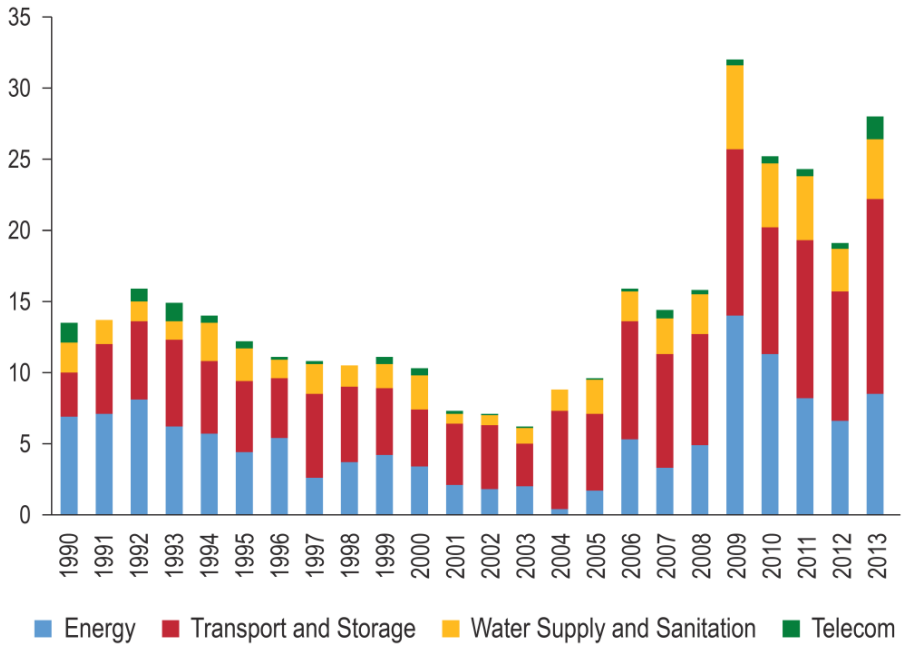



*Source: Authors' computations using OECD CRS (2014) database*

### 4.5.1 Other official flows (OOF)

Non-concessional official flows, or OOFs, are almost equivalent in magnitude to that of ODA loans, and are thus a fairly significant source of infrastructure investment. In 2013, out of total OOF, amounting to $68.5 million, the share of infrastructure was $27.6 billion (40 percent) (Figure 27). The significant increase in OOF for infrastructure mimics the trend of concessional ODA funding. The decline in investments during the recent global recession is however more stark and prolonged. But as is the case with ODA, the levels of investment appear to have rebounded in 2013. In terms of sectoral composition, here too, transport and energy are the most prominent destinations of OOF financing, accounting for nearly 50 percent and 33 percent of the shares respectively. The water sector, at around 16 percent, and telecommunications at less than 3 percent for most years, account for a much smaller proportion of such non-concessional official development flows.

**Figure 27 Other Official Flows by Sectors, current US$ billions**




*Source: Authors' computations using OECD CRS (2014) database.*

**Box 6 China – the growing infrastructure investor in Africa**

Chinese development assistance as a source of infrastructure investment has been growing, particularly ins sub-Saharan Africa, where official Chinese investments have grown from less than $313 million in 2000 to $4.4 billion in 2012. Between2007-2012, the average annual flow of such financing was about $5 billion, far exceeding any other single bilateral or multilateral source.

During the 2000s, the volume of Chinese investments was skewed towards resource-rich countries (Foster and Briceño-Garmendia 2009), following "opportunities across the continent's energy and extractive industries" (ICA 2013). However since 2010, the scope of Chinese infrastructure investment in sub-Saharan Africa has broadened.

China plays a major role in sub-Saharan African infrastructure financing by filling the gaps that are not met by either the private sector or ODA. The presumption has been that China directs its funding towards countries with natural resources (the "Angola model"). In fact, the 2009 World Bank report, while recognizing that 35 counties received support from China, stated that the largest support was for resource-rich countries (Foster and Briceño-Garmendia 2009). Similarly, the Infrastructure Consortium for Africa (2013) report declared, "Chinese funding follows opportunities across the continent's energy and extractive industries."

Since 2010, however, the reach of Chinese investment has broadened. While Chinese financing in resource-rich countries (using IMF classification) is still double the average volume of those the flowing to the non-resource rich countries, this gap has sharply diminished over time. The cumulative average of Chinese financing to resource-rich countries doubled from $300 million to over $622 million between 2005-2008 and 2009-2012. But over the same period, Chinese commitments to the non-resource rich countries leapt from $43 million to $285 million – a 550 percent increase.

*Source: Gutman, Sy, and Chattopadhyay (2015)*

## 4.6 Climate finance

There is no accepted definition of what constitutes climate finance. As a general matter, it is finance focused on addressing the impacts arising from climate change – mitigation and adaptation. For instance, the UNFCCC Standing Committee on Finance uses the following working definition: "climate finance aims at reducing emissions, enhancing sinks of greenhouse gases and aims at reducing vulnerability of, and maintaining and increasing the resilience of, human and ecological systems to negate climate change impacts" (UNFCCC 2014).

As can be seen in Table 5, what can count as climate finance in the UNFCCC is only international climate finance from developed to developing countries and private sector capital mobilized by public finance. In contrast, total climate finance includes all sources of climate finance – international climate finance from developed and developing countries as well as domestic sources of climate finance as well as all private sector finance.

**Table 5 Components of Climate Finance and Green Finance**

| **Definition** | **Source** | **Public Finance** (Bilateral, Public Financial Institutions, Climate Funds) | **Private Finance** Leveraged by Public Finance | **Other Private Finance** |
|---|---|---|---|---|
| **UNFCCC Climate Finance $100 billion p.a. by 2020** | International climate finance from developed countries to developing countries | X | X | |
| **Total Climate Finance** | International + domestic climate finance from developed & developing countries | X | X | X |

*Source: Meltzer (2016)*

There have been myriad efforts to count total flows of climate finance (UNFCCC 2014). In terms of amount of climate finance going towards the UNFCCC $100 billion pledge, an OECD/Climate Policy Initiative (CPI) study estimates that almost $61 billion of this $100 billion was provided in 2014, comprising $43.5 billion in bilateral and multilateral public finance, $1.6 billion in export credits and $16.7 billion of private finance that was mobilized by public finance (OECD 2015-2).

One of the most comprehensive accounting tallies of total climate finance has been done by the CPI and this work is the baseline against which the UNFCCC makes its climate finance calculations. As reflected below in Table 6, in 2014 total climate finance was $391 billion, up from $331 billion in 2013. Of this amount, public finance accounted for approximately $148 billion, or 38 percent of total climate finance. Yet private finance constituted the majority of climate finance flows in 2014 at $243 billion, up 26 percent from $193 billion in 2013.

The amount of private climate finance is also likely much higher,as the CPI private finance figure only captures investments in renewable energy. Table 6 includes in italics estimates of private climate finance which increased private sector flows of climate finance in 2014 to $765 billion. Including government's domestic budgets for climate – which CPI reports according to estimates could be $60 billion per annum - raises total 2014 climate finance to $825 billion (CPI 2015a). This figure is in a similar range to that of the UNFCCC Standing Committee on Finance, which uses the CPI figure and adds an estimate of investments in energy efficiency to find that total climate finance in 2013 was as high as $650 billion per year (UNFCCC 2014).

**Table 6 Climate Finance by Sector , 2013 (US$ billions)**

| | Renewable Energy | Energy Efficiency | Transport | Land Use | Adaptation | Other | **Total** |
|---|---|---|---|---|---|---|---|
| Public | 49 | 26 | 21 | 7 | 25 | 20 | **148** |
| Private | 243 | *90-365* | | *4.2* | *5.25* | | **243/** ***342-617*** |
| **Total** | **292** | ***116-391*** | **21** | ***11.2*** | ***30.25*** | **20** | **391/** ***490-765*** |

*Source: Meltzer (2016) based on CPI (2015) and UNFCCC (2014)*

Available climate finance ranges from $61 billion to $825 billion per annum, depending on whether we are referring to UNFCCC climate finance or total flows of climate finance (CPI 2015a). This range

includes public and private sources of finance, with public finance accounting for $43.5 billion - $148 billion.

Access to the OECD/CPI database allowed us to determine that, with regard to the UNFCCC $100 billion pledge, approximately $18 billion, or 40 percent of public finance, was for infrastructure and all private sector climate finance (which included only that invested in renewable energy) was infrastructure related.

Data limitations mean that it is not possible to determine how much of the $825 billion per annum is spent on infrastructure. Applying the 40 percent share to the larger public finance amount of $148 billion gives approximately $60 billion on low carbon infrastructure.

To understand in more detail how climate finance is being provided, table 7 shows the various sources and intermediaries of climate finance.

**Table 7 Climate Finance Landscape (US$ billions)**

<table>
<tr><th></th><th colspan="2">Sources/Managers of Capital</th><th>Financial Instruments</th><th>Location of Projects</th><th>Projects</th></tr>
<tr><td rowspan="7">Public Finance</td><td colspan="2">Governments and Agencies<br>15</td><td>Grants<br>14</td><td>Developed Countries<br>179</td><td>Renewable Energy<br>49</td></tr>
<tr><td rowspan="3">International Financial Institutions</td><td>National Development Banks<br>66</td><td>Low Cost Debt<br>69</td><td rowspan="5">Developing Countries<br>210</td><td>Energy Efficiency<br>26</td></tr>
<tr><td>Bilateral Development Banks<br>17</td><td rowspan="3">Risk Management<br>1</td><td>Transport<br>21</td></tr>
<tr><td>MDBs<br>47</td><td>Land Use<br>7</td></tr>
<tr><td colspan="2">Climate Funds<br>2</td><td>Market Rate Debt<br>102</td><td>Adaptation<br>25</td></tr>
<tr><td colspan="2"></td><td></td><td>Other<br>20</td></tr>
<tr><td rowspan="5">Private Finance</td><td colspan="2">Commercial Financial Institutions<br>46</td><td>Project Equity<br>24</td><td rowspan="5"></td><td rowspan="5">Renewable Energy<br>243</td></tr>
<tr><td colspan="2">Equity, Venture Capital, Infra Funds etc.<br>1.7</td><td>Balance Sheet Finance<br>175</td></tr>
<tr><td colspan="2">Institutional Investors<br>0.9</td><td rowspan="3"></td></tr>
<tr><td colspan="2">Project Developers<br>92<br>Corporate Actors<br>58<br>Households<br>43</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="4">Total</td><td>391</td></tr>
</table>

*Source: Meltzer (2016) based on CPI (2015)*

As can be seen, public provision of climate finance has been dominated by the international financial institutions and NDBs. These institutions provide climate finance mainly as concessional and market rate debt. On the private sector side, the main source of finance is balance sheet finance by corporations and project developers, representing over 60 percent of private sector climate finance. Households are also significant sources of climate finance. In contrast, financial intermediaries such as banks make up only around 19 percent of total private climate finance.

The table also highlights the very limited involvement of institutional investors in infrastructure, a notable absence given that such investors are globally the largest source of private capital with approximately $110 trillion in AUM (Bielenberg et al. 2016).

**Box 7 Climate finance and recommendations to encourage renewable energy investment**

Just as renewable energy technologies have evolved, so too must the approaches to promoting them. In the early stages of encouraging renewable energy, attention focused on developing subsidy programs and one-off demonstration projects. Now that non-conventional renewables including solar have become increasingly competitive, the focus of intervention should shift to providing support for high-volume commercial deployment. To maximize their impact, donors can leverage their scarce public funding with other sources of financing, including private investment and commercial bank debt. This public funding to encourage investment in climate-friendly projects or policies is broadly referred to as climate finance. Embedded in the climate finance concept is the idea that at this stage of maturity, renewables can be enabled by lighter-touch donor interventions.

Thus far, climate finance has effectively been deployed only through DFIs (including NDBs like BNDES), but private sector entities are also eligible to directly access some funding through the Green Climate Fund, or in partnership with NDBs. While NDBs have a mandate to promote development, they also have strict investment criteria and generally offer rates similar to commercial banks, although sometimes with better terms and a willingness to take risks. DFIs typically will not invest in a project that does not meet investment criteria even if it would have a positive development impact, as this is contrary to their mandate and institutional continuity.

Donor-supplied climate finance can enable NDBs and other players to invest more in renewable energy in a number of ways. One critical role climate finance can play is sharing risks with lenders. For example, the Canadian Climate Change Fund provides co-funding to several NDBs by taking a higher-risk, subordinate position in the loan structure, enabling a NDB loan to be priced at more attractive rates and terms (IDB 2015). Climate finance can also reduce project transaction costs, such as legal fees and technical due diligence, or provide grants for advisory services or other technical assistance, such as feasibility studies (CIF 2015, IDB 2015). These cost savings can be passed on to borrowers, making renewables more competitive.

Climate finance is also important because through its early, higher-risk lending, it establishes a track record for new technologies and business models, which provides assurance to local banks of the technology and loan performance. For example, the IADB's Climate and Clean Energy Finance Facility provides loans to distributed renewable energy projects selling power to private off takers, a market currently underserved by financial institutions. The facility's loans are between $500,000 and $10 million, and use donor climate finance to reduce transaction costs for legal services and their technical review, reducing costs borne by the projects (IADB 2013). The IADB's direct lending to this sector, made possible by climate finance, helps demonstrate loan performance to commercial banks. This type of "learning by doing" will occur naturally as the renewables sector evolves, but can be accelerated by sharing aggregated loan performance data and case studies and designing standardized transaction structures that can dramatically reduce transaction costs. Just as solar panel costs have fallen due to greater manufacturing economies of scale, so too will transactions costs with greater volumes of financing.

These types of innovative financing mechanisms will be key to stimulating broader financing for renewable energy projects in Central America and across the world. Also, while they incur risks, they also potentially generate profits that can be re-invested into additional projects, unlike grants and other traditional donor funding.

Recommended uses for climate finance to encourage renewables

1. Use climate finance to improve terms for renewable energy projects, such as providing a one-year grace period for principal repayment, and to reduce transaction fees paid by private developers for project assessment;
2. To encourage local banks to lend to renewable energy projects, provide credit guarantees and risk-sharing, and long-term lines of credit;

3. Provide technical assistance to develop public underwriting criteria for renewable energy projects;
4. Provide accessible and inexpensive country risk insurance to increase the number of private international investors;
5. Develop structures that encourage new players to finance renewable energy in emerging markets. Huge pools of capital are held by institutional investors like pension funds in developed countries, and in some more advanced developing countries like Colombia as well. As discussed, these investors face restrictions on the amount of financing they can make into illiquid investments like infrastructure, as well as restrictions on the riskiness of their investments, often as measured by public ratings. DFIs could play a key role in helping to securitize renewable energy project financing into bonds or other tradeable, exchange-listed assets that are better suited to institutional investors' portfolios.

In parallel, reforms still need to be made at the national regulatory level in order to create fundamentally attractive energy markets and enabling environments for investment in renewable energy. Traditional donor funding is still needed to help governments plan and implement these reforms.

Recommendations for national governments:

1. Eliminate subsidies for fossil fuels and internalize their social and environmental costs;
2. Establish long-term binding targets for renewable energy with explicit paths to achieve them to make the opportunity for investment clear;
3. Follow international best practices in drafting PPAs and offering tenders;
4. Allow net-metering and wheeling in addition to offering tenders so that distributed energy can also contribute to renewable energy goals;
5. Consult with investors and other stakeholders to ensure policies and processes address barriers and encourage investment.

*Source: Chapman et al. (2016)*

# 5. Impediments to delivery of sustainable infrastructure

Despite its critical importance, investments in sustainable infrastructure are lagging and those that are being made are not as sustainable as they should be.

The protracted delays and difficulties with infrastructure investment are partly due to its inherent characteristics. They are long-term, require large upfront investments but generate cash flows after many years. They are subject to high risks, especially in the initial phases. Infrastructure investments are typically complex, involving many parties. They are vulnerable to policy and political risks and require appropriate regulation, since they are often natural monopolies such as in transport, water, and power distribution. Investments depend on specific circumstances and tend to be less liquid and carry risks that are difficult to insure. However, even if revenues do not cover costs, indirect externalities and social benefits may be large but difficult to measure. Consequently, markets alone cannot provide effective infrastructure services and private investments cannot often be realized without some form of public support Figure 28).

While these attributes affect investment decisions and outcomes in both developed and developing countries, EMDCs face additional limitations. First, policy and institutional gaps are greater. In particular, many lack a coherent and trusted legal and institutional framework, political and regulatory risks such as pricing and threat of unilateral and arbitrary action tend to be higher, and institutional capacities are less developed and governance is weaker. Second, many countries lack a pipeline of well-structured projects. Proposals that do come forward are often subject to higher costs. Implementation tends to be subject to greater delays and higher costs. EMDCs also face greater difficulties in mobilizing long-term finance and the costs of financing are much higher than what is available in developing countries. Third, infrastructure investments worldwide face sustainability gaps. Investment decisions are affected by major price distortions, notably pervasive fossil fuel subsidies and the absence of carbon pricing. These price distortions greatly affect the incentives to invest in low-carbon technologies, especially given the low prevailing prices for fossil fuels. While the broader impediments to infrastructure investment are now better recognized, there is little attention even in the G20 to incorporating sustainability criteria in investment planning and project selection. Consequently, infrastructure investments are not as sustainable as they should be and sometimes generate negative externalities or costs to others. Higher investment costs, higher financing costs, and higher sustainability costs act as a vicious cycle to impede the quantity and quality of infrastructure investment.

## 5.1 Five main impediments

As highlighted in Bielenberg et al. 2016, there are five major barriers that inhibit financing going to infrastructure in general, and are magnified for sustainable infrastructure.

**Lack of transparent and bankable pipelines:** There are often three related issues. First, governments often fail to develop long-term plans, so future infrastructure needs are unknown. Second, even when long-term plans exist, the pipeline may not be clearly communicated to investors (only half of the G20 publishes infrastructure pipelines, for example) (G20 2014). When it is not clear how many projects will take place in a specific geography or sector, it is difficult for investors to justify investing in due diligence and credit evaluation expertise in those areas or to invest in local staff and partnerships.[4] Third, many infrastructure projects are not "bankable,"[5] meaning they do appear to be likely to deliver high enough risk-adjusted returns to attract private-sector equity or debt. Or, costs and risks may not appear to be allocated appropriately.

Middle- and low-income countries face additional challenges. Not only do they often lack project-

development resources, but their governments may not be able to afford the funding commitments required or cannot offer sufficient guarantees to mitigate the perceived risk of the project.

These kinds of pipeline problems make it more costly for investors to raise funds and invest in infrastructure. According to the head of asset management at a major South American investment bank, in one middle-income country where it does business, private-sector investment lags because "funds must be raised, but then with no actionable project, you're either collecting fees over and above the cost of capital or paying a deal team to not do anything while they wait for the project to materialize." [6]

Building a sustainable infrastructure pipeline is even more difficult because it must take into account climate-change mitigation and adaptation planning. Even when plans are in place, a lack of defined standards for sustainable infrastructure, such as for resiliency and energy efficiency, complicates project design and creates more reasons for the private sector to stay away.

**High development and transaction costs:** Inefficient bidding and procurement processes discourage private investment. Many transactions are tailored to each individual project and there can be diverse and inconsistent standards. Investors with limited resources, time and expertise, such as pension and insurance companies, can find it difficult to assess projects when standards are so fragmented. For instance, the capital cost of similar infrastructure projects can vary by more than 50 percent due to differences in design, engineering, management, procurement, and sourcing (Garemo, Hjerpe and Mischke 2015). Transaction time and costs rise considerably when unique financing structures must be designed for each project and jurisdiction.

Transaction and development costs for sustainable infrastructure projects may be even higher because limited data on financial and risk performance makes deal evaluation more complicated. Also, sustainable technologies can change so quickly that historical performance data is useless. As one senior investor told us, "Institutional investors need to see a track record of performance to determine risk/return. Right now, there is no track record of long-term investment returns" in sustainable infrastructure.[7] On the whole, investors are less familiar with sustainable infrastructure and associated technologies and often have difficulty incorporating elements such as resiliency into their cost-benefit analyses.[8] Sustainable infrastructure can also comprise small-scale assets such as distributed and micro-generation renewable projects that do not justify traditional transaction costs unless they can be bundled.

**Lack of viable funding models:** A major constraint to attracting investment in infrastructure is funding risk or adequacy and certainty on the ultimate source of revenues for an infrastructure project (WEF 2014). Funding for an infrastructure project can come from four main sources: user charges tied directly to the cost of providing the service; general purpose tax revenues; earmarked charges or fees such fuel surtaxes and vehicle registration fees; and land value capture associated with infrastructure development. One constraint on revenues that is particularly pertinent in middle- and low-income countries is that users are unwilling or unable to pay high enough charges to allow full cost recovery, plus a return on investment. For example, in some sub-Saharan African countries, up to 70 percent of water does not result in revenue because it is either unmetered or stolen (Bielenberg et al. 2016). Even water infrastructure that generates revenue is often highly subsidized, making it subject to fiscal risk.

For sustainable projects, the matter is even more complicated. Even when sustainable infrastructure is net present value (NPV) positive over its lifetime, such projects can have higher upfront costs, while the savings accrue to the operator or owner. For example, developers pay more to make buildings energy efficient, but it is the homeowner or business that benefits from lower energy bills. Other sustainable infrastructure costs more over the lifecycle of the asset in the current policy environment. This is because the impact of positive externalities such as cleaner air or fewer emissions are difficult to calculate, much less monetize.

**Inadequate risk-adjusted returns:** Many infrastructure projects cannot deliver the 10-15 percent rates of return private investors expect. There are several private actors, such as private equity firms, that

appear well positioned to perform the due diligence and take on the risks associated with sustainable infrastructure. But they often require returns above what most projects can offer. Other institutional investors, such as pension funds, may be willing to accept lower returns, but want relatively safe investments. They might take on more risk, as one pension fund executive told us, "as long as we're paid for that risk in additional returns." Two ways to enhance the attractiveness for the private investor is de-risking by the government or a third party such an MDB or supplementary revenues from the government. Such supplementary revenues can be justified by the positive spillovers of infrastructure projects that can be tapped through targeted tax revenues (Yoshino 2016).

Sustainability complicates the risk-return issue because the technologies and platforms are often new. Also, because sustainable infrastructure often requires more upfront capital, the risk is that much higher. Sustainable infrastructure can carry significant risks related to construction, procurement, and operation; investors can mitigate these to some extent through risk-sharing or broader cost allocation.

Policies that create market distortions, such as fossil fuel subsidies, or do not address unpriced externalities, such as local air or CO2 pollution, make it more difficult to develop sustainable projects with attractive economics. Even when adequate funding models are in place, returns for sustainable infrastructure can be low relative to other investing options. At the same time, few models exist to capture the positive returns from lower total cost of ownership (TCO) that sustainability carries, such as resilience, lower operational costs, and cut carbon emissions.

**Unfavorable regulations and policies:** Regulations on investment limits, capital adequacy, reserve requirements, the valuation of assets and liabilities, and limits on foreign investment can discourage investors from making longer-term and cross-border investments. Basel III is a global, voluntary regulatory framework aimed at strengthening banks in the wake of the financial crisis by increasing bank liquidity and decreasing bank leverage (Roumeliotis 2010). Basel III regulation of banks' capital, leverage, and liquidity intentionally discourages mismatches in the maturity of assets and liabilities, which makes it harder and more expensive for banks to issue long-term debt such as project finance loans. Solvency II is an EU directive that codifies and harmonizes EU insurance regulation that largely concerns the amount of capital EU insurance companies must hold. This regulation treats long-term investments in infrastructure as of similar risk to long-term corporate debt or investments, requiring higher capital ratios which degrading return profiles.[9] Further, governments tend to use cash accounting standards that do not differentiate between long-term investments that add value and near-term consumption. These policies may not favor infrastructure investments that realize returns over a longer time horizon.

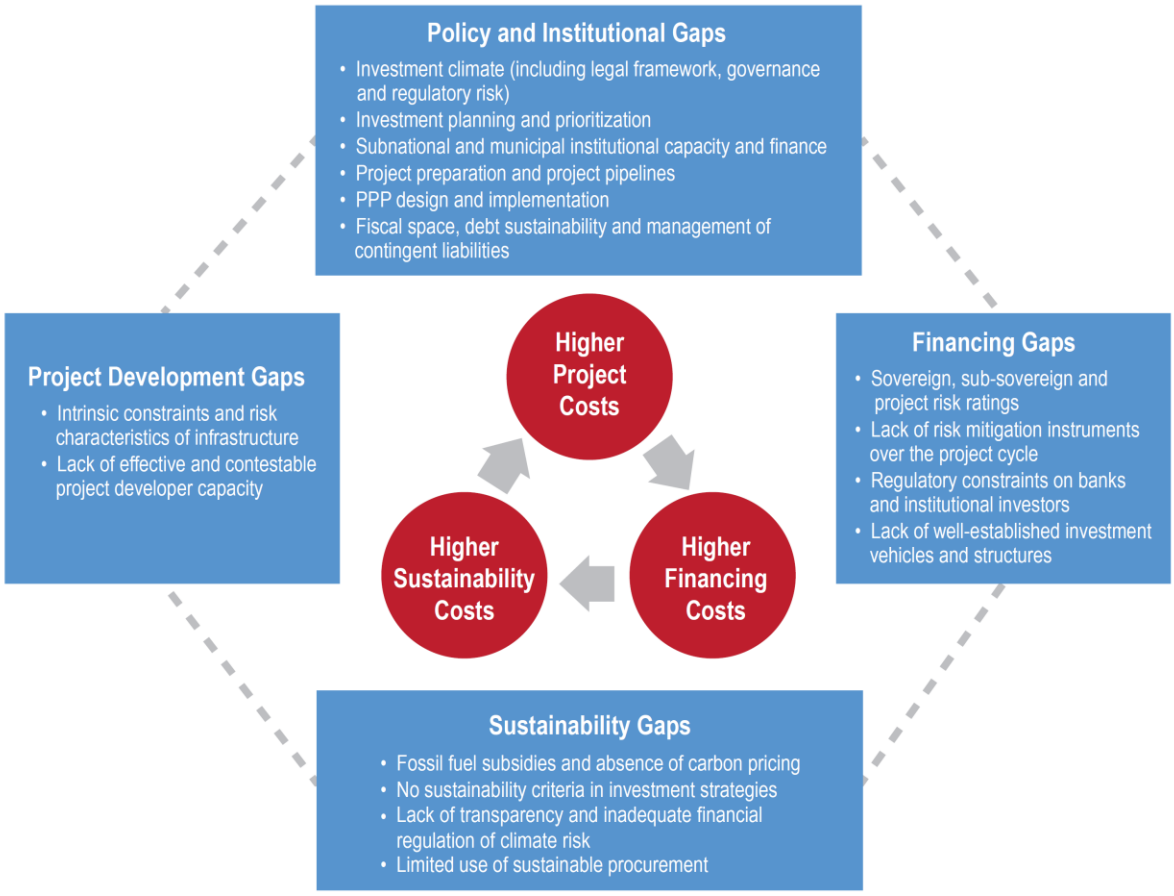
Uncertainty around tax policies, particularly in middle- and low-income countries, has a depressing effect on infrastructure investment because it makes it difficult to project long-term net cash flows. In addition, tax policies may not be structured to reward longer-term investment choices or reflect the lower climate-related risks associated with sustainable and resilient infrastructure. The outlook for tax policies that support sustainable infrastructure is unpredictable and many current initiatives, such as support for renewables, are short-term.[10] As one investor told us "This type of uncertainty has stopped developers from going into certain countries where it is extremely hard to separate politics from regulatory action. Investors find it difficult to assess the changes of regulatory changes and how those changes may impact their project NPV."[11]

## 5.2 Availability and costs of financing

Despite ample global savings and record-low long-term interest rates, infrastructure investments in developing and emerging economies are often unable to attract long-term financing, and the costs of financing are relatively high—in some cases prohibitively so. Lowering the costs of financing can make a big difference to the economic viability of the investment, to the affordability of the service provided especially for the poor, and for making sustainable investments more viable.

The special characteristics of infrastructure make its financing more difficult. Even in developed countries, only 2 percent of institutional investor assets are invested in infrastructure, despite the fact that, in principle, the steady long-term returns of infrastructure assets are ideally suited for institutional investor portfolios. In EMDCs, impediments to securing long-term low cost financing are much greater than in developed countries. Often it is asserted that the problem is not financing (given abundant funds at low interest rates), but rather matching the supply of finance from the private sector with investable projects. In other words the problem is the lack of "bankable" projects. But if access to financing is not available or its cost too high, which is often the case, then few projects will be investable, even if economic and social returns are reasonable.

**Figure 28 Impediments to sustainable infrastructure: A vicious cycle**



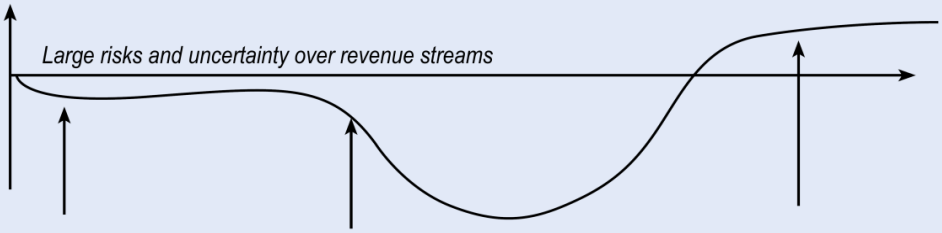

*Source: Bhattacharya et al. (forthcoming)*

Understanding the factors impeding the availability of infrastructure finance is critical if infrastructure investments in EMDCs are to be successfully scaled up. As described earlier, infrastructure investments in EMDCs need to rise from around $2 trillion per annum now to $3.5-$4.5 trillion annually if they are to meet the growth and development objectives embodied in the SDGs. The bulk of these investments in emerging markets and developing countries are greenfield investments. At present about half the financing comes from governments and other official sources and half in the form of private finance. The public sector will continue to play a major role in the provision of certain types of infrastructure, such as rural roads and watershed management. Given fiscal space and public debt constraints and the efficiencies

that private involvement can bring, a larger proportion of the incremental financing needed will have to come from the private sector. The decision to involve the private sector should be based primarily on efficiency gains, since funding costs for governments are typically 200-300 basis points lower than the private sector.

The financing that is needed and will be provided by the private sector will depend on the stage and characteristics of a given project. As shown in Figure 29, the biggest risks and constraints to financing arise at the early stages of the project when there are risks of cost overruns, and greater uncertainties and risks regarding future revenue streams. Once a project reaches completion, and there is greater certainty about investment costs and future revenues, it can be more readily securitized.

**Figure 29 Risk and financing considerations at different phases of the life-cycle of an illustrative infrastructure project**

| | Preparation | Construction | Operation |
|---|---|---|---|
| **Description** | Developer/government organizes feasibility studies; models cash flows, finances; organizes contracts with utilities, operators and construction firms | Construction first build the project to specifications | Separate operating company takes over operation and maintenance of the project |
| **Main risks** | Macroeconomic & political risks<br>Technical risks to project viability<br>Environmental and planing risks | Macroeconomic & political risks<br>Construction risks (e.g., of overrun, delay) | Macroeconomic & political risks<br>Demand/traffic risks<br>Operating risks<br>Policy risks (e.g., tariff changes) |
| **Cash flows (stylized)** |  | | |
| **Financing moments** | During project preparation and feasibility studies the developer seeks patient capital or, often, public funds | Once project is 'bankable' the developer will seek equity investors and debt providers to finance the project | Once construction is compete and started to operate project can be refinanced to reflect the changing risk profile |

*Source: Bhattacharya, Romani and Stern (2012)*

Because of the high risks and need for specialized expertise in the early stages of projects, equity will likely come primarily from sponsors (often construction companies) or governments. Banks have a comparative advantage in the early stages of project financing, because they have the necessary expertise and play an important monitoring role. Also, they can match disbursements to project implementation and if necessary they can restructure the financing relatively flexibly in the face of unforeseen events. For the same reasons, bond financing is less well suited for the early stages of projects. Specialized infrastructure funds as well as some institutional investors with expertise and green finance may also be willing to take an equity stake or provide debt finance. Because of the uncertainties and the lack of cash flow, debt financing needs to be long-term. Once a project becomes operational and begins to generate positive and more certain cash flows with less risk of debt default, refinancing of the debt from the initial phase becomes possible. Bond finance is well suited to take over the debt, but in practice has been used relatively little. With a change in the nature of the project, ownership can shift from construction companies to investors with specialized expertise in operating and managing the asset. Similarly, governments may also be able to divest their equity stakes to the private sector more readily at this stage.

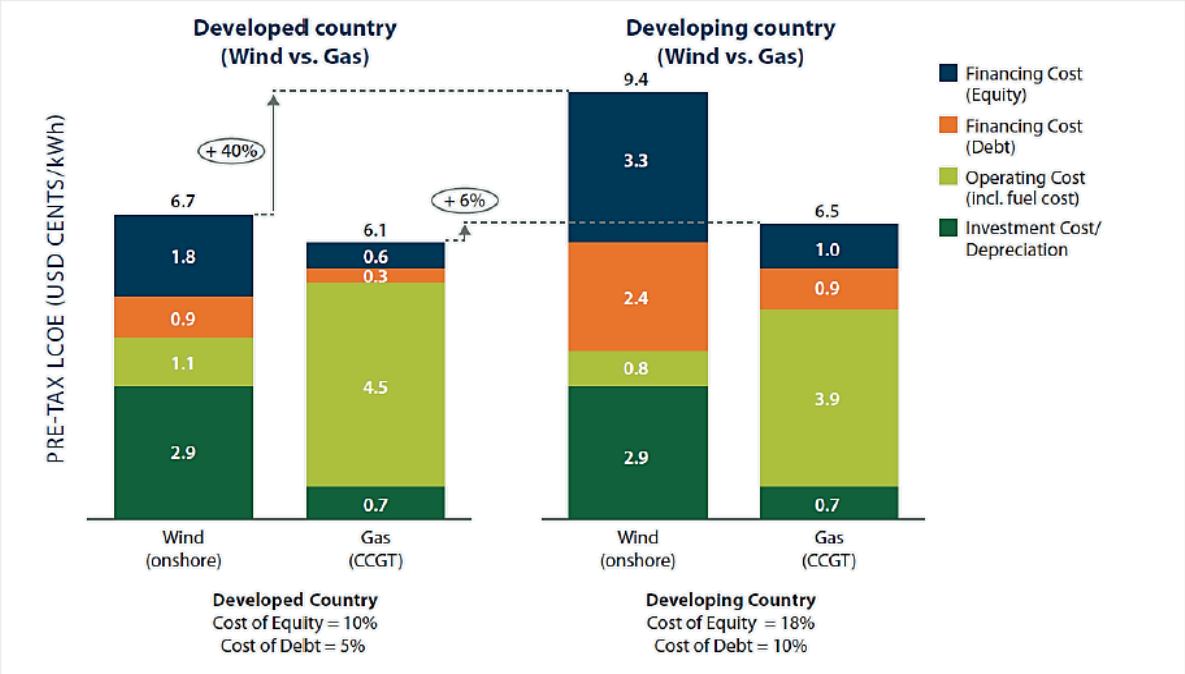
While this matching of the evolution in the nature of risks over the project cycle with different types of financing is relatively straightforward, in practice emerging markets and developing countries face difficulties in accessing both equity and debt finance in both the early and later stages of the project cycle. This is especially true in the context of the ongoing shift from large international project sponsors to smaller domestic sponsors.

Another major concern for many EMDCs is the relatively high costs of financing. Overall costs of financing reflect the risk premium that investors demand for holding assets, including infrastructure. Risk premia are a function of factors such as assessment of the macroeconomic fundamentals for a country, the financial standing of the sovereign or sub-sovereign, and the project entity and liquidity of the asset (Haugh et al. 2009).

These factors affecting risk premium are a key reason for the higher cost of financing in developing countries. The risk premium is compounded due to the nature of infrastructure as an asset - which is illiquid and long-term – and thereby particularly exposed to policy and regulatory risks. Such risks are heightened even further for investments in sustainable infrastructure that rely on policy support such as subsidies or feed-in-tariffs to be economically viable. A particular concern is the persistence of fossil fuel subsidies and the absence of a carbon price that fully reflects the social costs of GHG emissions.

The impact of these factors on risk premia and the cost of capital for infrastructure projects in developed and developing countries is highlighted in Figure 30. As can be seen with the example of investing in onshore wind power, even though the operating costs for wind turbines are lower in developing countries, the cost of investing in wind power in developing countries is 40 percent higher than in developed countries due to the relatively higher cost of debt and equity.

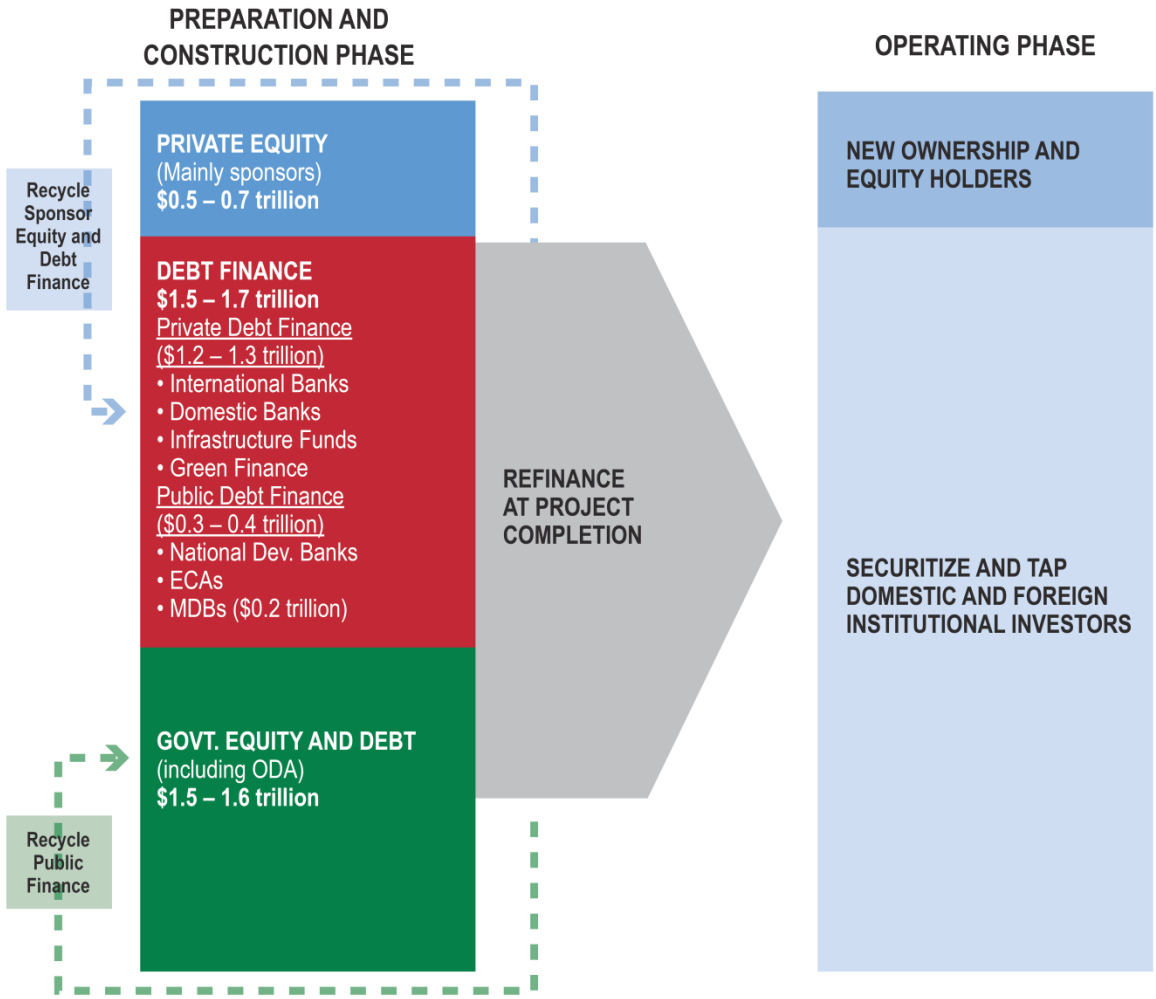
**Figure 30 Sustainable infrastructure often is more capital-intensive, which makes (low-cost) finance even more important**




*Source: Waissbein et al. 2013*

The figure also highlights how the upfront cost of infrastructure projects magnifies the impact of higher capital costs. For instance, the much larger upfront investment costs for wind compared with gas mean that more capital is needed at the initial stage of the investment. And even though wind has lower operating costs over the life of the project when compared to gas, the capital needed to finance the upfront costs overwhelms the gains on the operating side.

**Figure 31 Infrastructure financing requirements for emerging markets and developing countries**



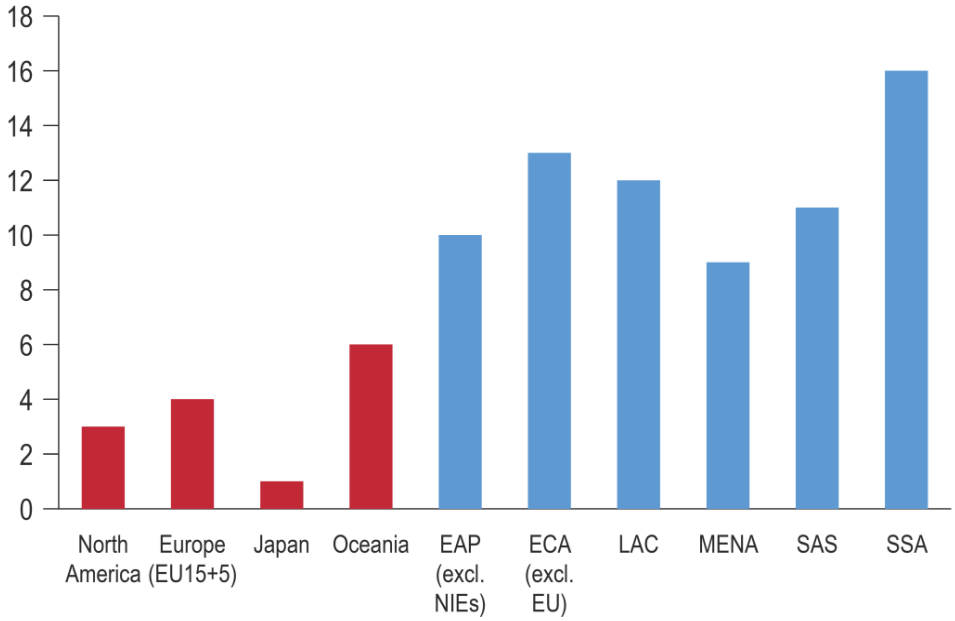

*Source: Bhattacharya et al. (forthcoming)*

Figure 31 illustrates an approach to meet the large financing requirements in emerging markets and developing countries. EMDCs will need $3.5 - $4.5 trillion per annum in new infrastructure investment to meet the SDGs. While the private sector will continue to provide a significant share of the financing, the bulk of the incremental financing will have to come from the private sector, given constraints on public sector balance sheets and the efficiency gains that can come from greater private sector involvement. At the greenfield stage, the bulk of private sector equity will need to come from sponsors. The much larger need is for long-term debt finance, given that equity to debt ratios tends to be as high as 1 to 10 during the initial stage of the project. The bulk of this finance will have to come from banks with infrastructure funds, with green finance playing a potentially important complementary role. Once the project reaches

the operational phase, it is possible to refinance a large part of the initial equity and debt commitments. New owners who are specialized in operating infrastructure projects can replace investors specialized in construction. More significantly, the generation of more certain cash flows opens up the prospect of replacing bank debt with bond finance which can be held by both domestic and foreign institutional investors. This allows for a recycling of equity and bank finance that can be used for new greenfield investments. This includes the recycling of public funds that can be used for new investments.

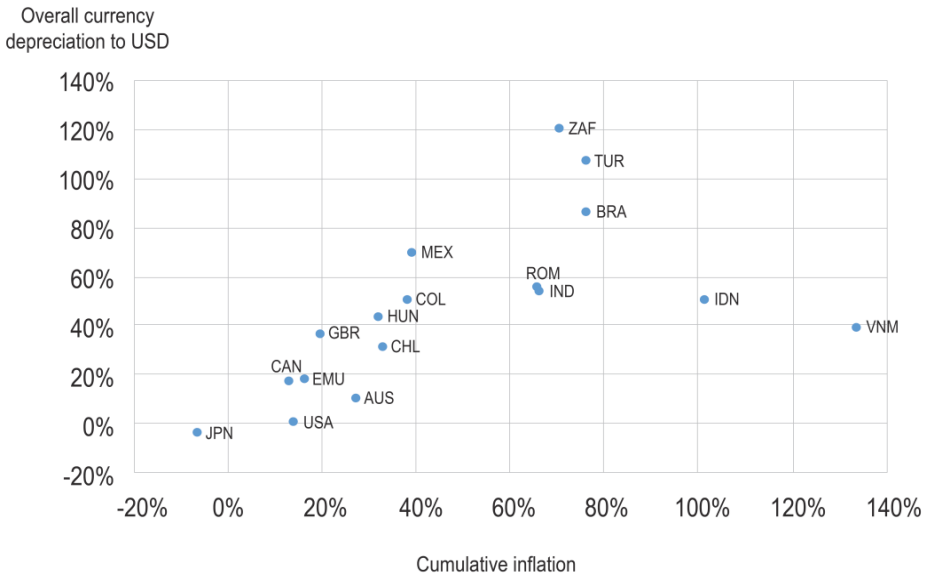
A significant challenge in financing sustainable infrastructure is obtaining affordable capital for the early stage of sustainable infrastructure projects. Many infrastructure investors do not have the capital to take on construction risk, yet a lack of contractual or regulatory certainty at the early stage of a project deters private investors, or makes the cost of capital prohibitive. For instance, debt is often difficult to access until a project can generate revenue and often the only private financing option available is developer equity, which is risky, expensive, and scarce (Roumeliotis 2010).

**Figure 32 Commercial bank prime interest rate, percent per annum**




*Source: World Development Indicators and CIA World Factbook*
*Definition: Commercial bank prime lending rate compares a simple average of annualized interest rates commercial banks charge on new loans, denominated in the national currency, to their most credit-worthy customers. Data based on December 31, 2015 estimates.*

**Figure 33 Currency depreciation to inflation using GDP deflator, period average for 2007-2014**




*Source: Exchange Rate data from [http://www.oanda.com/currency/converter/](http://www.oanda.com/currency/converter/)*
*Note: Horizontal Axis: Overall exchange rate depreciation to US$ (2007-2014), Vertical Axis: Cumulative inflation, GDP deflator (2007-2014)*
*GDP deflator series from World Bank WDI. Definition: Inflation as measured by the annual growth rate of the GDP implicit deflator shows the rate of price change in the economy as a whole. The GDP implicit deflator is the ratio of GDP in current local currency to GDP in constant local currency.*

## 5.3 Four pillars of action

This paper argues that concerted actions in four areas can together break the vicious cycle whereby risk perceptions as well as the high costs of equity and debt financing for sustainable infrastructure make it so difficult to raise funds for the initial stages of projects. The four areas are as follows:

First vigorous actions are needed to correct fundamental price distortions. This can be done by eliminating fossil fuel subsidies and the establishing a carbon price corridor.

Second, concerted efforts are needed to strengthen and reshape public investment frameworks, which will be a complicated undertaking. In particular, improving the enabling environment and establishing robust capacity for designing and implementing PPPs are key priorities.

Third, addressing financing impediments over the project cycle (both greenfield investments and once projects reach the operating phase) and bringing down the costs of financing will be essential for facilitating investments and tilting incentives towards more sustainable projects.

Fourth, investments in technology and technology diffusion need to be expanded and accelerated to enhance sustainability and exploit the synergies between growth and a low-carbon transition.

The remainder of this report reviews the actions that are needed in each of these areas.

# 6. Addressing price distortions

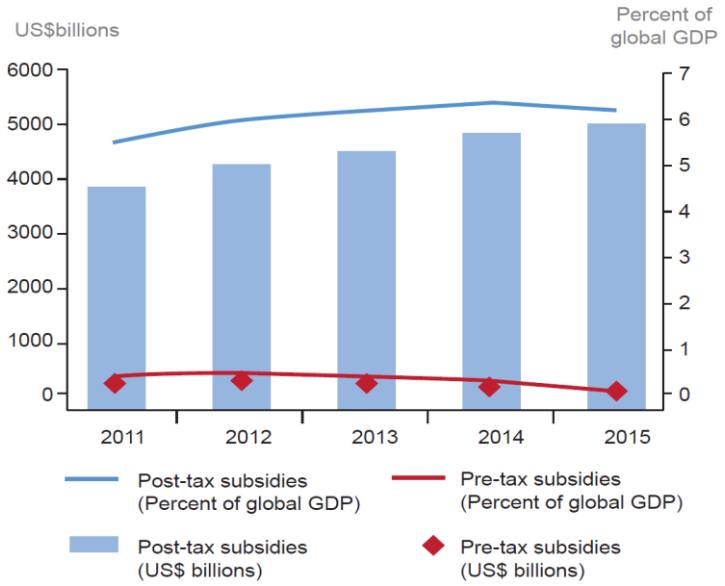
Correcting pervasive distortions in the pricing of natural resources and infrastructure services is essential to improving the public policy environment for sustainable infrastructure. The biggest distortions are fossil fuel subsidies and the lack of carbon pricing, which strongly bias infrastructure investment towards high-carbon energy sources. Also, such subsidies discourage the development of cleaner energy technologies, undermine efficiency in energy use, and cause seriously harmful environmental impacts. The magnitude of the distortions is huge.

## 6.1 Removing fossil-fuel subsidies

The IMF has estimated that the total cost of energy subsidies, including the failure to price in negative externalities in terms of pollution and climate change impacts, was $5.3 trillion in 2015, or 6.5 percent of world GDP (Figure 34). Fossil fuel subsidies account for as much as 97 percent of the estimated total. The largest component is associated with coal, followed by petroleum. The subsidies are pervasive across countries. Emerging Asia accounts for about half of the total subsidies, while advanced economies account for about a quarter.

**Figure 34 High cost of global energy subsidies**

Global Energy Subsidies




*Source: Coady et al. (2015)*

Elimination of fossil-fuel subsidies would reduce global $CO_2$ emissions by an estimated 20 percent or more. About three-quarters of the subsidies are related to local environmental damages, notably pollution and fiscal losses. Removal of the subsidies could cut premature deaths from air pollution by more than half (WHO estimates that outdoor air pollution causes more than 3 million premature deaths a year). It could also generate substantial fiscal gains, estimated at $2.9 trillion (3.6 percent of world GDP) in 2015. These fiscal gains could be channeled to better uses, such as improving government finances, investing in sustainable infrastructure, bolstering research and development in green technologies, and supporting social safety nets that are better targeted than fuel subsidies, which tend to be highly regressive. Most of

the benefits of energy subsidies, typically more than 90 percent, accrue to non-poor, higher-income groups (Arze del Granado et al. 2012, IEA 2014). Targeted measures such as adjustments to the tax and benefit system, which may require only a small fraction of the savings from the removal of the subsidies, will likely be more effective in helping the poor than cheap fossil fuels (Dinan 2015).

In many countries, just the fiscal losses from fossil-fuel subsidies (without factoring in failure to charge for environmental damages) are a multiple of total spending on health. This is the case even with some poor countries in sub-Saharan Africa that can ill-afford such misallocation of resources, for example, Cameroon, Congo, Côte d'Ivoire, Mozambique, and Zambia. In some major oil producers, such as Angola, fiscal losses from fossil-fuel subsides exceeded spending on health and education combined (Whitley and van der Burg 2015a).

While the removal of fossil-fuel subsidies would have global benefits by reducing carbon emissions, the bulk of the gains would accrue locally through environmental and fiscal benefits. It is, therefore, in the countries' own interest to move ahead unilaterally with fossil-fuel pricing reform. Also, evidence shows that concerns about large negative impacts on firms' competitiveness and carbon leakage—companies moving their activities to other jurisdictions with lower carbon costs—are exaggerated (World Bank & ECOFYS 2015, Arlinghaus 2015, Fischer et al. 2015). Where the potential impacts may be more significant, as in more carbon-intensive industries, they can be addressed through complementary policies to facilitate adjustment by firms and workers, such as transition relief and retraining programs. Evidence suggests that the cost of such transition support measures is likely to be small compared to revenue mobilized from fossil-fuel pricing reform, say around 15 percent (Rydge 2015, Goulder 2013). Longer-term, countries that make quicker adjustment to efficient energy pricing will be at a competitive advantage. So the case for unilateral action by countries to reform fossil-fuel pricing is strong. Nonetheless, global coordination would certainly help strengthen national reform efforts—and help achieve collective outcomes more efficiently.

Several countries are taking steps to remove or reduce fossil-fuel subsidies, especially taking advantage of the prevailing low petroleum prices. More than 30 countries have taken action to phase-out these subsidies since 2013. This diverse group of countries includes both some major consumers and producers of fossil fuels, such as Angola, Egypt, Ghana, India, Indonesia, Iran, and Mexico—and most recently Saudi Arabia. These reforms are encouraging, though many do not go far enough and in some cases the reform was partially reversed later, such as in Nigeria. Analysis of these reform episodes shows that reforms have a better chance of being deeper and more durable if they are part of a broader and longer-term reform effort rather than isolated actions in response to short-term exigencies (Whitley and van der Burg 2015b). Overall, fossil-fuel pricing reform needs to go much further, not only to remove explicit fiscal subsidies but also to begin to address implicit subsidies relating to the damages caused by pollution and carbon emission (Arezki and Obstfeld 2015).

## 6.2 Instituting carbon pricing

The single most important public policy action that can be taken to incentivize lower-carbon investment is to put a price on carbon emissions. Doing so would align the price paid by carbon users with the true social opportunity cost of carbon. It also serves as a market mechanism to influence the behavior of producers and consumers. It raises revenues and can reach all sectors. .

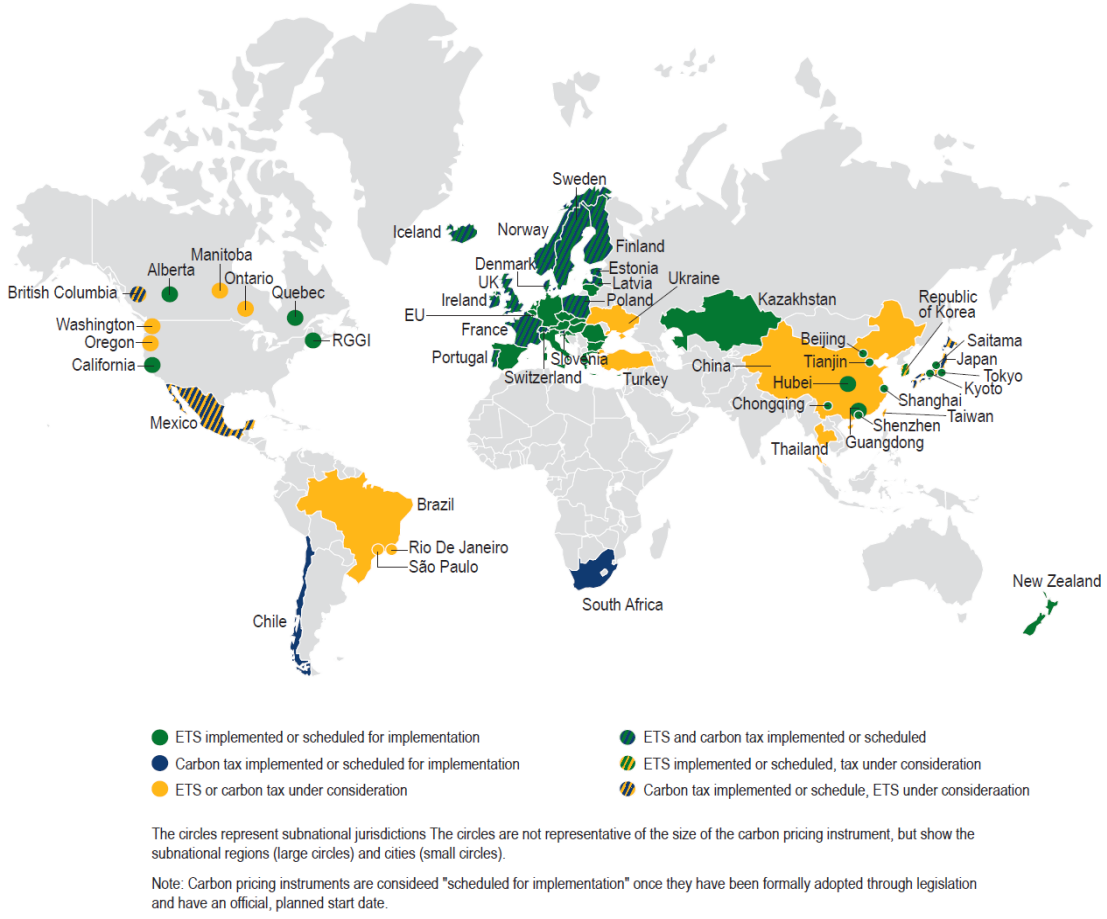
Regulation can also play a role, such as through instituting environmental standards in energy and transport, but pricing is more efficient than a patchwork of regulations covering a discrete number of activities (Farid et al. 2016). Regulatory approaches do not provide the clear, uniform price signals needed to redirect investment and innovation. They are more complex to administer and do not raise revenue. Where used, regulations should be applied to promote a broad range of mitigation responses and

harmonize carbon prices across programs and sectors as much as possible. They could also be designed to have price-like features, such as combining energy efficiency and emission standards with tax/subsidy schemes with fees/rebates for those falling short of /exceeding the standards.

Emission taxes and emission trading systems are the main instruments for implementing carbon pricing. Since 2012, the number of carbon pricing arrangements implemented or scheduled for implementation has almost doubled, rising from 20 to 38, with arrangements in the EU, China, and the US being the most notable in terms of their coverage of emissions. Using a mix of carbon taxes and emission trading schemes, there is now some form of carbon pricing at the national level in almost 40 countries (including 28 in the EU's emission trading system), and there are more than 20 pricing arrangements at the subnational level. But these pricing arrangements collectively cover only about 12 percent of global GHG emissions (Figure 35 a/b).

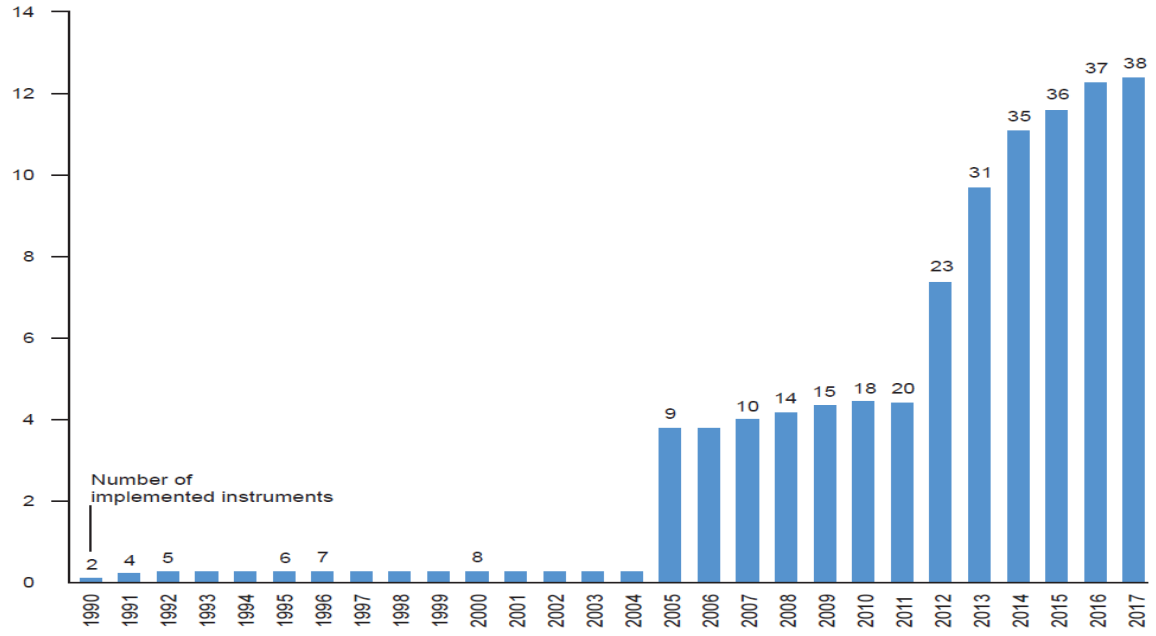
**Figure 35 Growing but still limited coverage of carbon pricing**

**(a): Regional and country distribution of carbon pricing arrangements**




*Source: World Bank Group and ECOFYS (2015)*

**(b) Number of regional, national, and subnational carbon pricing arrangements and % of global GHG emissions covered**




*Source: World Bank Group and ECOFYS (2015)*

Carbon prices in existing arrangements vary considerably, ranging from less than $1 to $130 per ton of $CO_2$ equivalent ($tCO_2e$). The majority of emissions—around 85 percent— are priced at less than $10 per $tCO_2e$, well below the price that economic models estimate is needed to meet the goal of keeping global average temperature to well below 2°C above pre-industrial levels (Figure 36). A transition to a greater coverage of emissions, and at higher prices, will be needed.

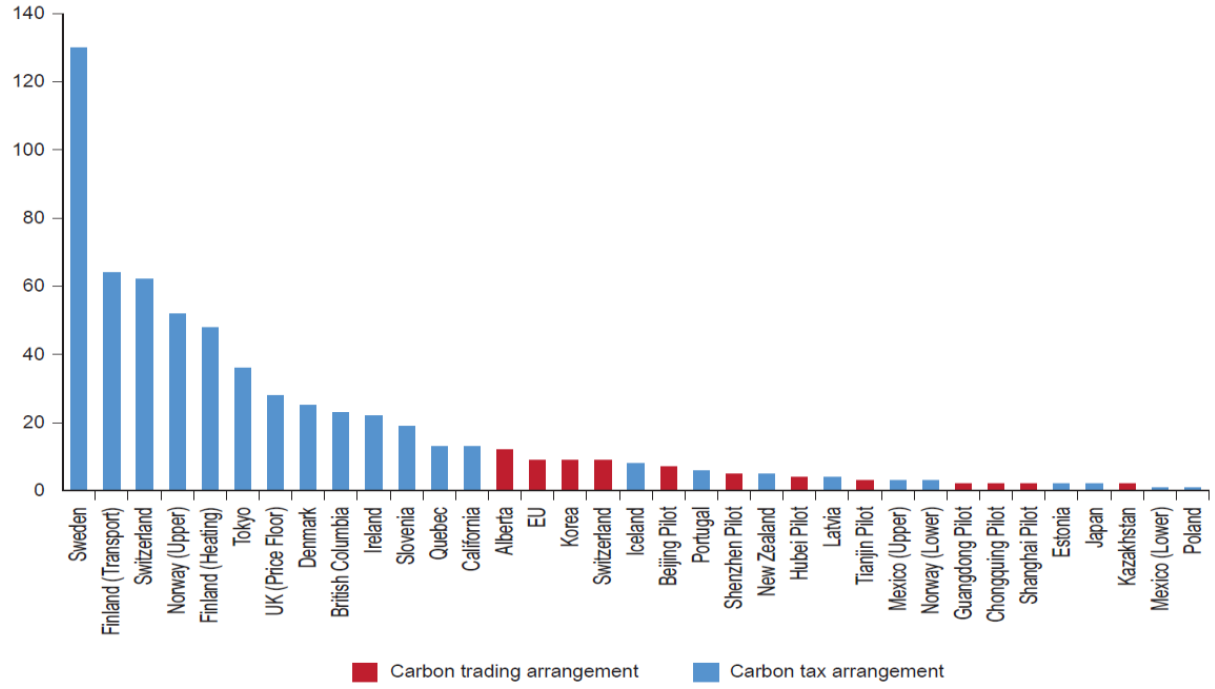
Looking ahead, more than 90 countries included some form of carbon-pricing schemes among the actions they intend to take as part of their INDCs submitted in Paris. This is a welcome development. The OECD and the World Bank have developed a set of principles that can help guide future carbon pricing arrangements. The FASTER principles are based on fairness, alignment of policies and objectives, stability and predictability, transparency, efficiency and cost-effectiveness, and reliability and environmental integrity (OECD and World Bank 2015a).

The momentum for mitigation action following the Paris agreement provides an opportunity to develop stronger consensus, support, and coordination across countries on instituting carbon pricing, including progress towards establishing a carbon pricing corridor with a price floor and a rising price over time. An approach combining a price floor coupled with commitment to progressive increases towards full optimal pricing would provide clarity and credibility on price signals, as well as appropriate gradualism to allow time for consequent economic adjustments and actions to mitigate the impact on vulnerable segments of the population. Gradual and tailored adjustment is particularly important for low-income developing countries (Gillingham and Keen 2012).

A concerted push is now needed to translate the policy momentum from Paris into tangible and timely progress on carbon pricing. International fora such as the G20 and the Carbon Pricing Panel recently convened by the IMF and the World Bank can provide political leadership and complement the UNFCCC process by establishing a focused platform to address and provide guidance on technical, administrative, and economic cooperation aspects of carbon pricing—such as assessment of the environmental and economic impacts of alternative levels and trajectories of carbon taxes, issues in the design and administration of tax and trading schemes, methodology for comparing different national level

approaches, links with other fiscal reforms, implementation of carbon pricing in large and complex federal systems, harmonization of tax administration across countries, aspects relating to international trade, and feasibility of including non-$CO_2$ GHG emissions (McKibbin et al. 2015).

**Figure 36 Low level of prices in most existing carbon pricing arrangements**




*Source: World Bank Group and ECOFYS (2015)*

## 6.3 Other pricing reform

Pricing reform is not limited to the energy sector, although the distortions there and related implications are especially significant. Distortions are widespread in the pricing of other natural resources and infrastructure services. Governments need to review pricing across sectors to align them better with economic fundamentals, including externalities, and use more efficient targeting mechanisms to achieve equity objectives.

In water supply, for example, subsidies provided through public utilities are estimated at more than $450 billion or 0.6 percent of global GDP annually, encouraging both inefficient and unsustainable resource use and causing fiscal losses. As in energy, these subsidies are also inequitable; for example, Cabo Verde, India, Nepal, and Nicaragua provide the richest households with $3 worth of subsidized water, on average, for every $1 worth provided to the poorest households (Kochhar et al. 2015). Getting prices right would create incentives for more efficient water use, check negative externalities such as groundwater depletion, improve cost recovery and enable better operation and maintenance of existing assets, encourage new investment in sustainable water infrastructure, and reduce fiscal burdens. Poorer households can be protected more efficiently through better targeted arrangements, such as well-designed lifeline rates or income support channeled through social safety nets.

# 7. Strengthening investment frameworks

Public policy has the most prominent ramifications for global infrastructure – both because of the extent of direct investment in the public sector and because public policy is essential in setting up the necessary investment framework that can encourage private sector involvement and support from MDBs. The role of public policy in creating the conditions that enable a large increase in private sector investment is particularly important, given the often significant price tag of these projects and their long-term nature, which leads investors to place a premium on having in place a stable and predictable policy and regulatory environment. Even in the presence of a robust private sector, direct public investments will continue to play an important role, such as in rural roads and water management, and the public sector will need to provide necessary balance sheet support to meet the viability gap in private investments. Moreover, public policy is needed to create the incentives that direct investors toward sustainable projects instead of toward carbon intensive projects.

This will require governments to develop strategic investment plans for sustainable infrastructure at the central, local, and city levels. Public policy needs to strengthen the institutional capacity of public and private sectors to prepare sustainable infrastructure projects. Public procurement policies also need to ensure that the social benefits of sustainable infrastructure projects are accounted for over the entire project life cycle.

## 7.1 Enhancing institutional capacities

Boosting infrastructure investment at scale and with the quality needed will require stronger investment planning capacity as well as project preparation and implementation expertise. While the infrastructure development needs are huge, the capacity to translate those needs into sound investment plans and projects and manage them effectively is often limited. Potential efficiency gains in infrastructure investment from improved investment management could be as high as $1 trillion a year globally, equivalent to roughly one-third of total current annual investment in infrastructure (McKinsey 2013).

### 7.1.1 Developing national strategies for sustainable infrastructure

Countries need to articulate clear and comprehensive strategies for sustainable infrastructure and embed them in overall strategies for sustainable and inclusive growth and development. Addressing one group of projects at a time will not do. Sustainability is not just about individual projects; it is about reflection of the sustainability dimension in the overall strategic, policy, and investment framework. There is a need for a broader articulation of national strategies on the direction of change and plans to address policy and market failures and other constraints to sustainable infrastructure development. National strategies need to inform, and be supported by, strategies in key infrastructure sectors and subnational jurisdictions that are important providers of infrastructure. Only such integrated strategic frameworks will ensure coherence across public policy actions and investments, facilitate coordination across sectors and levels of government, and provide the clarity and confidence to private investors to do their part.

Sustainable infrastructure measures, to varying degrees, form part of the intended nationally determined contributions (INDCs) countries announced in the lead-up to the Paris meeting. More than 180 countries submitted such national climate action plans. The commitments countries have made are more ambitious than their past commitments, but they collectively fall short of the goal to limit global warming to well below 2°C above pre-industrial levels. So the collective level of ambition will need to be raised. An important outcome of the Paris meeting, therefore, is an agreed process to verify progress on implementation and review action plans every five years with a view to strengthening them to achieve the

climate goals. It will also be important for countries to reflect and integrate their action plans—or INDCs— in overall national growth and development strategies.

**Box 8 NDCs are a critical instrument to link climate goals to growth strategies.**

The Paris Agreement on climate change concluded in December 2015 was designed around nationally determined climate targets. These targets, called Nationally Determined Contributions (NDCs) set forth each country's goals regarding its climate policy and in many cases provide quantified targets and dates for reaching them. The specific form of targets within the NDCs can vary substantially, including for example absolute emissions reduction targets, targets for improving the emissions intensity of GDP, targets for deployment of clean energy and renewables, and goals for improving resilience and adaptation. It is expected that these goals will be renewed roughly every five years and that information about progress toward the NDC targets will be made available to the global community to facilitate assessment.

In addition to its role in driving forward emissions reductions under the Paris Agreement, the NDC system provides a regular, recurring prompt for countries to evaluate and revise their goals, timelines and policy strategies related to many aspects of climate policy. Viewed broadly these include not only the emissions and energy dimensions of a country's policy approach, but also ought to include elements such as development, resilience, and national economic growth and investment strategies. In parallel, the Paris Agreement calls on countries to develop and report on national strategies for long-term decarbonization, and these long-term strategies will necessarily be deeply embedded in national approaches to overall economic growth and investment in sustainable infrastructure. As such, the NDC process viewed in this way will provide an important prompt for countries to link their economic, finance, industrial, and development strategies with their climate policy overall and with specific sectoral needs in, for example, transportation, agriculture, energy, and industrial sectors.

While the NDCs therefore present a potentially powerful opportunity to help integrate action on climate with national strategies on economic growth, the processes and mechanisms to integrate these goals across national governments may be underdeveloped. A key focus in the near term should therefore be the explicit linking of national economic strategies with both implementing existing NDCs and development of the next round of targets.

*Source: Nathan Hultman, Nonresident Senior Fellow, Brookings Institution (2016)*

The G20 group of major economies can provide leadership on this effort. Together, these economies account for around 80 percent of global carbon emissions. As part of G20 processes, all G20 countries have prepared and peer-reviewed national growth and investment strategies over the past two years. These are important initiatives, as they consolidate different elements of country policies and G20 work streams in growth and investment frameworks that permit a more integrated and strategic consideration of policy linkages and priorities at the national level as well as areas for coordination at the international level. However, climate sustainability so far has received very limited attention in these strategies. The strategies are also insufficiently linked to collective G20 work on some important elements of the sustainability agenda, such as reform of fossil-fuel subsidies, energy policy, and climate finance.

The G20 growth strategies address the agenda to achieve strong, sustainable, and balanced growth, but sustainability is approached mainly in terms of macroeconomic and fiscal sustainability. Longer-term sustainability of growth related to environmental stress and climate change is at best only weakly incorporated in the growth strategies. The G20 investment strategies focus on boosting investment as a key element of the agenda to lift economic growth, with particular attention to ramping up infrastructure investment. While country investment plans include specific investments in areas such as renewable energy and disaster resilience, climate sustainability is not integrated in the investment strategies as a cross-cutting theme and imperative that informs the investment agenda as a whole (Box 9). The Paris agreement and the INDC process provide an opportunity to better integrate climate sustainability, and related sustainable infrastructure agenda, into these national investment and growth strategies.

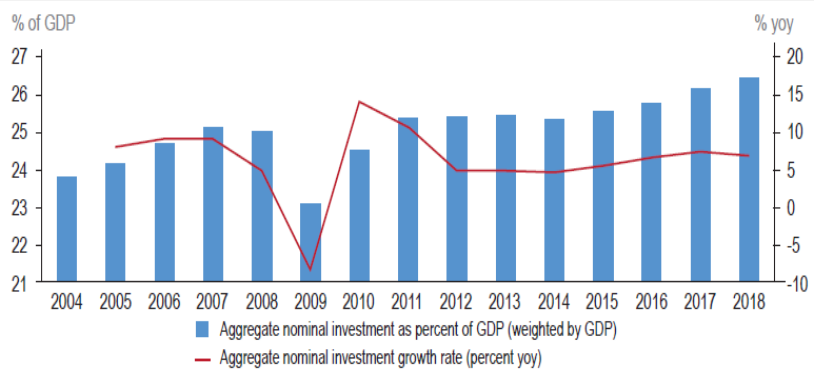
**Box 9 Need to better integrate sustainability in G20 investment strategies**

Growth strategies prepared by all G20 countries in 2014 called for boosting investment and addressing infrastructure shortfalls as crucial to lifting growth and job creation. To flesh out the investment agenda, G20 countries subsequently prepared investment strategies that were assessed and peer-reviewed in G20's Investment and Infrastructure Working Group and eventually discussed by G20 Leaders at their summit in November 2015.

Based on estimates provided by G20 countries, total G20 investment is projected to exceed GDP growth in the period ahead, with the investment to GDP ratio rising in most G20 countries relative to current and pre-crisis levels. For G20 countries collectively, the investment to GDP ratios rises by about 1 percentage point during 2015-18 to reach 26.4 percent (see chart). There is a large variance in G20 investment ratios at the level of individual countries; in 2014, they ranged from about 17 percent (Argentina, Italy, and UK) to 46 percent (China).

The need to address infrastructure gaps is a major driver of the projected increases in investment. While aiming to boost the quantity of investment, the G20 investment strategies also emphasize measures to ensure quality. These include improvements in policies in key infrastructure sectors, investment planning, and project preparation and implementation. Improvements in fiscal management to underpin increases in public investment also receive attention. Other areas of emphasis are improvement of PPP frameworks and promotion of modalities to leverage more private financing. The strategies also address the agenda to improve the climate for investment in countries more broadly through policy and institutional reforms.

**G20 investment/GDP ratio and investment growth rate**




*Source: OECD (2015b)*
*Note: Projections for 2015 and beyond.*

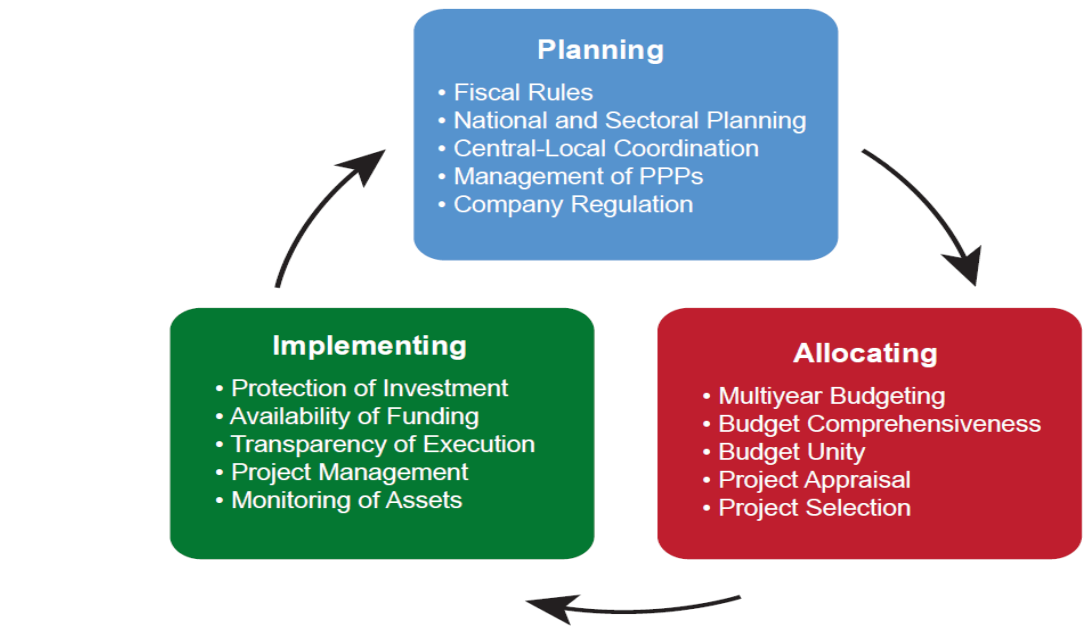
The investment strategies include a variety of sustainable infrastructure projects. This is especially the case with the energy sector, where many strategies include projects for clean/renewable energy generation and improved efficiency in energy use. Several strategies include projects to address disaster risks. A few strategies also mention policy reforms such as carbon taxes and incentives for sustainable investments and research and development. However, for the most part, attention to climate sustainability and resilience is fragmentary, limited to a few discrete investments and policy initiatives. The sustainability dimension is not incorporated in the investment strategies as an overarching concern to be reflected in the design of the overall investment program and across the policy and investment choices that are made. This is a missed opportunity. Climate protection requires a deeper, systemic integration of sustainability in country investment and infrastructure development programs and policies. This need should receive more attention as the G20 investment strategies are further developed and implemented.

*Source: Qureshi (2016)*

### 7.1.2 Public investment management

The IMF recently developed a Public Investment Management Assessment (PIMA) framework that for assessing public investment management capacities and diagnosing areas for improvement (Figure 37). PIMA complements diagnostic tools for project management and good governance developed by the World Bank and the OECD, respectively. PIMA incorporates elements related to integration of investment planning with fiscal frameworks, coordination of public investment across levels of government, and private participation in infrastructure provision. Assessment scores across the 15 elements of PIMA show much larger gaps in capacity in developing countries compared to the more developed ones, but they also identify important areas for improvement in the latter group.

**Figure 37 Elements of public investment management framework**




*Source: IMF (2015)*

Differences in public investment management (PIM) capabilities are mirrored in large differences in public investment efficiency across countries. The analysis finds that moving from the lowest quartile to the highest quartile in public investment efficiency could double the impact of investment on growth (IMF 2015). It also finds that strengthening PIM institutions can close more than two-thirds of the public investment efficiency gap in countries relative to the best performers. The largest payoff is in emerging economies and, notably LICs typically have weaker PIM capacities; estimates of potential gains from public investment that are lost due to PIM weaknesses range from an average of 13 percent in advanced economies to 40 percent in low-income countries.

Priorities for strengthening PIM vary across country groups. In general, priorities for action relate more to the planning stage of the PIM cycle in countries at a higher level of development, whereas the implementation and delivery stage also needs to be a focus in countries at a lower level of development. Advanced economies need to strengthen central-local coordination, enhance medium-term budget frameworks and integrate them with national and sectoral strategic planning. Emerging market economies need to adopt more rigorous and transparent arrangements for project appraisal, selection, and

management. LICs need to strengthen both project development and the institutions and processes related to project implementation and monitoring, including improving procurement processes that can be especially prone to corruption. Most countries, but especially emerging and developing economies, would benefit from strengthening institutional capacities to develop, appraise, negotiate, and manage PPPs. This would allow them to catalyze more private investment while ensuring value for money and minimizing fiscal risks. Improvements are also needed in fiscal frameworks for accounting for and managing related contingent liabilities.

### 7.1.3 Strengthening project preparation and incorporating sustainability

In many EMDCs, weak project pipelines are a particularly important—often a binding—constraint to boosting public infrastructure investment and attracting more private participation. Taking climate risks and sustainability into account in a systematic way magnifies the challenges for investment planning and project development and management. A systematic approach requires: i) incorporating environmental sustainability as an integral, cross-cutting element of government investment programs and policies; ii) systematically capturing environmental externalities in project appraisal and ensuring their proper valuation; and iii) consistently applying environmental safeguards to investments, such as those relating to carbon emissions and pollution or energy efficiency.

Using shadow prices to fully capture environmental externalities in project appraisal is a growing practice among public investment agencies and parts of the private sector, but it needs to go much further in terms of coverage and consistency of application (Smith and Braathen 2015). Governments can take leadership by using shadow pricing of carbon in their own projects and catalyzing its broader use (Morris 2015). Relatedly, governments need to review the use of discount rates in project evaluation, to ensure they are not resulting in a bias against low-carbon, climate- resilient infrastructure investments whose positive externalities typically take a long time to materialize. Together with improved project analysis, governments should establish clear investment planning frameworks and standards for integrating sustainability in the prioritization and selection of projects (Box 10).

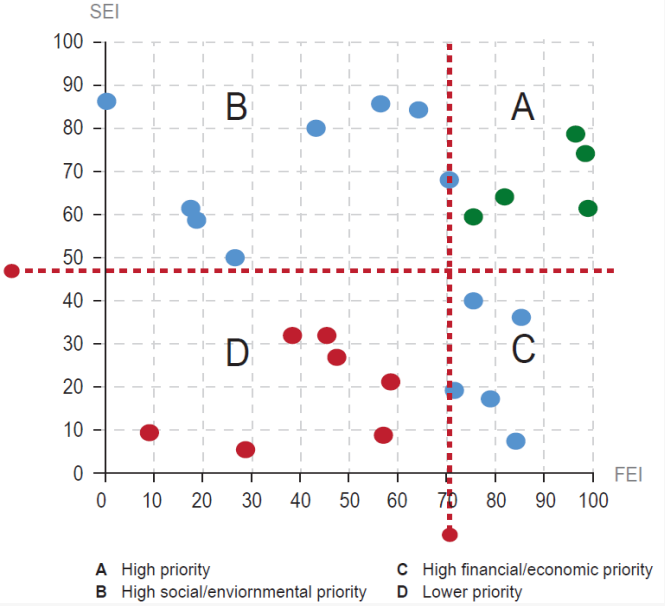
Governments need to develop and implement procurement processes that incorporate sustainability criteria. Public procurement averages around 15 percent of GDP in OECD countries and typically accounts for a higher proportion in developing countries (OECD 2015c). In India, for example, it is variously estimated between 20-30 percent of GDP (CUTS 2012). So incorporating sustainability criteria in procurement provides an important avenue to governments to promote sustainable approaches to project development and management. Such criteria could include elements such as use of shadow prices for carbon in project evaluation, total cost of ownership analyses, output-based specifications, and climate risk mitigation and resilience standards (UNEP 2013). In addition to incorporating sustainability criteria in procurement for public sector infrastructure projects, such as bid-build and design-build projects, governments can incorporate them in requests for and evaluations of PPP proposals, as discussed earlier. A number of countries have put in place elements of sustainable procurement; there is a need to develop more systematic and consistent approaches and disseminate good practice (Box 11).

**Box 10 Prioritization of infrastructure projects**

Large infrastructure investment requirements coupled with tighter fiscal constraints have sharpened the need for careful prioritization of infrastructure projects to make the best use of available budgetary space. Another challenge is to integrate environmental risks and sustainability into project assessment and selection. The World Bank has recently developed and pilot-tested an Infrastructure Prioritization Framework (IPF) that planning agencies may find useful as part of the toolkit to respond to these challenges in a systematic way.

As illustrated in the chart below, the IPF is a quantitative approach that synthesizes financial, economic, social, and environmental indicators and considers these alongside the public budget constraint. The key output is a graphical display of projects' performance along two axis, defined by financial-economic index (FEI) and social environmental index (SEI) composite scores. Policymakers determine the specific indicators or criteria comprising each index and associated weights based on government policy goals and stakeholder consultation. Indicators may include such financial-economic indicators as financial rates of return and multiplier effects and such social-environmental indicators as the number of targeted beneficiaries/jobs created and carbon footprint. The IPF can incorporate the outputs of cost-benefit analysis as inputs to a multi-criteria model.

**Infrastructure prioritization framework – integrating sustainability**




In the chart, each dot represents the estimated scores of a proposed infrastructure project. The red dashed lines represent the budget constraint. In the example shown, from an FEI perspective, resources would be sufficient to finance only those projects with an FEI score above 70. From an SEI perspective, resources would be enough to finance only those projects with an SEI score above 45. Quadrant A contains high-priority projects that score high on both FEI and SEI. Projects falling in Quadrant D may be classified as low priority as they score low on both FEI and SEI. Projects in Quadrant B and C score relatively high on either FEI or SEI but not both. All projects in either quadrant B or C, or a mix of projects within each, could be implemented with available resources. Identification of these medium-priority projects leaves space for expert review and informed political debate.

The framework is designed to allow flexibility to adapt to local contexts, in terms of the criteria included, weighing of trade-offs, and demands on data and technical capacity. It recognizes that decisions on projects involve political judgment. Its main contribution is to bring the multidimensionality of infrastructure projects systematically into project assessment and provide a structured and transparent platform for decision-making.

*Source: Qureshi (2016) based on Marcelo et al. (2015).*

Efforts to build capacity for project preparation and investment management will need to reach beyond central government agencies to cover subnational and local-level entities that will have a major role in ramping up investment in sustainable infrastructure. City-related infrastructure accounts for the bulk of total infrastructure investment, but investment planning and management capacities are often the weakest at municipal levels. Only about 20 percent of the world's largest cities have the basic analytics necessary for low-carbon planning (World Bank 2013a). Also, intergovernmental investment coordination mechanisms and fiscal relations will need more attention.

Governments and their development partners, especially MDBs, will need to scale up investment in building institutional capacities to develop and manage stronger pipelines of infrastructure projects that are both bankable and sustainable. The primary responsibility for capacity building and project pipeline development lies with governments, but project preparation facilities (PPFs) supported by MDBs and bilateral donor agencies can help by mobilizing technical expertise and financing. The requisite technical skills are often scarce in developing countries. Moreover, project preparation costs in these countries can reach as high as 10 percent of total project investment (World Bank 2013b).

**Box 11 Sustainable procurement: challenges and good practices**

Today, almost three-quarters of OECD countries have some policies encouraging sustainable public procurement (SPP) at the central government level. Some developing countries also are adopting SPP practices. A review of current practices reveals a set of challenges and corresponding good practices.

- ***Establishing clear legal and policy framework.*** Some OECD countries such as Germany, Japan, and the US have established clear legal frameworks, allowing them to direct purchasing activities to achieve set sustainability goals. Among developing economies, China and Colombia, for example, are putting SPP policy frameworks in place.
- ***Assessing value for money over an asset's life cycle.*** While 79 percent of OECD countries identify the cost of sustainable projects as a key barrier to expanding the use of SPP, only 16 percent implement lifecycle cost evaluation systematically. Such evaluation, incorporating and properly valuing lifecycle costs and benefits, should be mainstreamed into procurement practices. The EU has put in place a directive that now requires that project tenders be evaluated on whole-life value and total cost of ownership.
- ***Including environmental standards in design, selection, and award of projects and contract performance.*** In 2010, 24 OECD countries included environmental considerations in technical specifications for products and 18 in the award criteria for contracts, but only 13 in contract performance.
- ***Building professional, multidisciplinary teams.*** Teams need to include multidisciplinary professionals—procurement officials, lawyers, and professionals with technical SPP capacity, such as engineers. Capacity building should be supported through focused SPP training, especially in developing economies.
- ***Raising stakeholder awareness.*** Communication strategies to raise awareness of buyers, the market, and citizens about SPP solutions and benefits can help promote SPP visibility and uptake.
- ***Monitoring impact.*** Mechanisms should be put in place to evaluate if SPP polices are achieving their goals and to disseminate good practice.

*Source: Qureshi (2016) based on OECD (2015d)*

A review of PPFs conducted by the G20's Development Working Group called for significantly increasing the resources devoted to project preparation (G20-DWG 2014, with supporting studies ASI 2014 and CEPA 2012). It also called for rationalizing and consolidating PPFs to achieve scale and focus and for improving coordination among them. The review of PPFs in Africa found much fragmentation and diffusion of focus, with upwards of 60 such facilities in the region. Another recommendation was to strengthen support to building governments' upstream capacities (such as diagnostics, prioritization, pre-appraisal) to ensure that the most meritorious projects enter the downstream project preparation process. Upstream capacities can be especially important for sustainable infrastructure projects, to instill sustainability into project planning and preparation from the outset.

MDBs will have a key role in supporting national efforts to boost capacities for sustainable project preparation and pipeline development, through stronger and more effective PPFs and knowledge sharing. Addressing sustainability, promoting harmonized approaches, and improving coordination, including through joint initiatives, merit particular attention, as they step up project preparation support to countries in scaling up infrastructure investment. MDBs also need to incorporate sustainability more consistently in

their own analytical and investment frameworks. In their current individual and collective efforts, MDBs are responding to this agenda (MDBs 2015b). Complementing stronger and better coordinated MDB support, part of the climate funds stemming from the Paris Agreement could be usefully deployed to help build capacities in countries to integrate sustainability in investment policies and project preparation.

The private sector can also help more with preparation of projects that potentially involve private participation. With appropriate safeguards to reduce risks of conflict of interest, early engagement of private investors augments project preparation capacities and strengthens links with financing (Arezki et al. 2016). Increasingly, interested private investors, including institutional investors, are becoming engaged in early stages of project preparation. For example, InfraCo, a privately managed early-stage financier of projects in developing countries, has been so engaged successfully in Kenya, Uganda, and Zambia (Bielenberg et al. 2016). The private sector arms of MDBs can step up support, at both upstream and downstream stages. For example, the International Finance Corporation provides upstream support on the enabling environment for private participation through its Public-Private Infrastructure Advisory Facility and downstream support to project development through its InfraVentures program.

## 7.2 Strengthening public investment

Together with improving the environment to mobilize more private investment, public investment will need to be ramped up to meet the projected large growth in infrastructure demand and address the challenge of sustainability. Increased investment will need to be supported by substantial enhancement of investment management capacities to ensure efficiency and impact and integrate sustainability objectives in investment programs and projects. This presents a particular challenge in EMDCs that will see the largest increases in infrastructure demand but have weaker institutional capacities.

### 7.2.1 Reversing the decline in public investment

The public sector continues to dominate the provision of infrastructure in EMDCs, though the private sector role has been increasing, as noted above. In these economies, the public sector typically accounts for two-thirds to three-quarters of infrastructure investment. In India, for example, the public sector accounts for about 70 percent of infrastructure investment. In low-income countries, this share tends to be still higher. By contrast, the private sector typically accounts for about two-thirds of infrastructure investment in advanced economies, as, for example, is the case with the UK. The public sector role extends beyond its direct investment, given the catalytic role of its engagement. The catalytic role of public investment will be particularly important in leading and supporting the transition from traditional to sustainable infrastructure models.

As highlighted earlier, public investment rates have been on a declining trend in most economies for much of the past three decades. With infrastructure forming a major part of public investment, the decline in public investment rates has resulted in growing infrastructure gaps. This is reflected in a substantial decline in the stock of public capital relative to GDP across advanced and emerging economies over the past three decades—by an average of around 15 percent—as accumulation of capital stock lagged behind growth in economic activity (IMF 2014b). Even in those economies where measures of the quantity of infrastructure appear relatively high, deficiencies in the quality of infrastructure have increased.

The decline in public investment must be reversed if the public sector is to play its due role in addressing existing infrastructure gaps and future infrastructure development needs, including investments and research and development in climate change mitigation and adaptation. This is particularly the case where public investment levels were relatively low to begin with. In countries with high investment levels,

notably China, aggregate investment may need to decline as part of the broader process of economic transformation. The main issue in these cases is the allocation, quality, and sustainability of investment.

### 7.2.2 Managing a more decentralized pattern of investment

Public investment is generally a shared responsibility across levels of government. This is particularly true in advanced economies and some large emerging economies, where regional and local governments typically undertake well over half of public investment. Subnational governments accounted for 72 percent of total public investment in OECD countries in 2013, with the share as high as 80 percent or more in some countries, for example, Canada and Japan (OECD 2015a). Among large emerging economies with federal structures, the subnational share of public investment is 75 percent or more in Brazil, India, and South Africa (Frank and Martínez-Vázquez 2016). Of Brazil's 75 percent subnational share in 2014, 55 percent was funded from subnational governments' own sources and 20 percent from federal transfers (Garcia-Escribano et al. 2015). Investment is generally much more centralized in lower-income developing countries.

With rapid urbanization, the role of cities and municipal governments in infrastructure provision in emerging and developing economies will increase. The role of local governments will also increase because sustainable infrastructure opens more avenues for decentralized provision, such as small-grid or off-grid supply of renewable energy compared to the traditional model of a centralized grid. Cities consume more than two-thirds of the world's energy and release at least the same proportion of energy-related GHG emissions. In the next 15 years, the world's urban population will grow by 70 million people a year. Urban areas will account for more than 70 percent of total investment in sustainable infrastructure over the same period (CCFLA 2015). Empowering cities and local governments, within a framework of clear accountabilities, will be crucial to meeting the challenge of scaling up infrastructure while ensuring sustainability.

As cities grow, the divergence between demands for infrastructure and the ability of governments to deliver is widening. Traditional approaches to infrastructure funding—user charges and general tax revenues—are not generating enough revenues to finance the expansion of infrastructure services. The application and scaling up of land value capture offers an important potential source of financing especially for urban infrastructure (WEF 2014).

## 7.3 Improving the private investment climate

Promoting greater private investment will be crucial to meeting the sustainable infrastructure challenge. Of the estimated additional investment in sustainable infrastructure of more than $3 trillion per annum required over the next 15 years, more than a half will need to come from the private sector. The case for a stronger promotion of private investment rests not only on the need to mobilize more financing; increased private participation can spur efficiency and innovation.

### 7.3.1 Reducing costs of doing business and policy risk

Boosting private sector investment will be especially important in developing countries, where the infrastructure needs are large but private involvement in infrastructure is relatively low. In many of these countries, risks relating to public policy and transaction costs of business are a major impediment to private investment in infrastructure. Such risks and costs depress risk-adjusted returns and keep the price of capital for infrastructure investment high, even when long-term interest rates are low. Private investment in infrastructure is especially sensitive to country-level policy risk, more than foreign direct

investment overall. A World Bank study found that an improvement in country risk ratings by one standard deviation is associated with a 27 percent higher chance of having a private participation in infrastructure commitment and a 41 percent higher level of investment in dollar terms (Araya et al. 2013). Reform of infrastructure and carbon pricing, as discussed above, would improve price signals and predictability, addressing one major source of policy risk and distortion of investment decisions. Countries also need to improve the enabling environment for investment through broader regulatory and institutional reforms.

One broad area for attention is the framework of regulations and institutions that influence the ease of doing business within the country. These include business entry and exit regulations, competition policies, regulations and structures affecting access to finance, foreign investment rules, laws governing investor and property rights, tax policies, and anti-corruption laws. At the level of individual infrastructure sectors, clarity on overall sector investment strategy and the role envisioned for private and foreign participation, sector policies on user charges/cost recovery and environmental standards, consistency and credibility of incentives such as feed-in tariffs, and sectoral institutional arrangements and capabilities for investment planning and project development matter greatly for the enabling environment that investors face. Government policy has a key role in providing long-term direction on sector pricing, such as in electricity markets. On the side of financing, regulatory and institutional frameworks enabling the development of capital markets that provide long-term financing and risk mitigation instruments are especially important for infrastructure investments given their longevity and risk-return characteristics.

### 7.3.2 Improving the institutional and regulatory framework for PPPs

More specifically for infrastructure, a sound legal and institutional framework governing private participation in infrastructure through PPPs is key to attracting more investment and ensuring its effectiveness. Transparency and credibility of processes for selection of projects and delivery models, negotiation, and risk sharing are crucial. Investors' confidence in consistency of policy and implementation is helped by standardizing contracts and concessions, purchase agreements, and bidding documents as much as possible.

Appropriately structuring PPPs in terms of distribution of risks and returns and supporting regulation is vital to maximizing value for money—to benefit not only from the additional financing that private participation brings, but also from its expertise to produce efficiency gains and capacity to innovate (Buckberg et al. 2015). Poor contract designs can thwart these potential benefits, producing inefficient project outcomes and saddling governments with large fiscal costs and liabilities. Maximizing benefits and minimizing risks requires specialized skills in developing and contracting PPPs. Related capacities in governments will need enhancement, which may require setting up dedicated units. Countries and local governments that have established strong institutional mechanisms, in terms of legal frameworks and capacities, tend to be more successful in tapping the potential of PPPs.

**Box 12 Lessons from PPP case studies**

***The Philippines: a PPP market with momentum.*** Thanks to a clear overall investment strategy and supporting regulatory and institutional reforms, PPP activity has picked up considerably in recent years. A National PPP Program was launched in 2010, with the creation of the Philippines PPP Center (PPPC), which functions under the control of the President's office. In parallel, the original BOT Law and implementing regulations have undergone an overhaul, and a new PPP Act is being introduced. As of May 2015, the PPPC had a pipeline of 61 projects across energy, transport and other sectors. Other factors contributing to success include: strengthening project preparation with a well-staffed PPPC functioning as a central unit and engaging with line agencies, and with coordinated support under a Project Development and Monitoring Facility led by the ADB; developing risk

mitigation instruments, including the creation of a national "PPP contingent liability fund"; and improving the enabling environment for domestic financial institutions to provide longer-term financing.

***Turkey: a growing PPP market.*** Private sector involvement in infrastructure started in the early 1990s with a number of projects in energy and transport and has grown steadily since, bolstered also by Turkey's privatization program in the early 2000s covering a substantial portfolio of infrastructure assets. There are three key reasons for the success of PPPs in Turkey: a strong political will, reflected in improvements in the legal framework and guarantee mechanisms; development of a strong pipeline of projects through capacity enhancements; and strengthening of domestic markets for long-term finance. Still, challenges remain. The enabling environment could be further improved by enhancing consistency, transparency, and competition in project development and procurement. A central PPP unit could be beneficial for consistency, transfer of know-how, and alignment of PPP contracts with international best practice.

***Colombia: paving the way for PPPs for better roads.*** Colombia was disappointed when it received few bids for the first three rounds of its road program. To do better for the Fourth Generation (4G) program—40 projects expected to bring in up to $25 billion—it took steps to improve the enabling environment and provision of project financing. It worked: 4G has already seen a record number of bids. Enabling environment improvements included the creation of a stronger National Infrastructure Agency, improvement of the legal framework for PPPs, and passage of laws that improved land acquisition and streamlined the environment licensing process. On the financing side, a state development Bank (Financiera de Desarrollo Nacional) was established to provide loans and guarantees to PPP projects to complement commercial bank loans and capital market offerings, helping to mitigate risk and catalyze more project financing.

***Brazil: the largest PPP market.*** Brazil is the largest PPP market in the developing world. It accounted for around 40 percent of all private investment in infrastructure in developing countries in 2014. Two recent sustainable urban transport PPP projects illustrate some of the reasons for Brazil's success. The first is the Linha 4 metro line that adds critical capacity to Sao Paulo's transit network and connects poor suburban communities. The second is a bus transit-oriented development in a working-class neighborhood in Belo Horizonte. At the national level, clearer policy and legal frameworks for private participation in infrastructure have been established, combined with efforts to develop the domestic capital market. At the subnational level, local governments have been empowered, together with capacity building to structure PPP projects.

***Chile: a mature PPP market.*** Chile is the most mature infrastructure investment market in Latin America. Starting with transport projects in the 1990s and followed by facilities management PPPs in the mid-2000s, Chile raised about $12 billion in investment. The country attracts strong investor interest and has an active secondary PPP market. The foundation was laid by broad improvements in the regulatory environment for private investment and development of the domestic capital market, including institutional investors. The Central Concessions Unit has played a key role, having developed strong capacity in preparation and management of PPPs. Project pipeline development was accompanied by improvements in policy frameworks in concerned sectors. The procuring agency also made effective use of risk mitigation mechanisms, through provision of explicit contractual guarantees.

*Sources: EBRD (2015), Leipziger and Lefevre (forthcoming), and Bielenberg et al. (2016).*

With increased emphasis on sustainable infrastructure, consistent treatment of climate risk in PPP frameworks will be important, complemented by broader policies (such as carbon pricing) that affect incentives towards sustainability. Sustainability criteria could be reflected in requests for and evaluations of PPP proposals, and applied in a consistent manner. These could include, for example, evaluation of projects over their entire lifecycle to fully capture downstream costs and benefits, carbon emissions, and water use intensity. The use of such criteria can add to the technical complexity of project design and evaluation. Such criteria are being used in many advanced economies, such as those in the EU, and have been applied to projects in some middle-income countries as well, for example, Brazil and South Africa. More knowledge sharing of best practice and standardization would help advance their use and foster consistency. Also, increasing private investor interest in sustainable infrastructure would help promote sustainable approaches. This is reflected in the changing composition of PPP investments. Of the $40 billion of investment in electricity generation PPP projects in developing countries in 2014, $22 billion

was in renewable energy, with onshore wind and solar photovoltaic as the most common technologies for renewable energy projects (World Bank 2015a). More than 1,000 major companies and investors have endorsed carbon pricing and around 450 now use an internal carbon price to guide investment decisions (CDP 2015).

Improving the policy frameworks and institutional capacities to effectively promote and manage PPPs will be particularly important for middle-income countries in meeting their infrastructure investment requirements. Of the total investment of more than $6 trillion per annum in sustainable infrastructure that is needed globally in the next 15 years, around two-thirds, or $4 trillion, will need to take place in these countries. This is well over double their current level of investment. PPP projects will be a key modality for meeting the incremental investment requirements. Private participation in infrastructure in developing countries has been rising over the past decade and averaged around $150 billion annually over the past three years. This will need to be scaled massively. In 2014, as much as three-quarters of the total private participation was accounted for by five middle-income countries-- Brazil, Turkey, Peru, Colombia, and India (in that order). More middle-income countries will need to improve their enabling environments to attract private participation. Private participation is much more limited in low-income countries, as reflected in the small share of sub-Saharan Africa in the total flows. However, these countries over time can also aim to mobilize more private investment through strengthening their policy and institutional frameworks, as some lower-income African countries have shown, such as Ghana, Kenya, and Tanzania. Country case studies provide useful lessons on public-private partnerships from actual experience in a variety of regional and institutional settings (Box 12 & 13).

There is a rich body of assessments and indicators of countries' investment climate that can help in identifying the most serious deficiencies and priorities for reform. For example, the World Bank's *Doing Business* reports assess key regulatory and institutional aspects of overall business environment in a country (World Bank 2015b). The INFRASCOPE assessments developed by a group of MDBs (with EIU) focus on country policies and capacities for infrastructure PPPs (MDBs 2015a). The CLIMATESCOPE assessments initially developed by the IADB with Bloomberg for Latin America and later expanded to cover countries in other regions focus more specifically on the investment climate for clean energy projects (BNEF 2015). Moreover, substantial work has recently been done in the G20—under the auspices of the G20 Investment and Infrastructure Working Group and Development Working Group and with the support of the World Bank, other MDBs, and the OECD—on specific policies and best practices to improve the enabling environment for investment in infrastructure and promote private participation (OECD and World Bank 2015b/c).

MDBs have undertaken a range of initiatives to enhance capabilities and performance with respect to PPPs. They have jointly set up a PPP Knowledge Lab to provide a comprehensive online resource (MDBs 2016). The Asian Development Bank, Inter-American Development Bank, the World Bank and the Public-Private Infrastructure Advisory Facility (PPIAF) have issued the second version of the PPP reference guide (World Bank, ADB and IADB 2014). The guide presents a global overview of the diversity of approaches and experiences in the implementation of public-private partnerships (PPPs), providing an entry point to the substantial body of knowledge on PPPs that has been built up. It reviews when and how PPPs should be used; the policy and institutional frameworks that need to be put in place for sound PPPs; and ways in which PPPs can be developed and implemented. The World Bank and PPIAF have issued their latest assessment of benchmarking PPP procurement that assesses government capabilities in 82 economies across four key areas: PPP preparation, PPP procurement, unsolicited proposals and PPP contract management (World Bank and PPIAF 2016). The assessment finds huge variations in practice and that most economies fall short of recognized good practices. The MDBs and PPIAF have also established the APMG certification program for PPP experts (APMG 2016). Finally, the MDBs have set up an international infrastructure support system in cooperation with two national development banks that aims to promote and facilitate high quality and efficient global project delivery accessible to the public and private sector (SIF 2016).

**Box 13 Public-Private Partnerships in urban transport – Brazil**

High rates of motorization and urbanization as well as burgeoning demand (particularly in developing countries) have made transport the world's fastest-growing source of carbon emissions. Global investment in transport is projected to reach $45 trillion in 2050, and investments made today in transport infrastructure will have long-term lock-in effects on economic and environmental outcomes. The private sector can be an important source of finance – as well as operational expertise -- to meet the growth in demand.

However, private participation in transport investment in developing countries remains limited. Transport projects face particular risks given their long-term nature and high public visibility: long construction periods leave ample time for cost overruns and delays; demand can be difficult to predict; the project finance structures typically used to finance such projects add cost and complexity. Transport investment in an urban context involves more physical constraints and price pressure, as public authorities aim to meet broader equity and accessibility objectives. And sustainable transport systems face additional challenges: services like public transport typically involve a longer return on investment than projects like toll roads; poor policy support or economic disincentives like fuel subsidies may dampen demand; and unfamiliarity with less carbon-intensive transport modes may drive up the cost of capital.

How can national and local public authorities in developing countries attract more private investment in sustainable urban transport? Two examples from Brazil – the Linha 4 metro line in São Paulo and the Estação Barreiro bus terminal in Belo Horizonte -- offer some lessons.

Since the 1990s, the Brazilian government has made great efforts in the areas of policy, institutions, industry, and finance to encourage private investment in infrastructure. Urban transport governance was decentralized; local governments empowered to engage with the private sector; a legal basis for public compensation paid directly to private providers established; financial incentives created to drive greater private investment; among others.

The case of Linha 4, a 12.8-km subterranean metro line with six stations, is notable as the first urban transport PPP to be implemented under Brazil's formal PPP laws. The line adds critical capacity to the São Paulo Metropolitan Region's (SPMR) transit network and connects poor suburban communities to central employment areas.

The structure of the Linha 4 is a concession contract, signed for a term of 32 years during which the private concessionaire was required to invest in rolling stock, operations and data systems and management of a rail yard. This $1.85 billion project faced cost overruns, which raised the public share (financed by DFI loans and contribution from the state) from 60- 80 percent, The private share was financed primarily by private banks. The private operator earns revenues from passenger tariffs, retail and advertising in metro stations, and also receives a subsidy from the public sector, paid monthly over 4 years. This payment is guaranteed by a state-level guarantee fund, backstopped by citywide transit revenues. The contract also contains several provisions to mitigate risk, including price adjustment to account for currency risk and adjustments in compensation based on demand.

The project has successfully integrated disparate transit lines in São Paulo and exceeded its capacity goals even though its cost (per km) is among the lowest of any line in the SPMR. What explains its success? First, the SPMR is an attractive place to invest. Second, development bank participation lent credibility to the project, in addition to financing. Finally, the use of guarantees reduced perceived repayment risk.

The second example is Estação Barreiro, a transit-oriented development in the city of Belo Horizonte. Here, the city partnered with a private company to develop a property in the working-class neighborhood of Barreiro into a mall with a public bus terminal on the ground floor, serving 23 different bus lines. The four levels above contain transit-related public services, a private mall with retail stores, a movie theater and parking.

The public sector paid a lump sum (financed by loans from BNDES and a subsidy from the state) to the winner of a competitive bid to construct the terminal and shopping center, as well as administrative and storage facilities. The concessionaire owns the shopping center building and earns revenues from leasing commercial space and parking; it does not share in bus tariffs. Other than the capital cost subsidy, non-financial guarantees and incentives were employed to mitigate risk, including exclusive use of the bus terminal building; a 10-year lease on retail stores on the second floor, where bus tickets are purchased and transit system accessed; and an arrangement with the city whereby passengers can leave the transit area for an hour without the need to purchase

a new ticket for onward journey.

Estacão Barreiro has been a largely successful transit-oriented development – and the concessionaire is currently developing another mall across the street, to be connected via a pedestrian walkway. One reason for its success is the willingness of the local leadership to remedy the reasons for an initial lack of interest by the private sector. Another is the location of the project: strong demand ensured ridership and therefore foot traffic in the mall.

What will it take to replicate such successes in Brazil and elsewhere? National-level policy and regulatory frameworks for PPPs are an essential first step, but even with such frameworks in place, capacity-building for structuring urban transit PPPs and a robust private capital market are needed. There might be opportunities for climate finance to support the involvement of the private sector through strategic interventions.

*Source: Based on Qureshi (2016)*

# 8. Transforming finance

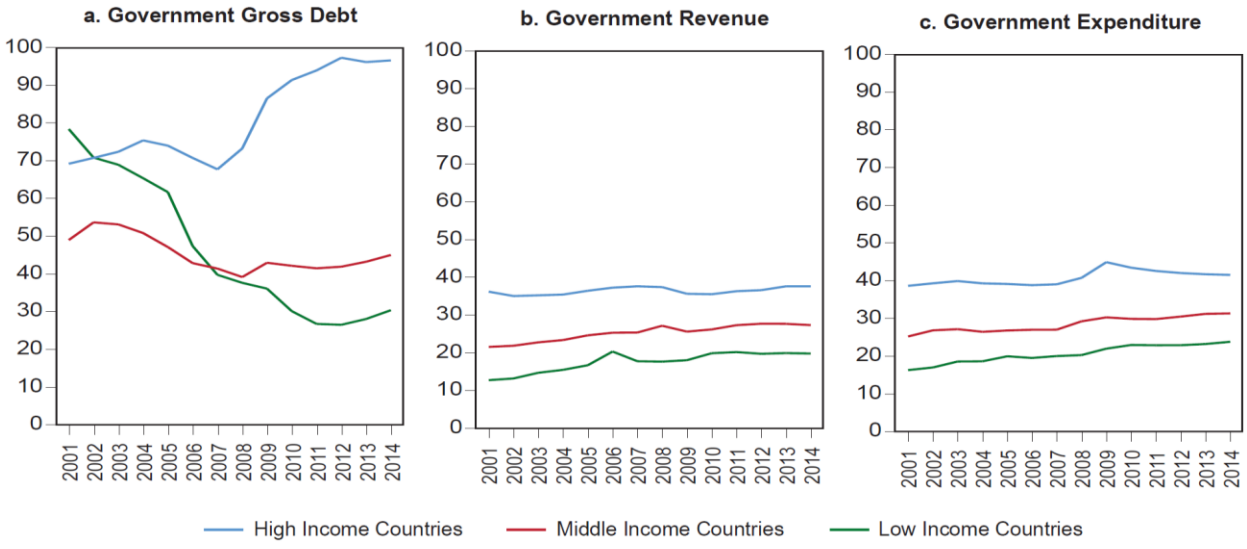
The scale of financing requirements for sustainable infrastructure calls for strengthening of resources from all sources. Domestic resources and private flows must provide the bulk of the financing, but official financing can play an important role in helping to close the infrastructure financing gap in EMDCs. Despite ample global savings and record-low long-term interest rates, infrastructure investments in EMDCs are often unable to attract long-term private financing, and the costs of financing are relatively high—in some cases prohibitively so. Improving access to and reducing the cost of private capital for sustainable infrastructure will require concurrent actions on several fronts including deepening of domestic capital markets, enhancing and scaling up risk mitigation instruments, developing infrastructure as an asset class, expanding the range of financial instruments and greening the financial system. MDBs have a central role to play in scaling up and reorienting investments in sustainable infrastructure as they are well equipped to address both the demand and supply constraints impeding investments in sustainable infrastructure.

## 8.1 Robust public finance foundations

Across advanced and emerging economies, fiscal positions in many cases are under strain. In advanced economies, public debt/GDP ratios rose sharply in the aftermath of the global financial crisis and many of these economies are engaged in fiscal consolidation efforts. In emerging economies, fiscal balances and debt positions improved appreciably in the decade preceding the crisis, but in a number of them, part of that improvement has been reversed in post-crisis years (Figure 38). Finding the fiscal space to meet the large sustainable infrastructure needs will require determined efforts to tap available scope for additional resource mobilization through tax and expenditure policies. It will also require better use of government balance sheets. Countries will need to expand fiscal space not only to meet the public sector's own investment financing needs but also to underpin its ability to catalyze private financing.

**Figure 38 Fiscal landscape: challenges and opportunities for reform**

Trends in government gross debt, revenue, and expenditure (percent of GDP)




*Source: IMF WEO Database (October, 2015) using World Bank WDI country income group classification*

### 8.1.1 Expanding the fiscal space through tax and expenditure measures

Advanced economies in general already raise substantial revenue relative to GDP but many have scope to raise more while also improving the revenue structure. Removing excessive and regressive tax exemptions, taxing negative environmental externalities, and making fuller use of property taxes are some options. Recent improvements in international tax rules, in relation to Base Erosion and Profit Shifting and Exchange of Information, can also help by reducing losses through tax avoidance and evasion—this would benefit both advanced and emerging economies. There is scope for rationalizing spending, such as on subsidies, pensions, and social security. Aging populations make the rationalization of pension and health spending especially important in advanced economies. Subsidies and social benefits are often poorly targeted. Only one-fifth of total spending on family benefits in advanced economies was means-tested in 2011 (IMF 2014b). More than half of the advanced economies in the G20 can improve their primary fiscal balance by more than 3 percent of GDP through tax and expenditure measures that minimize potential adverse effects on growth and equity (IMF and OECD 2015).

Revenues relative to GDP are much lower in EMDCs and there is typically more scope for greater revenue mobilization through tax reform and tighter tax administration. About half of these economies have tax/GDP ratios below 15 percent. As part of their efforts to support the Financing for Development agenda adopted at the conference in Addis Ababa in July 2015, the IMF and the World Bank have launched an initiative to help developing countries increase their tax/GDP ratios by at least 2-4 percent (IMF and World Bank 2015). Recurrent spending on public sector wages, subsidies, and social benefits typically account for as much as three-quarters of total government spending in these countries. In many cases, there is sizable scope for expenditure savings through rationalizing public sector employment and improving the efficiency of service delivery. There is also scope for improved efficiency in investment spending; an average developing country loses about 30 percent of the value of its public investment to inefficiencies in the investment process (IMF 2015, Gupta et al. 2014). Capturing the potentially sizable savings in spending and reallocating resources to better uses requires stronger efforts to improve public financial management systems, institutional capacities, and the quality of governance.

### 8.1.2 Carbon taxation: an environmental and fiscal win-win

In some areas, notably energy, reform of tax and expenditure policies can generate sizable fiscal gains and improve policy alignment with climate sustainability. The high cost of fossil-fuel subsidies was noted in an earlier section. Globally, direct spending on these subsidies, reflecting domestic prices below international supply costs, has declined from its peak of around $540 billion in 2013 because of the fall in petroleum prices and reform actions by a number of countries, but it still amounted to more than $330 billion in 2015 (Coady et al. 2015). In addition, revenue lost from tax expenditures related to fossil fuels amounted to about $315 billion in 2015. Almost half of the OECD countries, for example, charge lower VAT rates on energy products. Also, energy taxes, when expressed on a per-ton-of $CO_2$ basis, vary significantly across fuels and end-users. Of the 34 OECD countries, 30 have lower tax rates on diesel than on gasoline (OECD et al. 2015, OECD 2015e). Removing these subsidies and tax expenditures and correcting distortive tax differentials would both save valuable fiscal resources and shift incentives towards cleaner, sustainable energy and more efficient energy use. Equity objectives of such policies can be met through more effective means and at much lower cost (Flues and Thomas 2015).

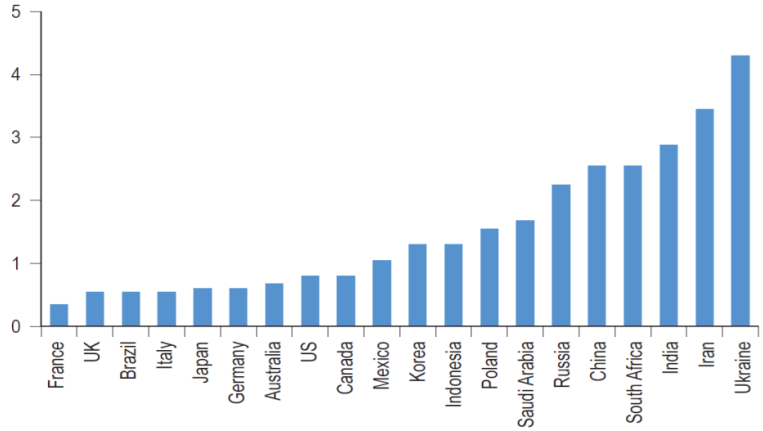
The largest distortion in terms of impact on the climate as well as loss of potential fiscal revenue results from the absence of a charge for the damages caused by carbon emissions from fossil fuels. That failure to charge for damages amounts to a huge implicit subsidy. These subsidies amounted to $4.6 trillion in 2015 (Coady et al. 2015). Putting a price on emitting carbon is a central element of an efficient strategy to reduce carbon emissions and shift the incentive structure towards sustainable infrastructure, but it can also raise substantial revenue that can contribute to meeting the large infrastructure financing needs. This

could take the form of levying taxes on carbon emissions or auctioning carbon allowances under emission trading schemes. As an illustration, a low initial carbon tax of $30 per $tCO_2e$, could generate fiscal revenue amounting to more than 1 percent of GDP on average in large emitting countries (Figure 39). Charging more fully for environmental damages can raise substantially more revenue. Calibrating the tax rate to charge for domestic environmental damages alone could raise revenues of almost 2 percent of GDP on average among the 20 largest emitters—and more than 5 percent in China (Parry et al. 2014). A simple and practical way to levy the carbon tax would be to build it into existing fuel excise taxes—which are well established in many countries and are among the easiest taxes to collect—and apply similar charges to coal, natural gas, and other petroleum products. Underpinned by a clear and credible commitment to pricing carbon, increases in the carbon tax rate could be phased in to allow economies time to adjust (Calder 2015).

Carbon taxes can be designed to be revenue neutral as well. Depending upon their circumstances and objectives, countries could opt to raise more revenue from carbon taxes and less from other taxes that can negatively impact economic performance, such as taxes on capital and labor. For example, revenue gains from pricing reform to eliminate fossil-fuel subsidies would allow advanced economies to halve corporate income tax. In emerging economies, the gain would be worth double their corporate tax revenues. So pricing carbon can be about smarter, more efficient tax systems, and not necessarily higher taxes (Lagarde 2015). The fiscal and administrative case for carbon taxes may be particularly strong in developing economies, where large informal sectors may be difficult to reach through broader tax instruments such as those on income or profits (Farid et al. 2016)

**Figure 39 Large revenue potential from carbon emission taxation**

Potential payoff from a $30/$tCO_2$-e carbon tax (percent of GDP)




*Source: Parry (2015)*

### 8.1.3 Strengthening sub-national finance and empowering cities

Of the estimated $6 trillion-plus of needed investment in sustainable infrastructure annually over the next 15 years, upwards of $4.5 trillion will be related to urban areas. Urban finance will thus form a core part of the financing challenge (Box 14). Municipal governments must improve their fiscal health if they are to be able to raise more private financing for infrastructure. Of the 500 largest cities in emerging economies, only 4 percent are deemed creditworthy in international financial markets and 20 percent in local markets (World Bank 2013a).

Strengthening fiscal capacities at local levels to finance and catalyze increased investment in sustainable infrastructure will require action, especially on two fronts. First, local governments need to boost their own-source revenues, which are typically low in developing economies. Own-revenue generation anchors

local government finances, including the capacity to borrow, but is also important from the perspective of accountability for investment. Second, intergovernmental fiscal relations should be reviewed to financially empower cities and local governments commensurate with their central role in meeting the sustainable infrastructure challenge (Ahmad 2015).

**Box 14 Meeting the challenge of financing sustainable infrastructure in cities**

Cities are at the center of the sustainable infrastructure development challenge. The urban investment needs are massive and financing gaps are large. Meeting the urban infrastructure financing challenge will require strong, coordinated actions across levels of government and with the private sector and external partners both to mobilize more public financing and attract more private investment. Cities have emerged as an important focus of infrastructure and climate finance agenda, including collaborative efforts among the world's major cities to find solutions and share knowledge, such as through the C40 and Compact of Mayors. A report released during the COP21 meeting in Paris by the Cities Climate Finance Leadership Alliance—a coalition of cities, governments, multilateral institutions, banks, and civil society organizations—proposed a five-pronged framework to meet the challenge cities face in financing needed investments in sustainable infrastructure.

***Adopt a financial policy environment that supports and encourages cities to invest in sustainable infrastructure.*** Cities are insufficiently empowered financially to play the key role they have in the development of low-emission, climate-resilient infrastructure. National governments should help local governments improve their own-revenue mobilization and also increase the flow of funding from the national to local level in support of sound investments through instruments such as grants, matching funds, tax transfers, and preferential loan rates. As an example, in Brazil, a fiscal transfer mechanism known as ICMS-Ecológico allows participating states to transfer part of their sales revenue to cities based on the creation of protected conservation areas. Rwanda's Environment and Climate Change Fund targets 10 percent of its funding to go to districts and cities.

***Support cities in pricing climate externalities.*** National governments and donors can provide financial and technical support to cities in developing schemes to price climate externalities, which would help achieve sustainability goals as well as raise revenues. As of September 2015, 23 cities, states, and provinces had employed carbon-pricing instruments. Tokyo's successful cap-and trade program was instrumental in reducing carbon emissions by 23 percent by the fourth year of its implementation.

***Improve support for urban project preparation***. Enhancing local government capacities to prepare investment-worthy projects could significantly increase their ability to attract funding. Project preparation facilities should develop a stronger focus on supporting cities and incorporating sustainability in projects. As an example, the Cities Development Initiative for Asia, led by the Asian Development Bank with a number of donors, has conducted 85 project preparation studies for medium-sized cities in Asia and 49 of the projects have already attracted almost $6 billion in financing.

***Stream more finance through local institutions.*** Channeling more financing through local financial institutions will help build local capacity and take advantage of local knowledge. Local financial institutions are often better placed to assess the creditworthiness of a city. Local institutions can also help with the more decentralized nature of some sustainable infrastructure investments, such as households and small businesses with solar panels. An example is Mexico's Ecocasa program. Supported by the Clean Technology Fund, Inter-American Development Bank, and Germany's KfW, Ecocasa is channeling funds through a local financial intermediary to local housing developers to use energy efficient and renewable technologies.

***Promote innovation in financial instruments and funding models.*** Development-bank and concessionary capital could support an expanded urban lab network to identify and pilot new urban climate finance mechanisms. Some such labs already exist, such as Climate-KIC's Low Carbon City Lab and the Global Innovation Lab for Climate Finance supported by a group of donors with private sector participation. Labs can also help to establish standards and lend credibility to new instruments, as, for example, the Climate Bonds Initiative, the World Bank and other MDBs are doing to promote green bonds and prepare cities for use of this instrument.

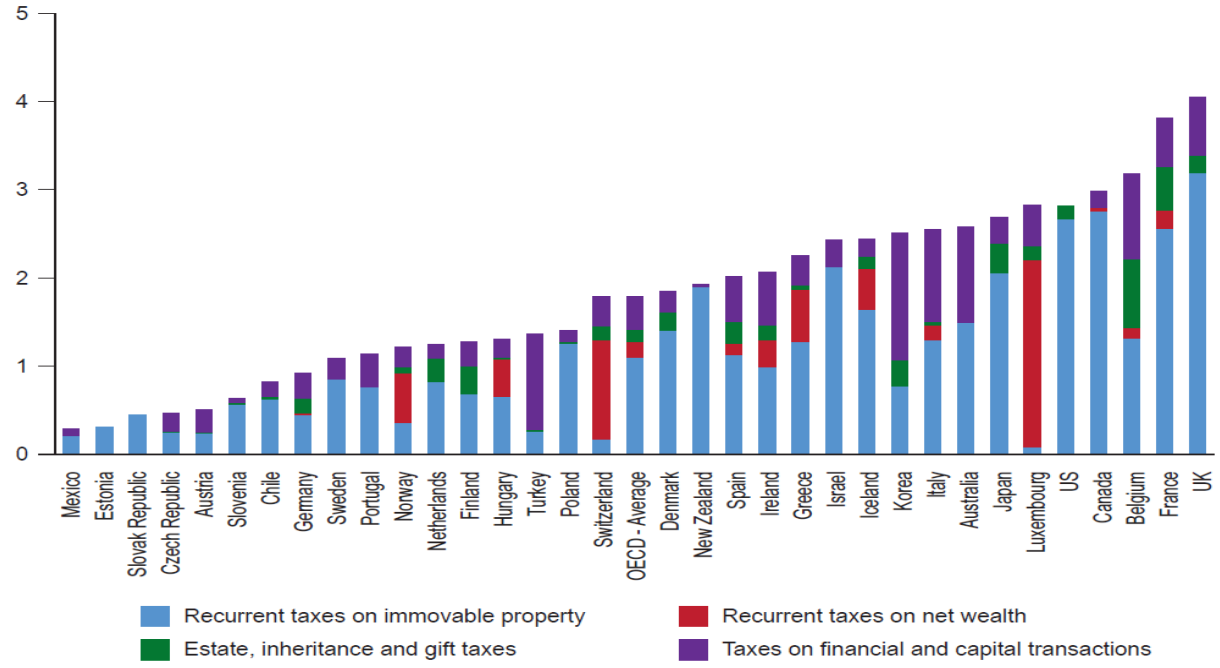
*Source: CCFLA (2015).*

Two local revenue sources that are generally inadequately tapped but can raise sizable additional revenue are property taxes and user charges. Even in many more developed economies, property taxes are relatively underutilized. In OECD countries, revenue raised from property taxes ranges from above 4 percent of GDP to well below 0.5 percent (Figure 40). Besides contributing to local government general revenues, property taxes can more directly help with the financing of infrastructure, such as through levies to capture improved land values as a result of a transport or adaptation project. In addition to their revenue potential, and administrative ease compared to some other tax bases, property taxes can be instrumental in promoting equity in public finance. They can also improve the tax structure by reducing the need for more distortive taxes.

User charges on infrastructure services such as electricity, transport, and water and sanitation, are often kept well below cost recovery levels, draining public resources, undermining proper operation and maintenance and efficient use of infrastructure assets, and discouraging new investment. Inadequate funding for maintenance often associated with low user charges can seriously undermine the efficiency and sustainability of infrastructure investments. According to one estimate, every $1 spent on preventive pavement maintenance reduces future repair costs by $4-10 (Baladi et al. 2002). Cities and local governments in many cases can raise much more revenue from better charging for infrastructure services, while structuring the charges in a way that protects poor customers.

**Figure 40 More can be raised from property taxation to finance large city infrastructure needs**

OECD Property Tax Collections, 2013 (percent of GDP)




*Source: OECD Revenue Statistics Database 2015*

Intergovernmental tax-sharing arrangements in developing economies typically have a high degree of centralization, with subnational governments heavily dependent on transfers from national governments, which complicates fiscal management, constrains creditworthiness, and undermines accountability at the subnational level. Tax-sharing arrangements should be reviewed to align them better with the increasingly important expenditure responsibilities at the subnational level. Also, intergovernmental transfers can be designed in ways that enhance incentives at the local level to bolster own-resource mobilization for investment and produce results, such as through matching and performance-based grants. South Africa,

for example, is using grants from its Green Fund along these lines (SSI 2012). In the US, the President's fiscal year 2017 budget proposes a Climate Smart Fund to reward states that leverage federal funding to cut carbon pollution and improve efficiency in the transport sector (CEA 2016).

National governments can also support local government capacity to borrow and mobilize private financing. In the US, for example, the federal government uses preferential tax treatment of municipal bonds and subsidies and guarantees on qualified state and local borrowing to boost access to capital markets at these levels of government. Managed well, such incentives can produce savings in borrowing costs at local levels that can substantially exceed the net cost to the national government (CEA 2016). Increased fiscal empowerment at the local level needs to be underpinned with efforts to strengthen local institutional capacities and public financial management systems, including fiscal responsibility frameworks for sustainable subnational borrowing.

### 8.1.4 Better use of government balance sheets

Strengthening fiscal positions through tax and expenditure reforms also enhances the scope for using government balance sheets to finance investment, by expanding fiscal space for borrowing and improving access to financing and lowering its cost. Countries with lower public debt/GDP ratios have more scope to use the government balance sheet than those with a high degree of indebtedness. But the scope for borrowing also depends on what it is used for. Even where the current level of indebtedness is high, as is the case currently with many advanced economies as well as emerging economies, additional borrowing to finance high-return investments, such as in infrastructure, could be contemplated.

Research shows that higher, well-managed infrastructure investment can have multiplier effects on output of 2-3 times the size of investment, with the impact likely stronger in developing economies with large infrastructure gaps (IMF 2014a, Calderón et al. 2015, Leduc and Wilson 2012, Standard and Poor's 2015). Besides boosting short-run demand, investing in infrastructure bolsters productivity and long-run supply (Bom and Ligthart 2014). So good infrastructure investment may be self-financing, as the public debt/GDP ratio may not rise as a result of investment—or even decline, with the government balance sheet improving rather than worsening. Also, the scope for more public investment, and its impact on economic output, may be greater currently with interest rates at low levels and many economies experiencing sizable slack (Christiano et al. 2011, Eggertsson 2011). Investing in infrastructure would offer benefits that "under current circumstances would outweigh the costs of its financing" (Fischer 2015).

Countries must exercise great care in managing their borrowing (as well as contingent liabilities) and ensuring debt sustainability, especially in the current period of fiscal stress in many countries. Debt sustainability assessments need to take into account longer-term economic impacts of the debt-financed expenditures and implications for government balance sheets. With the large investments needed in sustainable infrastructure in the years ahead, with potentially high long-term returns in terms of growth and environmental outcomes, reflecting this perspective in policymaking will be increasingly important (Derviş 2015). Stronger guidance on these issues from international financial institutions, both through their own practice and advice to countries, would be helpful. The IMF's role is particularly important in this context.

## 8.2 Mobilize private finance

Going forward the bulk of financing needs will have to come from the private sector. Leveraging private financing for sustainable infrastructure and lowering its cost will require much innovation in finance, to tap large pools of private savings held by the financial system. Technological innovation expands

possibilities for sustainable development; financial innovation will be important to capturing those (Pisani-Ferry 2015). Public policy can help mobilize more private financing in two important ways: by supporting the development of domestic capital markets; and by addressing specific constraints to private financing of infrastructure, and especially sustainable infrastructure, including through promotion of innovative finance.

### 8.2.1 Augment long-term finance for greenfield projects

Long-term private finance of the kind that supports infrastructure investment is relatively scarce in developing countries. This reflects both limited long-term lending by the banking system and a lack of development of other capital market institutions such as markets for bonds, equity and asset-backed securities, insurance and investment companies, and pension funds. Long-term financing is particularly scarce for smaller companies. In the median developing country, small firms' long-term debt-to-asset ratios are 1 percent, compared to 7 percent in high-income countries (World Bank 2015c). Domestic markets for long-term capital are relatively more developed in middle-income countries. Further development of domestic capital markets will be pivotal in meeting the infrastructure financing requirements in these countries. Domestic capital markets will need to provide well over half of all private financing for infrastructure in middle-income countries (Bielenberg et al. 2016). Investment in sustainable infrastructure, such as renewable energy, will involve a more diverse range of domestic investors, with more engagement of local governments and smaller investors. Domestic capital markets will need to play a larger role in meeting the needs of these investors.

Countries have taken different approaches to promoting the development of domestic capital markets and infrastructure finance, ranging from centralized approaches involving heavy reliance on large official development banks and direct measures such as directed and subsidized credit to more decentralized approaches seeking to foster development of a broader range of public and private capital market institutions. A key lesson of experience is that while capital market structures may differ, success fundamentally depends on a common set of reforms that address underlying market, policy, and governance failures (see Box 15 contrasting Brazilian and Indian experiences). Such reforms include policies that promote macrofinancial stability, a contestable banking system with sound regulation, a legal and contractual environment that protects investor and property rights, financial infrastructures that limit information asymmetries, and institutions that counter political capture and other ill-effects of weak governance. Underpinned by a solid policy and governance framework, state-owned development banks can play a useful role in addressing financial market institutional and financing gaps—and complement rather than hamper the growth of other financial institutions (World Bank 2012). Also, governments can facilitate the development of long-term corporate securities markets by developing the market for long-term sovereign debt. Policies that promote foreign investment can help as well, both in developing the domestic capital market and in boosting capital inflows.

Broad-based development of capital markets will be essential to meeting the infrastructure financing needs, to enable matching different pools of capital with the different risk-return characteristics of infrastructure investments and stages of the infrastructure project cycle (OECD 2015f). The special characteristics of infrastructure investment make its financing more challenging. Infrastructure investment typically involves large upfront costs and long payback periods, with risks highest in the initial construction phase of the project. Financing sustainable infrastructure projects can be still more challenging, as they can require higher upfront capital and longer payoff periods. Given these risk-return characteristics, equity capital from project sponsors and lending by banks (which have the necessary expertise and can structure financing more flexibly) can be expected to play a larger role in financing greenfield infrastructure investments and the construction phases of projects. Bonds and especially institutional investors that seek lower risk and stable long-term returns can contribute more in financing brownfield infrastructure investments and the operational phases of projects. Projects at an operational

stage, when they begin to generate positive cash flows and there is greater certainty about costs and returns, also offer opportunities for recycling the initial equity and debt financing and for securitization (Bhattacharya et al. 2012).

Much of the responsibility for developing domestic capital markets rests with national authorities but international cooperation and collective action can help. MDBs have an important role in providing support, through advice on policy and institutional reform and through structuring financial support and credit enhancement for long-term projects such as infrastructure in ways that promote participation by private and institutional investors. The G20 also has taken initiatives to promote markets for long-term finance, with a focus especially on boosting finance for infrastructure. It has endorsed an action plan to support the development of local currency bond markets. In implementation of that plan, multilateral institutions (including the IMF, OECD, and MDBs) have prepared a shared diagnostic framework for advice to countries and mechanisms to coordinate their technical assistance (G20 2013). The G20 has also endorsed a set of high-level principles prepared by the OECD designed to promote long-term investment financing by institutional investors (pension funds, insurance companies, investment companies/funds) (OECD 2015g). Globally, pension funds hold around $35 trillion in assets, but only 1 percent of those are allocated to direct investment in infrastructure (OECD 2015h, Inderst and Stewart 2014). Governments, particularly in many middle-income countries (such as Chile, Colombia, and Mexico), heavily regulate investments by pension funds, which often have the effect of discouraging long-term and cross-border investment in assets such as infrastructure. The G20/OECD principles aim to assist countries in addressing tax, regulatory, project pipeline and other institutional constraints to long-term domestic and international investment by these investors.

It is important to ensure that financial market regulatory reform in the wake of the global financial crisis does not have the unintended effect of limiting long-term financing for investment and cross-border flows to developing countries. It is important to avoid regulations that exacerbate the reduction in such financing already occurring as a result of banks' post-crisis deleveraging. For example, there is concern that Basel III regulation of bank capital, leverage, and liquidity discourages long-term corporate and project finance loans by making such lending costlier for banks compared to short-term loans and mortgages. Lending to riskier sectors, such as infrastructure and green technologies, and locations, such as developing countries, could be impacted more (G30 2013). There are similar concerns with aspects of EU's new Solvency II rules regulating insurance companies. The G20 has recognized the need to address such potential implications in its further work on financial sector reform, supported by relevant international organizations.

Bank finance will remain crucial to financing greenfield infrastructure, particularly in the early and higher risk stages. This will require a central role for banks - particularly local banks in developing countries - in providing early stage funding (World Bank 2014).

Domestic private sector banks can play an important role financing sustainable infrastructure projects. Typically, banks provide the most important source of debt for sustainable infrastructure projects, either as the lead arranger making A-loans or participating through syndicated B-loans (OECD 2013). Banks are also often best placed to assess local project and sovereign risks and to provide lending in local currency.[12] In the renewable energy sector, banks, private equity funds, project developers and utilities can also play a role recycling debt and equity capital for sustainable infrastructure projects. Having invested in the early riskier stage of the project, these investors then end-up with billions of dollars' worth of mature operating wind and solar assets that earn a predictable return and which can then be sold to long-term, more risk-averse institutions, such as pension and insurance funds. The returns from the sales can then be reinvested into developing and constructing new sustainable infrastructure projects (UNEP 2015b).

**Box 15 Developing domestic markets for infrastructure finance: models and supporting policies**

What models should countries employ in developing domestic markets for infrastructure finance? A recent study by Climate Policy Initiative (CPI) examines this question by reviewing the experience of Brazil and India, two middle-income countries where strengthening domestic capital markets will be key to meeting their large infrastructure financing needs. Brazil has a highly centralized model with a strong development bank (BNDES). India has used a more decentralized model, with a diverse set of public and private institutions. The study reviews experience with wind energy projects in the two countries to examine how the different models performed.

The study finds that while theory suggests certain potential benefits and drawbacks of each model, the extent to which these actually materialize depends greatly on the broader policy, regulatory, and governance context. In both countries, potential and actual outcomes differ significantly (see table). The choice of the financing model matters but the model needs to be supported with policies and governance to optimize benefits and minimize drawbacks. It is largely because of deficiencies in these supporting frameworks that the two countries have similar outcomes in some important respects despite the differences in their financing models: for example, the public sector dominates infrastructure finance in both countries, and leverage and financial innovation are low.

The development bank model can do more than has been observed in Brazil. Complementary policies identified by the study that can improve the model include: focusing BNDES support on projects that provide large social and environmental benefits and require its funding for economic viability; introducing guarantee instruments to better allocate construction risks; easing regulatory restrictions on proceeds from refinancing to promote a refinancing market; and improving sector policy frameworks, especially in sectors other than power that have seen less reform (e.g., water companies in Brazil have a regulatory risk premium of 5 percent due to uncertain concession policies).

A key challenge facing India is the high cost of financing, which raises the cost of renewable energy by up to a third compared to advanced economies. Some policy improvements identified to lower costs include: having the public sector absorb more of the risks it is better-positioned to take on, e.g., off-take risks; and improving facilities for construction finance, refinancing, and hedging foreign exchange risks. Actions in these areas need to be underpinned by broader improvements in the regulatory and institutional framework governing investment and finance.

| **BRAZIL:** National Development Bank Driven | | **INDIA:** Multiple State-Owned and Private Institutions | |
|---|---|---|---|
| *Potential Benefits*<br>▪ Greater financial and administrative efficiency - scale economies<br>▪ Effective contribution to multiple government policy objectives<br>▪ Improved financial system liquidity | *Observed Benefits*<br>▪ Centralized model fell short of realizing full potential benefits<br>▪ Some financial and administrative efficiency gains, including clarity in roles and eligibility criteria and access to low-cost financing, but these do not appear to have reduced credit risk and overall cost of infrastructure | *Potential Benefits*<br>▪ Greater financial innovation<br>▪ Participation by more financial institutions and private investors<br>▪ Reduced government interference and other governance issues<br>▪ Smoother integration of international development finance | *Observed Benefits*<br>▪ Limited but improving impact on financial innovation<br>▪ More investors participate in infrastructure finance, but many are state-owned, so relatively limited gains in diversity<br>▪ Unclear evidence on reduced government interference<br>▪ Stronger role of international development finance but may primarily reflect greater need |
| *Potential Drawbacks*<br>▪ Reduced investment due to crowding out<br>▪ Prolonged high interest rate environment<br>▪ Governance issues due to concentration of decision-making | *Observed Drawbacks*<br>▪ Low BNDES interest rates limited opportunities for international investors, long-term commercial bank lending, and financial innovation<br>▪ Inconclusive evidence on prolongation of high interest rates<br>▪ Concentration of authority increased potential for governance failures and suboptimal investments | *Potential Drawbacks*<br>▪ Higher cost to the system<br>▪ Uneven investment across sectors<br>▪ Restricted use of pure project finance models<br>▪ Reduced leverage of projects leading to more risk seeking by investors | *Observed Drawbacks*<br>▪ Relatively high-cost system; examples of high administrative costs affecting projects<br>▪ In general, evidence finds that potential drawbacks are actually likely in Indian context |

*Source: Sahoo et al. (2015)*

As many governments move towards auctions for awarding tariffs and power purchasing agreements for renewable energy projects, it is likely that banks will begin to play a more pivotal role in the project cycle before financial closure on the project rather than mostly being involved after (UNEP 2015b). For example, South Africa's Renewable Energy Independent Power Producer Procurement Program (REIPPPP) requires bidders to submit bank letters stating the financing was locked-in. In effect, this outsources due diligence to the banks and had lenders take on a higher share of project development risk since they are providing financing before the project has been developed (Eberhard et al. 2014). It also gives banks a more strategic role, since the higher return they demand from the project, the lower the chances that the project will win the auction (UNEP 2015b). For the government, it solves that pernicious problem of actions resulting in "low-ball" offers that never reach financial close (Eberhard et al. 2014).

### 8.2.2 Enhance and scale up risk mitigation instruments

Sound structuring of risks is essential to creating the right incentives for the private sector and enabling private sector finance. This requires carefully constructed contracts that apportion risks to the private sector that should be borne by the private sector. In addition, risk mitigation instruments and credit enhancements are typically needed, given the very high uncertainties in the early stages of the project and the lack of creditworthiness of project entities. In particular, construction risk is a major barrier in EMDCs. Contractual agreements such as a turnkey construction contracts can be used as a risk mitigation instrument, but for large complex projects, contractors are unlikely to agree to a turnkey construction contract, or lenders may require additional assurances. Construction guarantees or first loss protection through mezzanine financing may therefore be needed. To preserve incentive compatibility, guarantees can be extended for a fee (for example as in the case of the UK Guarantee Scheme for infrastructure projects) and by charging higher interest rates for mezzanine financing.

Private investors also often need guarantees against policy and demand risks. Partial risk guarantees are the appropriate means to deal with such risks, but in practice investors often ask for excessive credit or cash flow guarantees. Excessive guarantees entail significant costs to the governments and undermine incentives for cost minimization. In such circumstances pure government procurement is more effective. As discussed below, MDBs have a comparative advantage in extending guarantees through their honest-broker role. While MDBs have attempted to extend guarantee programs for some time and new initiatives are being taken, the overall volume of guarantees remain modest and more work is needed to establish replicable and scalable models.

Guarantees are well suited to sustainable infrastructure because they can be precisely targeted and adapted to policy risks (CPI 2013). For example, when Spain and Italy abruptly lowered feed-in tariffs for renewables (Gehle 2014), there were increases in the perception of policy risk globally. CPI estimates that changes in policy support can increase a project's financing costs by more than 11 percent (CPI 2013).

While potentially exposed to higher policy risk, sustainable infrastructure should be less vulnerable to climate risk than traditional infrastructure, lowering the long-term risk profile of the investment. Therefore, some guarantees for sustainable infrastructure could be priced lower than guarantees for traditional infrastructure based on the lower climate risk. Differential pricing could also incentivize the private sector to invest in sustainable infrastructure, particularly if backed by guarantees. Guarantees make it possible for risk-averse investors to participate in a project they might otherwise avoid and learn from the experience. Guarantees cost money, so the goal is that the project goes well and investors would not need them the next time. There are limitations to how much MDBs can expand guarantees due to equity capital restrictions (Gehle 2014). Ideally, however, MDBs would not need to continuously expand guarantee allocations because, as investors become more familiar with the asset class, they will appropriately price the real risk profile of these investments.

Guarantees and credit enhancements are particularly important for middle income countries where perceived risks are typically greater than actual risks. Moody's has found default rates for project finance bank loans in OECD countries are only slightly higher than in non-OECD countries. Based on a sample of over 5,000 project finance loans from 1983-2013, default rates in OECD counties were 5.7 percent on average compared to default rates in non-OECD countries of 8.2 percent (Moody's 2015). Despite similar default rates, many funds only allow investment in OECD countries or charge much higher rates for financing in non-OECD countries. As a result, good projects do not get the financing they merit from risk-averse investors. Development bank guarantees provide a bridge to overcome these fears, pulling in private sector financing for projects that otherwise would not occur. All of these changes would have the long-term effect of encouraging the private sector to finance more sustainable infrastructure in middle and low income countries—with and without guarantees.

### 8.2.3 Developing infrastructure as an asset class

To better tap the large pools of capital held by institutional investors, infrastructure needs to be better developed and promoted as an asset class. The steady long-term returns and risk diversification opportunities offered by infrastructure assets are features that should be attractive to these investors. Yet, their commitment has been low, and also narrow in terms of investment modalities, mostly taking the form of equity (typically unlisted equity) on a project basis. The untapped potential for bond financing by these investors is large, especially when projects reach an operational phase (Ehlers 2014). Developing a strong pipeline of sound and bankable projects, standardizing project templates where possible, and improving the flow of information on projects to investors are essential to enhancing the profile of infrastructure as an asset class. So are regulatory and institutional frameworks for private investment in infrastructure that provide policy clarity and reduce risk. This underscores the importance of strengthening project preparation and improving the private investment climate, including upgrading frameworks governing PPPs and public procurement and reflecting sustainability criteria in projects and these frameworks, as discussed in earlier sections of this paper. Multilateral development banks have an important role in supporting countries in these efforts. The new Global Infrastructure Hub established by the G20 can also help, especially as a platform for knowledge and information sharing on project preparation and project pipelines and connecting potential investors with opportunities (Box 16).

With stronger capital market structures, and as investment in infrastructure bonds grows, trading in these bonds can enhance their liquidity and lower risk. Issuance of asset-backed securities for infrastructure assets could further develop the market for infrastructure as an asset class. Securitization could help diversify and pool risks better, create instruments to match the different risk appetites of investors, and increase liquidity. The European Investment Bank has recently launched a renewable energy platform for institutional investors (REPIN) to offer repackaged renewable energy assets in standardized, liquid forms to institutional investors (CPI 2015b). Improved underlying policy and institutional frameworks, greater clarity on the risk-return profile of sustainable infrastructure projects, and financial innovation could position infrastructure assets better in assessments by rating agencies.

Once infrastructure projects reach the operational phase and provide a reliable income stream, there is potential to crowd-in institutional investors. This is because many institutional investors prefer lower risk assets with a steady income stream – a stage the infrastructure projects can reach at the operating phase. Moreover, selling infrastructure assets to institutional investors at the operating stage allows banks to free up their balance sheet and reinvest in the earlier risky stage of new sustainable infrastructure projects.

**Box 16 Global Infrastructure Hub**

In November 2014, the Global Infrastructure Hub (GI Hub) was established by G20 countries as part of the Global Infrastructure Initiative. The aim of the GI Hub is to improve quality and quantity of public and private infrastructure investments, working in a formal partnership with the OECD, the World Bank Group and other multilateral development banks. In particular, the hub aims to lower barriers to investment, increase the availability of investment ready projects, help match potential investors with projects and improve policy delivery. Its mandate includes:

- **Development of a 'Knowledge Network:** to develop a knowledge sharing network in order to provide information on current financed infrastructure programs
- **Addressing key data gaps:** to review existing sources of project and procurement information and consider how data is and could be used to improve the efficiency of infrastructure markets.
- **Promotion and prioritization of G20 Leading Practices:** to draw on the G20 Leading Practices on Promoting and Prioritizing Quality Investment, and other work on 'standardization' for development of voluntary codes on procuring quality infrastructure as well as model processes for project identification, preparation and procurement, including documentation.
- **Capacity Building:** to build the capacity of the public sector to undertake procurements. Divisive initiative such as establishment of a virtual network of PPP Centers from around the world, partnering with China and the European Bank for Reconstruction and Development
- **Development of consolidated project database:** to ensure that there is a comprehensive, open source project pipeline database. Building on existing work, find a solution to present the pipeline in an open source single database and also to manage risks around the identification of specific projects in this database.

Established with a budget of A$50.8 million over the period 2015-2019, the hub expects to become an independent of data and analysis of the global demand and opportunities for infrastructure investment as well as help address blockages to infrastructure development through development of tools and insights to assess country level infrastructure environments.

*Source: Global Infrastructure Hub (2016)*

This sequencing of private capital into sustainable infrastructure projects reveals that the financing from institutional investors will be largely in brownfield projects. However, there may also be scope to increase some institutional investment in greenfield infrastructure in either project bonds or co-investing along with other entities such as local banks, NDBs or MDB in a syndicated loan.

Investments in infrastructure by institutional investors have traditionally been in equity vehicles in advanced economies (Ehlers 2015). However, over the past decade there has been a shift in allocation of assets towards debt (bonds) and away from equities (Bielenberg et al. 2016). This trend was accelerated by the global financial crisis. For instance, equity peaked at 15 per of project finance in 2008 and is closer to 10 percent (Croce and Gatti 2014). Moreover, the little institutional investment there is in infrastructure tends to be on a project basis, which limits the scope for such investments to those investors with the expertise to assess specific infrastructure risks and leads to higher transaction costs (Croce and Gatti 2014). Developing opportunities for institutional investors to scale their investments in sustainable infrastructure using debt financing will therefore be particularly important (Croce and Yemo 2013).

This will require developing infrastructure as an asset class. Success here will provide institutional investors with long-term inflation protected returns (Croce and Yemo 2013) that can help match institutional investors' long term liabilities – such as payouts by pension funds – with stable income streams. Sustainable infrastructure assets also tend to have a low correlation of returns with other asset classes, another incentive for institutional investors as they seek to diversity their investments to minimize risk (Deau 2011).

Developing infrastructure as an asset class will require a pipeline of sustainable infrastructure projects and a better understanding of their risk/return profiles. Achieving this will allow for an expansion of debt

financing vehicles such as green bonds tied to sustainable infrastructure projects. For instance, green bonds backed by a suite of sustainable infrastructure projects diversify risk and can be tailored to meet the needs of institutional investors (Croce and Gatti 2014). This underlies the need to develop appropriate financing vehicles for institutional investors, particularly debt instruments such as bonds. Such instruments should also be of the same duration as the underlying infrastructure to avoid reinvestment risk (Inderst 2010).

Better understanding the risk/return profile of sustainable infrastructure projects will also allow credit ratings agencies to assess bond risk. This should also enable increased allocations by institutional investors consistent with their fiduciary duties as fund managers. A large enough sustainable infrastructure bond market will increase liquidity and allow trading of such bonds, reducing the risk that otherwise arises from direct holdings of long-term illiquid infrastructure assets.

Despite the opportunities of infrastructure as an asset for institutional investors, allocation remains low. For instance, only around 1 percent of pension fund assets are allocated to infrastructure (OECD 2014). This points to a range of barriers that are preventing increased investments by institutional investors in sustainable infrastructure assets. One of these is a lack of investor confidence in the underlying governance and investment environment for infrastructure assets, particularly in EMDCs, where sovereign risk is higher (OECD 2014b). This is important for a number of reasons. For one, the long-term illiquid nature of infrastructure projects can make it difficult for investors to exit the market at short notice. As a result, policy uncertainty and lack of confidence in a country's economic and political institutions negatively affect perceptions of risk and ultimately the willingness to invest. This risk can be somewhat mitigated with a liquid bond market that allows trading and easier exit. Second, the risk of infrastructure projects defaulting is affected by the underlying investment environment. Where default risks are higher, the cost of finance from institutional investors will go up, or the risks could be such that institutional investors are unwilling to invest, given their relatively conservative risk profiles.

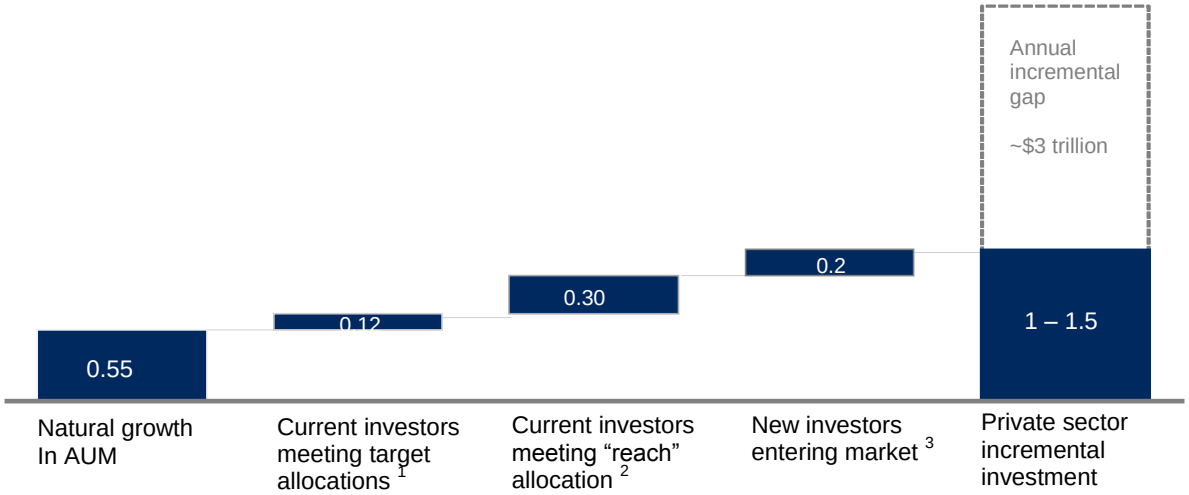
Countries also need robust capital markets that can issue asset-backed securities for sustainable infrastructure assets (OECD 2014). On the regulatory side, recent initiatives such as risk-based solvency standards, negatively affect the ability of institutional investors such as pension funds to hold less liquid infrastructure assets.

Another barrier is the absence of high quality and objective data on returns from classes of infrastructure assets, which prevents benchmarking by institutional investors (Croce and Yemo 2013). This prevents investors from correlating the risk of investing in sustainable infrastructure assets with other potential investments, undermining the ability to increase allocations to infrastructure assets in ways consistent with underlying fiduciary duties.

When it comes to sustainable infrastructure as an asset class, clear and objective standards that determine what constitutes sustainable infrastructure are also needed. Some initiatives are underway to address this, such as the green bonds indices developed by MSCIO/Barclays, but more consistent and widespread adoption is needed.

As the below graph shows (Figure 41), success in addressing these barriers and developing sustainable infrastructure as an asset class could lead to a significant increase in financing from institutional investors. According to Bielenberg et al. (2016), private institutional investment in infrastructure could reach $1 trillion to $1.5 trillion a year, up from current levels of $300 - $400 billion a year.[13]

**Figure 41 Potential annual incremental institutional investment**




*Source: Bielenberg et al. (2016) using Preqin Global Database (2015)*

### 8.2.4 Options for expanding the range of financial instruments

Increasing the flow of private capital into sustainable infrastructure will require developing new and innovative financial instruments that can respond to the requirements and capabilities of different investors. For example, institutional investors such as pension funds and insurance companies may not be able (or willing) to do the extensive due diligence required or to acquire the specialized knowledge associated with sustainable infrastructure. Nor do they favor multi-decade investments that can keep capital tied up for years. Private pensions, which represent more than 17 percent of total global AUM, must generate consistent returns to meet their ongoing obligations to pension holders.

Innovations in financial instruments could expand the range of investment options, improve risk-return profiles, help reach a wider investor base, and channel more resources to sustainable infrastructure. Instruments such as green bonds and YieldCos use familiar financial instruments to enhance capital flows to sustainable infrastructure. Green bonds and YieldCos already have shown a promising uptake. Debuted in 2007, the green bond market has grown rapidly in recent years, with outstanding issues estimated at more than $65 billion in mid-2015 (CBI 2015). The year 2014 saw the first issuance of a green bond by an emerging economy at the municipal level, by the city of Johannesburg. YieldCos are publicly traded companies created by a parent company that bundle operating infrastructure assets to generate predictable cash flows that are then paid out in dividends to shareholders. In the United States and Britain, YieldCos raised $4.5 billion in 2014. Strengthening the institutional structure underpinning the sustainable infrastructure-linked-instruments such as green bonds, YieldCos, and green ETFs can help promote their further growth, including platforms for their listing on exchanges and market value indices.

Green bonds have had a favorable reception from investors who see them as a good way to achieve market-competitive returns while incorporating climate change as part of their institutional missions. They resemble fixed income securities and are tradable. This could further incentivize investment by long-term institutional investors and support the development of sustainable infrastructure as an asset class.

Green bonds and YieldCos also reduce risks associated with infrastructure investments. For instance, the credit risk associated with green bonds is typically lower than that of similar project bonds because that

risk is assumed by the issuing entity and not by the cash flows from the individual project. Given these lower risks, green-bond yields tend to be on the lower end of the spectrum as well. YieldCos, on the other hand, reduce risk by pooling projects, thus helping institutions to diversify their investments.

Another option is to adapt the funding models. "Land value capture," for example, has long been used to finance railways, metros, and highways. This model seeks to capture the additional value created by infrastructure though impact fees, special assessment districts, or tax increment financing. In essence, this allows infrastructure to be financed based on its ability to raise the value of the surrounding land once it is built. Similar models could be designed for sustainable infrastructure; if adaptation infrastructure were to make a community safer from flooding and increase property values, for instance, this value could be used to finance the upfront investment. This could also be a powerful way to promote transit-oriented development in urban settings, since transportation infrastructure almost always increases the value of adjacent land.

While adopting and scaling up the range of financial instruments could be helpful, doing so does not significantly alter the risk-adjusted returns for sustainable infrastructure—the primary metric upon which portfolio managers are judged. Investors will stay away until these returns are shown to be as good as other options.

Another challenge is to develop financial instruments that respond to the growing need for small-scale infrastructure. This need has been rising due to the current trend of decentralization of infrastructure services such as water services and electricity (Perera et al. 2015). This is especially the case in emerging and developing countries where small-scale infrastructure is a critical element of economic development (Perera et al. 2015). As a result, the composition of the investments, financing flows, and infrastructure owners are likely to be substantially different between traditional and sustainable infrastructure, even though the total volumes of financing may not differ much (Bielenberg et al 2016). This will require working with a more diverse set of infrastructure owners that are not established creditworthy entities such as large corporations or central governments, but are smaller (and sometimes less credit-worthy) entities such as households, mid-sized industrial companies, and emerging economy cities. In addition to the challenge of financing less credit worth entities are the higher transaction costs arising from the need for project preparation, due diligence and structuring many smaller projects (Perera 2015).

For example, power is traditionally provided by a centralized grid financed by the government and operated by a utility. Renewable energy development, on the other hand, is often off-grid and financed by individual households or communities. In poor rural areas in countries such as Kenya and Tanzania, a significant share of new rural electrification is being financed by people making only a few dollars a day.

Developing new financial instrument to address these challenges will be needed. This could include bundling multiple projects in order to achieve scale and drive down the overall costs (Perera 2015).

Innovation will also be needed to finance a more diverse set of investors in sustainable infrastructure compared to traditional infrastructure, including many smaller and often less creditworthy investors, such as in solar energy. In rural Kenya and Tanzania, for example, a significant share of new rural electrification is being financed by low-income households. New models will be needed that contain transaction costs and offer adequate risk-adjusted returns for investing in small distributed assets, including possibly bundling multiple projects to achieve scale (Perera et al. 2015).

### 8.2.5 Strengthen financial regulatory standards and codes

*Address the negative impact of financial regulation on the incentive to invest in sustainable infrastructure.* Regulations on investment limits, capital adequacy, and reserve requirements, the valuation of assets and liabilities and limits on foreign investment can discourage investors from making longer-term and cross-border investments in sustainable infrastructure.

For example, Basel III regulation of banks' capital, leverage, and liquidity intentionally discourages mismatches in the maturity of assets and liabilities, which makes it harder and more expensive for banks to issue long-term debt, such as project finance loans. Solvency II is an EU directive that codifies and harmonizes EU insurance regulation which largely concerns the amount of capital EU insurance companies must hold. This regulation treats long-term investments in infrastructure as of similar risk to long-term corporate debt or investments, requiring higher capital ratios which degrading return profiles. Further, governments tend to use cash accounting standards that do not differentiate between long-term investments that add value and near-term consumption. These policies may not favor infrastructure investments that realize returns over a longer time horizon.

Uncertainty around tax policies, particularly in middle and low-income countries, has a depressing effect on infrastructure investment because it makes it difficult to project long-term net cash flows; in addition, tax policies may not be structured to reward longer-term investment choices or reflect the lower climate-related risks associated with sustainable and resilient infrastructure. The outlook for tax policies that support sustainable infrastructure is unpredictable and many current initiatives, such as support for renewables, are short-term. As one investor told us "This type of uncertainty has stopped developers from going into certain countries where it is extremely hard to separate politics from regulatory action. Investors find it difficult to assess the changes of regulatory changes and how those changes may impact their project NPV."

*Standardize and harmonize reporting of climate change risks.* There is a lack of consistency of reporting on financial reporting of exposure to climate risks and where this reporting happens, it is usually on a voluntary basis and lack of consistency in reporting requirements makes comparison across industries difficult. The Carbon Disclosure Project seeks to aggregate and standardize reporting by companies of the physical, regulatory and legal risks posed by climate change. Australia, South Africa, France and the European Union have also moved to require disclosure of environmental risks, however, each country requires different levels of reporting, some are mandatory, others are voluntary.

*Strengthen voluntary private sector commitments to support and invest in sustainable infrastructure.* While public policy actions and the strengthening of the financing architecture will play a central role in enabling private investment and promoting more sustainable approaches, voluntary private sector actions can play an important complementary role. Some progress on voluntary actions is already being made such as the Business Leadership Council initiative and the World Wide Fund for Nature Climate Savers, where investors are choosing to invest more in sustainable outcomes. UNEP estimates that such business-led voluntary efforts will reduce global greenhouse gas emissions by 0.63 GtCO2e in 2020. In addition, in July this year the White House launched the American Business Act on Climate pledge, where 13 of the largest U.S. companies representing a market capitalization of over $2.5tn pledged to invest at least $140bn in new low carbon investment and more than 1,600 megawatts of renewable energy, including company-specific goals to cut emissions as much as 50 percent, reduce water intensity as much as 15 percent, purchase 100 percent renewable energy and pursue zero net deforestation in supply chains. Later this year, the White House plans to mobilize more companies to pledge such voluntary actions. At COP21 in Paris, more than 114 companies set emission reduction targets and Goldman Sachs announced that by 2025 it would invest $150 billion into clean energy projects and technology.

Such voluntary private sector action is important in terms of the additional financing it can bring to achieving sustainable outcomes, including in infrastructure such as energy and transport. Voluntary private action can also have important demonstration effects, creating conditions that lead other businesses to making similar commitments and can stimulate further government action to reducing greenhouse emissions.

In the G20 context, the B20 can play an important leadership role in replicating the U.S. approach and catalyzing voluntary commitments from businesses in other G20 countries. The B20 has been actively engaged in bringing private sector perspectives on the policy actions that governments can take to

increase private sector financing of infrastructure (B20 2014). Largely absent from the B20 agenda on infrastructure so far has been the issue of sustainability and climate resilience.

### 8.2.6 Greening the financial system

Greening the financial system seeks to support the Paris Agreement's goal of making "finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development" (UNFCCC 2016). Already, work by UNEP and the Canfin-Grandjean Commission have begun to explore reforms to financial system to align its incentives and investments with achieving climate and broader sustainability goals (UNEP 2015c, Canfin and Grandjean 2015).

Greening the financial system is aimed at achieving the following goals:

- Facilitating the low carbon transition: such as by incorporating climate risk into financing decisions.
- Ensuring Financial Stability: given the risk that climate change could present to financial stability. Responding to this is within the mandate of financial regulators and central banks. Effective prudential responses to such risk should also increase the allocation of capital towards climate-friendly infrastructure and away from carbon intensive investments.
- Supporting the development of innovative green institutions and instruments: such as green investment banks and green bonds.

*Responding to Climate Risk.* The most significant reform that will more closely align financing decisions with climate change sustainable development needs is to require the financial sector to better account for climate risk. An appropriate accounting of climate risk by the financial sector should increase the attractiveness of climate-related infrastructure and reduce that of fossil fuel investments.

**Box 17 What is climate risk?**

There are three broad channels through which climate Change can affect financial stability (Farid et al. 2016):

***Physical Risks.*** Damage from climate and weather related events that could damage property or disrupt trade

***Liability Risks.*** Impact that could arise if parties who have suffered loss and damage from the effects of climate change seek compensation from those they hold responsible.

***Transition Risks.*** Financial risks from the structural economic adjustment to a low-carbon economy could result in re-pricing of a range of assets and commodities.

The main near-term climate risk is from the transition risk – the physical risk will manifest in the medium term and the liability risk will follow. A potentially significant financial cost arising from transition risk and the decarbonization of economies is the potential for stranded assets – assets that loose value or can't be used due to their impact on the climate such as investments in fossil fuel resources such as coal, oil and gas extraction or in entities that use fossil fuels (i.e. utilities, chemicals, metals). In fact, the carbon budget implied by a two degree climate goal could mean that 30 percent of global oil reserves, 50 percent of gas reserves and around 80- percent of coal reserve will be unusable (Ekins 2014). On the investment front, this means that approximately 80 percent of declared reserves owned by the world's largest listed coal, oil and gas companies are potentially subject to being stranded under a 2 degree world (CTI 2012).

The extent and speed of the transition risk will shape how the financial system responds to the losses from holding stranded assets. The value of potentially stranded assets is estimated at approximately one-third of global equity and fixed-income assets (PRA 2015, Covington and Thamotheram 2014). To better

understand what such an outcome might mean for the financial sector, financial assets should be 'stress tested' against different transitions scenarios (Farid et al. 2016). Accounting for such risk now should alter capital allocations away from economic sectors where transition risk is highest and into sustainable infrastructure investments.

To be effective, accounting for climate risks needs to be done by all relevant actors, including financial intermediaries such as banks, securities markets and institutional investors as well as by those actors and institutions regulating financial markets, including credit ratings agencies, regulatory and supervisory bodies and central banks.

*Disclosing Climate Risk.* One approach to incorporating climate risk into financing decisions is to require disclosure by investors and companies of their exposure to such risk. Bank of England Governor Mark Carney has emphasized that such transparency will be essential if the financial market is to react efficiently to climate change risks (Carney 2015). Blackrock – the world's largest investment firm with $4.6 of AUM - has noted that that "greater transparency of climate risks and exposures will likely lead to a gradual discounting of companies assets exposed to climate risk – and increase the value of those most resilient to these risks." (Blackrock 2015).

Climate risk disclosure can also reinforce the impact of climate policies and the transition towards a low carbon economy (Boissinot et al. 2015). Such disclosure could create a useful feedback mechanism between policy and markets, giving policy makers greater information on business exposure to risks and how they are managing these risks, which can help policy makers make more informed and targeted decisions (Carney 2015).

There are already various voluntary principles developed by the private sector that recognize the importance of disclosing exposure to climate risk (and the impact on sustainability more generally). The Principles for Responsible Investing (PRI) established in 2006 comprise six voluntary principles developed by institutional investors and supported by the U.N. and address the incorporation of environmental, sustainability and governance (ESG) issues into investment decisions. A key element of PRI is ESG disclosure by institutional investors and the entities in which they invest. More recently, the PRI oversaw the 2014 Montreal Carbon Pledge by over 120 Institutional investors with over $10 trillion in assets under management to measure and publically disclose on an annual basis the carbon footprint of their investments.

The Equator Principles are a complimentary set of principles guiding investing in large infrastructure projects. The Equator Principles require the incorporation of sustainability into financial risk management and include as one approach looking at ways to reduce an infrastructure project's GHG emissions. However, the principles are limited to reducing GHG emissions in ways that are technically and financially feasible, underlining the need to reduce the cost of financing climate-related infrastructure.

These principles are supported by various voluntary standards that companies can use to disclose their exposure to climate risk and their impact on broader sustainability issues.

**Box 18 Voluntary green disclosure standards**

*The Global Reporting Initiative* has developed a sustainability reporting framework for companies to use to report the impact of their business on sustainability issues.

*The Carbon Disclosure Project (CDP)* collects data on how companies identify and manage climate risks. This information is then made available to institutional investors for assessing the climate risk and corporate governance of the companies in which they invest (CDP 2015b).

There is evidence that such voluntary disclosure has had a positive impact, including on the effectiveness of boards in addressing climate risk (Ben-Amar and McIlkenny 2015). There are, however, limits to such voluntary approaches. For one, the UNEP inquiry, drawing on Bloomberg data, reported that 75% of 25,000 listed companies assessed did not disclose a single sustainability data point. Secondly, the proliferation of schemes and different disclosure requirements reduces comparability and effectiveness (Farid et al. 2016). This has led to calls to make such disclosure mandatory. Since 2009 the US Securities Exchange Commission has made it mandatory to disclose climate risk on businesses, including transition risk – the risk of potential laws and regulations (including international regulation) and physical risk (SEC 2010). In France, Article 173 of the Energy Transition Law came into force on 1 January 2016. Article 173 requires mandatory reporting by companies of the risks of climate change and how they take climate change into account and implement low-carbon strategies, and institutional investors have to disclose their portfolio carbon footprint and report on their climate risk exposure.

The evidence is that despite the growing appreciation of climate risk within the finance industry, increasing disclosure of exposure to climate risk and the potential of stranded assets has had little appreciable impact on financing and investment decisions. Blackrock for example has not found any climate change risk premium for equities (Blackrock 2015). Climate Tracker has concluded that the failure of the market to account for the potential for stranded assets under a scenario where the world achieves its two degree climate target points to there being a carbon bubble in fossil fuel intensive assets (CTI 2012).

This lack of results does not mean that these efforts at encouraging disclosure of climate risks are not worthwhile. Instead, it underlines that incorporating climate risk into financial decisions is still at an early stage, that steps to require disclosure to climate risk need to be expanded and their shortcoming addressed, and that additional action is required.

For instance, beyond merely identifying climate risks, investors and companies need to more fully reflect this risk in their investment decisions. Investors are taking some steps here. For example, the Global Investor Statement on Climate Change signed by 409 investors representing $24 trillion in assets includes agreement to support financing the transition to a low carbon economy; to better evaluate low carbon investment options and to work with the companies they are invested in to minimize climate risk; and to maximize the opportunities presented by climate change and climate policy (IFC 2013a).

There is also a need for institutional investors and asset managers to be more active. The first step is for such investors and mangers to better understand the carbon footprint of their portfolios. In fact, given the potential economic and financial significant of climate risks, understanding what this could mean for a portfolio is likely required by existing fiduciary obligations. Achieving this will likely require pushing for greater analysis and assessment of the impact of climate change in the entities in which they are invested (Guyatt 2012). Blackrock for instance is using its investment stakes to get corporate managers to improve their disclosure of climate risk (Blackrock 2015). CalPERS (California Public Employees Retirement System) used its investment in BHP Billiton to push for appointment of an outside director who could advocate for climate change action.

Another point of leverage for institutional investors is portfolio decarbonization – reducing investments in companies most exposed to climate risk and increasing the weighting of those less exposed and contributing to reducing GHG emissions. There is already evidence that decarbonizing portfolios is likely to enhance long-term investment performance (UNEP 2015b). However, for some long-term investors, engagement and changing the behavior of management can be a more effective strategy (Blackrock 2015).

Other complimentary action includes more consistent and better incorporation of climate risk into sell-side research and incorporation of climate risk by ratings agencies such as Standards and Poor into their corporate bond ratings.

In addition to these voluntary and private sector actions, there is room for a regulatory response from governments in reaction to the systemic risk climate change can pose to financial stability. Addressing the challenges of climate change for the financial system is dictated by financial prudence, given the potential negative impact of climate change across a wide range of balance sheets and what this could mean for macro-level financial stability (Carney 2015). It is due to the potential risk climate change poses for financial stability that the G20 asked the Financial Stability Board (FSB) to consider ways that the financial sector can take account of climate change. In December 2015, the FSB established the Task Force on Climate-related Financial Disclosures to undertake a coordinated assessment of how financial reporting can incorporate climate-related issues that are responsive to the needs of diverse stakeholders including lenders, insurers, investors, and other users of disclosures. The aim of the exercise is to encourage effective climate disclosures that can reduce uncertainties in decision making and thus the potential of destabilization of financial markets from unforeseen corrections in asset values due to climate change.

In development of these recommendations, Stern and Zenghelis (2016) argue for inclusion of 1) clearer articulation and unbundling of material risks, 2) marginalization of non-physical risk and, 3) forward-look assessments of business vulnerability. Under the first, they argue that principles and practices for voluntary disclosures should first and foremost help clarify the existence of effective risk management processes that include some assessment of material risks. To achieve this end, relevant, coherent and verifiable metrics need to be developed that need enunciation of risk definitions on the onset. Secondly, financial risks arising from nonphysical climate change impacts can result in rapid changes in valuation and need to be emphasized in greater depth. These non-physical risks arise from, a) policy/legal/litigation, b) technological changes, c) market economic responses, and d) reputational considerations and involve feedback loops as well as threshold impacts ("tipping dynamics") that can cause abrupt changes in valuation. The recommendations should include consideration of contingency planning, the absence of which can be very informative for investors in decision-making. Furthermore, firms should reveal the basis for their planning (or lack thereof) to reveal the assumptions they make in planning for these risks which will convey the degree to which they find climate-action policies credible. The principles should also address the absence of forward-look assessments that address development of strategies for transitioning business models once ambitious climate policies are in place. Undertaking explicit sensitivity analysis and stress-tests should be encouraged to test their viability with varying carbon prices and regulations. Forward-look assessments can thus tease out the underlying assumptions firms make and help investors make informed decisions and assess market capitalization.

**Box 19 The Financial Stability Board's work on climate risk disclosure in the financial sector**

The industry-led Taskforce on Climate-related Financial Disclosures is conducting a high-level review of the existing landscape of climate-related disclosures – including current voluntary and mandatory climate-related disclosure regimes – to identify commonalities, gaps, and areas for improvement. They propose seven fundamental principles that are critical for an effective regime for climate-related financial disclosure: 1) present relevant information; 2) be specific and complete; 3) be clear, balanced and understandable; 4) be consistent over time; 5) be comparable among companies within a sector, industry or portfolio; 6) be reliable, verifiable and objective; 7) provide information on a timely basis.

In December 2016, the Taskforce has released a common set of recommendations for voluntary disclosures.

Central banks also have a role to play here. In fact, a number of developing countries such as China, Bangladesh and Indonesia have developed green or sustainable financial sector regulations that require integration of environmental and social considerations into bank lending decisions. For example, in 2011 Banco Central do Brasil was the world's first bank regulator to request banks to monitor environmental risks as part of the implementation of Basil III's Internal Review for Capital Adequacy. China has

developed Green Credit Guidelines, Bangladesh has a Green Banking Framework and Indonesia has the Roadmap for Sustainable Finance. The Swedish Financial Services Authority reported to the Swedish Government about sustainability aspects of the bank's lending in 2015 and in 2016 published an assessment of the risk climate change poses to financial stability.

*Greening the Banks.* As discussed, banks will need to play a greater role financing sustainable infrastructure. In terms of voluntary action that banks could take, drawing on the equator principles or PRI, banks could commit to the type of reporting and disclosure of their exposure in their balance sheets to climate risk. A complimentary approach would be for banks to also include climate risk in their credit risk management processes. In fact, there is evidence that integrating sustainability criteria in credit risk management improves its predictive validity of by approximately 5 percent (Weber 2015). Banks could also stress test current portfolios against various climate risk scenarios. In addition to greening the banking system, some countries such as the U.K., Australia and Japan and in the U.S, states such as California, Connecticut and New York have established green investment banks (GIBs). A green investment bank is a public entity that uses limited public capital to mobilize private investment into domestic low carbon and climate resilient infrastructure. This includes mobilizing private investment to meet domestic target for renewable energy deployment, energy efficiency and GHG emission reductions. These GIBs have also tended to be established in countries that do not have a national development bank. Green Investment Banks aim to leverage private capital for investment in climate change mitigation and adaptation. Some GIBs such as the UK GIB are required to deliver a return on capital and in this respect are not mere grant making entities. For instance, the UK GIB turned a profit in the second half of 2014-15 and is projected to generate an overall return of 9 percent when its projects are fully operational. In 2014, the Australian Clean Energy Finance Corporation achieved a 4.15 percent return (net of operating costs) and their current portfolio of investments in 2015 is projected to generate an annual return of 6.1 percent once fully deployed.

GIBs bring a range of benefits to financing LCR infrastructure. As the UK GIB has demonstrated, the sectoral and technical expertise that the GIB can bring to a deal has contributed to de-risking projects. For instance, institutional investors have been prepared to invest in a GIB developed platform that holds equity positions in renewable energy infrastructure projects, in part based on the reassurance provided by the technical experience of the UK GIB (UNEP 2015b). The GIB also uses other risk mitigating tools such as loan loss reserves, guarantees and debt subordination to apportion risk according to risk appetites of different private sector capital.

GIBs tend to focus on domestic investments in climate mitigation and adaptation. This reflects the fact that most climate-related infrastructure investments are local. As a result, GIBs in developing countries can be used to channel UNFCCC climate finance – which by its nature is finance flowing from developed to developing nations. GIBs can then either reinvest such finance whether appropriate green investment vehicles are present such as wind or solar funds, or can invest directly in project developers, working with local banks and other investors to support new climate-related infrastructure projects.

## 8.3 Central role of MDBs

To meet the challenge of financing sustainable infrastructure, and the SDGs more broadly, official flows to developing countries in support of development and climate action will need to increase. Official concessional assistance is especially important for lower-income countries that have limited access to private financial markets. But a paradigm shift is needed in how development finance is used. Rather than simply filling financing gaps, development finance will need to be used in innovative ways that leverage much larger pools of financing. Even in the best-case scenario, official flows will measure in the hundreds of billions. But the financing requirements measure in the trillions. Going from the billions to the trillions will require a much stronger mobilization of domestic resources and private flows (World Bank 2015d).

The bulk of the financing needed will come from these two sources. The key role of development finance will be to support countries in unlocking and catalyzing more financing from these sources. Both traditional official development assistance, and climate finance commitments made in Paris, will have a much larger impact if used in such catalytic ways.

The role of multilateral development banks will be especially important in this paradigm of catalytic development and climate finance. If anything, the role of MDBs is more important than it has ever been given the imperative to scale up and the equally important challenge of ensuring that infrastructure investments are undertaken sustainably compared to the past. MDBs are well equipped to address both the demand and supply constraints impeding investments in sustainable infrastructure. With their combination of technical and policy support, low-cost long-term financing, and risk mitigation services, these institutions can be instrumental in leveraging substantial increases in flows of private finance to sustainable infrastructure and lowering their cost. This leveraging role will be in high demand especially in middle-income developing countries, where the financing needs are large and private capital will have to play a major role in meeting those needs. The type of finance provided by the MDBs and their supporting services are well-suited to funding and leveraging investment in sustainable infrastructure. But the capacities of these institutions will need to be substantially expanded to enable them to provide and catalyze finance on the scale needed.

Their support can help countries strengthen policy and institutional underpinnings to unlock demand and their presence and oversight can help reduce project specific risks. Infrastructure investments and financing involves multiple actors, all with overlapping but different agendas, time horizons, constraints and degrees of commitment, and with contracts of different types and the need to manage the degree of recourse that lenders will have (WEF 2014). MDBs are well positioned to act as trusted conveners. They can help to unlock the scale of financing that will be needed for greenfield investments and to ensuring that the costs of such financing can be significantly reduced. MDBs can also play an important role in enabling investments that have reached an operational stage to attract a wider pool of investors including long-term institutional investors, creating a virtuous cycle of financing. In order to play such an effective transformational role, the MDBs will need to be transformed themselves so that they are more effective than they have been and can lead the way to establishing replicable models of investment and financing.

### 8.3.1 Support for policy and institutional reforms

MDBs can play a central role in supporting policy and institutional reforms needed to scale up sustainable infrastructure. They can do this by building the knowledge of leading practices drawing on experiences across the world, by supporting country actions, and by working with the IMF, the G20 and the OECD in establishing effective platforms for international cooperation and support. As the previous discussion has highlighted there are a range of areas where countries have to make significant progress in order to transform investment potential to investment demand. These include: (i) investment planning and prioritization that protect against political risks and are informed by sustainability criteria; (ii) legal, regulatory and institutional frameworks to attract private investments that are adapted to country circumstances; (iii) capacity and facilities to prepare projects; (iv) effective PPP units that can develop, implement and oversee PPP contracts and have the capacity for negotiations and re-negotiations; (v) effective tendering and procurement processes; (vi) legal enforcement and dispute settlement mechanisms; (vii) stronger domestic financial intermediaries and deeper capital markets; (viii) local private sector capacity for PPP projects; and (ix) effective monitoring and evaluation mechanisms. In virtually all of these areas, MDBs have a comparative advantage in providing support for reforms and capacity building and for alleviating short-term constraints for example in project preparation and design and implementation of PPP contracts. MDBs are already engaged in providing support across all these areas and there are many good examples of successful interventions. MDBs are also scaling up their support in some critical areas to unlock demand such as in project preparation by establishing and

enhancing project preparation facilities. Nevertheless, the combined efforts fall short of what is needed to bring about systemic change. MDBs therefore need to be mandated and enabled to scale up and make more effective their individual and collective efforts to bring about the policy and institutional transformation that is needed, country by country and in the platforms for international collective action working in partnership with other players.

### 8.3.2 Catalyze change to make infrastructure more sustainable

As highlighted earlier a key pillar must be the elimination of fossil fuel subsidies and the adoption of carbon pricing. The IMF, OECD and the World Bank have all undertaken extremely valuable analyses of the issue and put forward proposals for ambitious action. The IFIs working with the G20 can be a powerful force for international cooperation and country actions. The MDBs in particular can help countries design and implement reforms that can enable them to tap the significant efficiency and revenue gains that are possible while protecting the poor and vulnerable. More generally, MDBs can help countries ensure that sustainability is embedded in all the processes and steps of investment planning and project preparation and execution described above.

Multilateral development banks will have a key role in supporting national efforts to boost capacities for sustainable project preparation and pipeline development, through stronger and more effective PPFs and knowledge sharing (tools, standardized formats, best practice, knowledge platforms). Addressing sustainability, promoting harmonized approaches, and improving coordination, including through joint initiatives, should receive particular attention as they step up project preparation support to countries in scaling up infrastructure investment. Multilateral development banks also need to incorporate sustainability more consistently in their own analytical and investment frameworks. In their current individual and collective efforts, MDBs are responding to this agenda (MDBs 2015b). Complementing stronger and better coordinated MDB support, part of the climate funds stemming from the Paris Agreement could be usefully deployed to help build capacities in countries to integrate sustainability in investment policies and project preparation.

MDBs also need to modify their own assistance and lending frameworks to support systemic change. The approach cannot simply be to withdraw from particular sectors or sub-sectors such as hydro, nuclear or coal. Instead they need to support strategies that will enable countries to make the most effective transition to more sustainable investment paths including to faster decarbonization. This will be based on country circumstances and MDBs can help countries evaluate options based on rigorous cross-country evidence and methodologies including the pricing of negative externalities. MDBs must also adopt sustainability criteria and shadow pricing in their own lending decisions.

### 8.3.3 Address the large potential infrastructure financing gap

MDBs can play a critical role in helping to meet the large potential infrastructure financing gap faced by emerging markets and developing countries, where the gap has to be understood not just as the availability but also the costs of financing. As noted earlier, emerging markets and developing will need $3.5 - $4.5 trillion p.a. in new infrastructure investment to meet their sustainable development goals. While the public sector will continue to provide a significant share of the financing, the bulk of the incremental financing will have to come from the private sector given constraints on public sector balance sheets and the efficiency gains that can come from greater private sector involvement. At the greenfield stage, the bulk of private sector equity will come necessarily from sponsors. But the ability of sponsors, especially local sponsors to generate large equity infusions are constrained by the lack of revenues in the preparation and construction phase. While MDBs can work with governments to address the equity constraint of sponsors, the much larger need is for long-term debt finance given that equity to debt ratios

tends to be as high as 1 to 10 during the initial stage of the project. Moreover as noted bond finance is not well suited for early stage financing. So banks, and increasingly local banks, will have to play a key role in meeting debt finance requirements for infrastructure projects but their ability and risk appetite will be constrained by their own balance sheets and regulatory requirements. Moreover the costs of financing will reflect the underlying risk premia associated with sovereign borrowing, which as noted is high even in countries such as Brazil and India. As a result costs of financing are typically high sometimes prohibitively so. MDBs can play an important role in improving the availability of long-term debt finance and reducing its costs in four ways.

**Scale up their own direct financing thereby augmenting the availability of finance and reducing the cost.** Since MDBs are able to borrow in international and local markets at the most competitive rates and for long maturities they are the most effective mechanism for providing long-term debt finance at least cost for infrastructure financing. The higher the underlying costs of borrowing of a country the greater the benefit. Since only a small portion of the capital contribution is paid in, relatively small infusions of capital into the MDBs can generate large volumes of additional lending. Thus as illustrated in the Box below, a one-time infusion of $35 billion together with an increase in gearing ratios and optimization of balance sheets can enable MDBs to increase their lending from around $70 billion p.a. for sustainable infrastructure to over $200 billion p.a. Also, as argued, such an increase is the most effective way for developed countries to meet their obligations on climate finance and do so with maximum leverage.

**Crowd in other sources of long-term debt finance from all sources.** This includes international and local private banks, national development banks, official development assistance, official export credit agencies, other MDBs, domestic and international banks, infrastructure funds and institutional investors. As discussed earlier syndications provide a powerful means for gaining leverage while maintaining incentives for tight monitoring for greenfield investments. MDBs could lead in such syndications or participate in syndications by other institutions. Based on past experience MDBs can mobilize 4-5 times from other sources for a dollar lent. Thus a scaling up in the lending capacity of the MDBs with leverage could result in over $1 trillion in long-term debt finance p.a. which would be a major contribution in closing the financing gap.

**Box 20 Enabling MDBs to scale-up support for sustainable infrastructure**

There are three key challenges in the scaling up of long-term debt finance: (a) ensuring the availability of long-term debt finance at this scale; (b) reducing the high costs of borrowing in emerging markets and developing countries; and (c) careful monitoring to ensure the economic, financial and environmental sustainability of the investments.

Multilateral development banks can play a pivotal role in meeting these three challenges, but to do so effectively they will need a significant expansion in their combined lending capacity from around $70 billion per year at present to over $200 billion per year. Augmenting the lending capacity of the MDBs is also the most effective way for developed countries to meet their commitments on climate finance and ensuring that this finance has the maximum development and climate impact.

The total current equity capital of the MDBs (IBRD, IFC, AsDB, AfDB, EBRD and IDB--paid in and callable, excluding the EIB which is a special case) is about $680 billion. Total annual lending is about $70 billion (this is down from the peaks of 2010-2012 because of much tighter capital constraints on the World Bank).

Assuming that the capital of these institutions is doubled by 2020, then incremental lending could be increased by $70 billion. Total equity infusions needed would be on the order of $35-$50 billion. This would of course be a one shot contribution. One approach is by combining the balance sheets as is being done in the AsDB; another approach would be to credit the excess equity in the soft arms of the multilateral development banks (IDA and AsDF in particular) to the advanced countries that could be used to finance their contributions in a capital increase. Some relaxation of financial gearing ratios and optimization of balance sheets could allow MDBs to increase their lending by at least 50 percent. A good example is the Latin American Development Bank (CAF) which has a

gearing ratio that is double of the conventional MDBs. So total lending could increase by a further $70 billion.

While the bulk of this incremental lending could be targeted to sustainable infrastructure, providing support for both development and climate actions, it would allow the MDBs to also scale up support for other dimensions of the SDGs such as the provision of basic services.

This incremental MDB lending could be used to leverage and be combined with other official development finance. While the ODA/Climate Finance component is likely to remain quite constrained in terms of additionality, there is significant scope to expand the financing role of official credit agencies in the financing of sustainable infrastructure (for example the role of US EXIM Bank in the financing of Power Africa). Scope for additional lending by the export credit agencies of developed and developing countries could be in the range of $40-$60 billion. .

This total pool of official development finance could be used to mobilize a much larger sum of private capital. The key will be to put together viable and well structured financing packages on which MDBs have a comparative advantage. Based on past experience it should be possible to mobilize anything between two and four times the amount of total private capital. So by using the MDBs to anchor a major scaling up effort, total financing could increase by $600 billion to $1 trillion a year.

Two additional ways of scaling up the role and impact of the MDBs in financing sustainable infrastructure would be to augment the infrastructure facilities that are being set up in the MDBs and to get other financial institutions to join the larger multilateral effort. The Global Infrastructure Facility (GIF) established by the World Bank provides a promising avenue for crowding in private finance. As successful and replicable models are established, the GIF and other facilities could be scaled up without requiring contributions from countries that are constrained in providing such financing. Platforms can also be set for collaboration and co-financing with other financial institutions including the Asian Infrastructure Investment Bank (AIIB), the BRICS New Development Bank (NDB) and the Latin American Development Bank (CAF) as well as other regional and national development banks.

Establishing a robust institutional structure of MDB led lending would allow not only a significant mobilization of private capital but more effective use of all pools of capital including tailoring financing in a way that can maximize development and climate impact. A successful program of MDB led financing including addressing of constraints on the demand side could set the stage for a further expansion of capital beyond 2020 as an extremely efficient way of recycling global savings for the financing of sustainable infrastructure.

Syndication can help to raise private sector capital while reducing balance sheet exposure for development banks; that makes it a useful instrument for financing sustainable infrastructure (IFC 2013a). For development banks, the standard loan syndication process, the B-loan, involves apportioning a set of its project portfolio to a commercial bank or other financial institution.

In other cases, private institutions may act as lead arrangers. This has the benefit of increasing competition in loan markets and taking advantage of their financial expertise in structuring deals.

Increasing loan syndication allows development banks or other primary lenders to recycle their capital for more sustainable infrastructure investment, thus increasing the number of projects they finance. Reducing transaction costs in this way is particularly helpful for small deal size projects and projects that require a premium or include new technologies. Moreover, by providing a lower-risk, lower-cost way to participate, syndication gets the private sector involved, building their confidence in the sector and their willingness to invest. For instance, an MDB loan to finance a $200 million bridge project might be syndicated across 20 or more secondary investors. Conversely, development banks could also choose to pool a selection of smaller loans, thus offering secondary financers more diversified exposure.

Loan syndication can help catalyze private sector financing in developing countries and increase south-to-south lending as middle- and low-income markets and assets grow. Emerging-market financial institutions have been increasing their participation in the IFC's loan syndication program, accounting for 29 percent of IFC loan syndication in 2013 and doubling commitments from the previous year (IFC 2013b).

What would happen if all MDBs increased their loan syndication portfolio to the levels of the leading ones? The IFC has the highest syndication ratio, at 41 percent. The EBRD has the highest percentage of its portfolio dedicated to sustainable infrastructure, at 34 percent.[14] If other MDBs increased to those rates, an additional $35 billion to $75 billion could be mobilized over a 15-year period (Bielenberg 2016).

Increased sustainable infrastructure loan syndication would be particularly valuable for middle- and low-income countries, where development bank loans are concentrated. Though MDBs have successfully mobilized private-sector financing in middle- and low-income countries through loan syndication, syndication could be used actively for sustainable infrastructure Other actors, such as national development banks, could also increase their loan syndication in a similar manner, which would result in higher flows to sustainable infrastructure.

**Enhanced use of well-designed risk mitigation instruments and credit enhancements**. As discussed earlier the proper allocation of risks is key for sound infrastructure project financing. Well-designed risk mitigation instruments can help mitigate against risks that the private sector cannot bear such as policy and revenue risks while ensuring that the private sector remains responsible for risks that are under its control. Several MDBs are experimenting with new approaches that can be built on to create better and more replicable models that can be used to greatly scale up the use of risk mitigation instruments by the MDBs. Credit enhancements can also be used to bring down the costs of private financing. Such credit enhancements can be used to offset the risk premia associated with the sovereign or sub-sovereign as well as the project entity and must go hand in hand with the steps that MDBs take to manage these risks. The value of these credit enhancements must also be assessed against the alternative which is direct lending by the MDB.

**Box 21 Kenya's Lake Turkana Wind-Power Project**

The targeted application of MDB guarantees can make or break large-scale infrastructure projects. Such was the case with the €625 million Lake Turkana Wind Power Project (LTWP), whose success depended on a €40 million guarantee from the African Development Bank (AfDB) and the Standard Chartered Bank.

LTWP, a wind farm that covers 40,000 acres (162 square kilometers, or a little more than two Manhattans) aims to provide 310 megawatts (MW) of reliable, low-cost wind power to the Kenyan national grid. Total installed capacity in Kenya in 2014 was 2,294 MW. The LTWP site is more than 428 kilometers away from the nearest substation, so a transmission line must be built to deliver the electricity from the wind farm to the national grid. The state-owned Kenya Electricity Transmission Company Ltd (KETRACO) agreed in 2013 take responsibility for the $185 million transmission line, which was critical to the success of the wind farm.

Concerned about construction timelines, in 2012, the World Bank withdrew its guarantee from the transmission line (Gachiri 2013). That delayed the project for more than two years—a real-life demonstration of the integral role of guarantees in bringing projects to completion. At the end of 2014, the AfDB and Standard Chartered stepped in with guarantees to cover loss of revenue due to transmission line delays.

Construction began in 2015 and is expected to finish in 2018. "By reducing the risk profile," noted the AfDB, "the partial risk guarantee will accelerate financial closure and reduce the overall cost of capital to the project." (ibid). In effect, by reassuring investors, this €40 million is helping the project reach its €600 million target.

*Source: Bielenberg et al (2016)*

Despite the frequent use of guarantees by different types of development banks, they account for a very small proportion of the portfolio of MDBs and are especially underutilized for climate finance. In 2014, only 5% of climate finance from MDBs went to guarantees (with the rest distributed through loans, grants, and equity) (MDBs 2015).

Finance and infrastructure (particularly energy) receive the most MDB guarantees (ibid). With the exception of regionally-oriented MDBs, the majority goes to Eastern Europe, Central Asia, and sub-Saharan Africa. (The IFC, however, guarantees a large amount of financing to China) (ibid). Guarantees are well suited to sustainable infrastructure because they can be precisely targeted and adapted to policy risks (CPI 2013).

Guarantees have an average private-sector leverage ratio of 5, meaning that every dollar in guarantees mobilizes $5 in private capital. Given that, the financial case for increasing the amount of sustainability-related MDB guarantees is strong. There are also a variety of helpful ripple effects, particularly in middle- and low-income countries. One is that these guarantees signal the importance of sustainability to other investors, providing an incentive for traditional projects to incorporate sustainable principles. Another is that worthwhile projects are completed that otherwise would be considered too risky. . Finally, when sustainable infrastructure projects in middle- and low-income countries succeed, that improves perceptions of risk, generates data, and builds capacity for future efforts.

Based on current MDB guarantee stock of $4.2 billion, of which $2.7 billion is dedicated to infrastructure, and a weighted average of 6 percent of guarantees allocated to sustainability projects, we can project the impact of various scenarios. If 30 percent to 40 percent of infrastructure guarantee portfolios were allocated to sustainable projects, and infrastructure guarantee volume increased 20 percent to 40 percent, we estimate that could mobilize incremental private-sector flows of $12 billion to $33 billion over 15 years. That is well within reach. The European Bank for Reconstruction and Development's (EBRD) allocation for sustainable infrastructure is at 34 percent, which suggests other banks can do the same.

**Help close the viability gap in the financing of sustainable infrastructure.** As noted there are several reasons why infrastructure projects face a viability gap. First, social returns to an infrastructure investment are typically higher than the private returns. This is because of the long-term and network effects associated with infrastructure projects. Another important dimension is environmental sustainability including climate impact and resilience. Properly priced investments in more sustainable infrastructure over the whole project cycle will be economically viable, but in the absence of such pricing, there will be a need for capex grants or other financing supplements to incentivize and enable more sustainable infrastructure investments. Another source of a viability gap is the inability of low-income users to pay for the infrastructure service. There are valid social objectives for governments or donors to close the resulting viability gap although in many cases there is significant scope for raising user fees for better-off users as well. Third, the costs of financing itself can contribute to the viability gap. Even with the actions noted above, the costs of financing may remain too high leaving many projects with high social returns as "un-bankable". Reducing the overall costs of financing through blending private finance with concessional, MDB and other official finance can help to create viable financing packages. MDBs have a comparative advantage in working with governments to create such viable financing packages that help transform investment potential in sustainable infrastructure into investment demand but without distorting fundamental incentives.

MDBs have a comparative advantage in mobilizing development capital to finance the upfront premium that may be needed for sustainable infrastructure projects through a package of blended finance. Development capital could be used to increase the share of infrastructure projects that are considered sustainable. If development banks, bilateral aid organizations, and climate finance organizations dedicated $10 billion to $15 billion a year to finance sustainability premiums for energy efficiency, this could increase the value of energy-efficient infrastructure by up to $176 billion a year.[15] Over 15 years, that means there would be $2.6 trillion in sustainable energy-efficient projects that would have not otherwise been built sustainably.

**Box 22 EBRD's Industrial Energy-Efficiency Audit program**

The European Bank for Reconstruction and Development (EBRD) has built energy efficiency and a total cost of ownership (TCO) savings approach into the Industrial Energy-Efficiency Audit program. Under this program, EBRD consider the energy-efficiency potential of all its industrial and commercial loan applications. It also estimates the incremental investment required to pay for the efficiency upgrades and the potential return on that investment. If a client accepts the option to implement the energy efficiency measures, as more than 60 percent do, EBRD funds a third-party energy audit to confirm the potential savings (D'Addario 2013). The incremental investment required is then covered under the same loan terms as the original loan, with payback covered by the TCO savings; these often exceed the premium in less than two years (ibid).

Despite the proven benefits, the program is still relatively small; if it could be scaled up, that might attract the private-sector to finance sustainability premiums as well. In fact the private sector does appear somewhat interested in financing sustainability premiums using TCO savings, mostly in in high-income countries. For example, Sustainable Development Capital LLP (SDCL) is a London-based fund management firm that advises clients on environmental investments; among other things, it finances energy-efficiency retrofits in infrastructure and real estate. Under the SDCL model, energy efficiency improvements are delivered to the client at no upfront cost. SDCL takes on the financing and risk, earning financial returns through TCO savings. SDCL operates in the UK, Ireland and Hong Kong, and is working on funds in New York and China.

Development capital could help to ensure that sustainability investments using TCO savings target the right locations. If the EBRD model could be expanded to demonstrate the business case for sustainability in middle-income countries that could encourage private sector actors like the SDCL to invest in these markets.

*Source: Bielenberg et al. (2016)*

**Catalyzing post-completion re-financing.** Together with other players notably the OECD and the G20, the MDBs can help push for collective actions that can help promote infrastructure as an asset class to attract a wider pool of investors. MDBs can help develop and pioneer replicable models of refinancing once projects reach the operational stage both by establishing viable refinancing packages at the project level and establishing platforms that can attract different pools of investors. MDBs can also set up credit enhancement mechanisms to attract long-term institutional investors into emerging markets that have sovereign ratings at or near investment grade but where the project remains a notch below investment grade. Credit enhancement to a sufficient degree could be extremely valuable since most international pension funds and insurance companies require a project to be rated at investment grade in order for them to be allowed statutorily to invest in a project. They can also securitize their own asset portfolios enabling institutional investors to participate and stimulating domestic capital market institutions.

MDBs can contribute to expanding the range of instruments to augment the pool of investors, allow for better risk matching and enhancing the focus on sustainability. Development banks can help shift financing structures from large governments and large corporate entities to cities, smaller developers and households that will play an increasing role in sustainable infrastructure investments such as in renewable energy and transport.

While MDBs possess key advantages that can help alleviate critical constraints to infrastructure investment and financing in emerging markets and developing countries, they will need to undertake reforms and adjust their business models to address their own constraints: procedures and requirements are overly cumbersome leading to costly and lengthy project approvals; financing instruments are not sufficiently flexible in relation to needs; and there has been an erosion in the technical capacity and skills of staff. While MDBs need to become more cost effective they cannot simply go back to the old practices of business-as-usual infrastructure. Instead they have to pave the way to creating a better infrastructure that is more productive and more sustainable.

**Box 23 Global Infrastructure Facility**

The World Bank established the Global Infrastructure Facility (GIF) in 2014 as a joint platform with other MDBs in order to facilitate the preparation and structuring of complex infrastructure public-private partnerships (PPPs) to enable mobilization of private sector and institutional investor capital. In particular, GIF aspires to make infrastructure in emerging and developing economies an attractive asset class to the full range of private investors seeking diversification into long-term assets in faster growing economies. By enabling collaboration and collective action on complex projects beyond the capacity of single institutions, as well providing upstream support on market structure and project identification and appraisal, as well as through transaction preparation, and integration of financial structuring and credit enhancement, GIF can improve risk tolerance and investment profiles of previously unattractive investment opportunities.

The GIF operates according to the following core principles:

- **Providing public goods:** Focusing on enabling investment in core infrastructure, particularly those infrastructure projects that are climate-smart or trade-enabling.
- **Mobilizing the private sector:** Concentrating on financing and implementation modalities that draw together the comparative advantages of the public and private sectors to expand investment and improve infrastructure services.
- **Achieving value for money:** Selecting viable projects that are expected to achieve value for money for recipient country government(s) and service users; then, through sound project appraisal, design, structuring, and procurement, helping ensure that value for money is achieved in practice.
- **Promoting sustainability and inclusiveness:** Ensuring that projects adhere to best practice standards for social and environmental responsibility.
- **Collaborating for best results:** Mobilizing partners' technical and financial resources in an innovative and flexible way to achieve greater leverage and address the complex infrastructure financing challenges that are beyond the resources of any individual partner.
- **Augmenting partners' capacity:** Complementing individual partner efforts by supplementing existing resources.

In first three years, the GIF will operate in a "pilot phase" with a seed funding and initial capitalization $80–$100 million. This approach will help test the concept, activities, and partnership model of the new facility. The allocation level allows for supporting 8 to 10 pilot interventions initially in a range of sectors, regions and project types. It is expected that through these initiatives, GIF will contribute to development of stock of high quality and well-structured infrastructure projects in the long term, in particular, testing infrastructure investment models for emerging and developing economies.

*Source: World Bank (2015g)*

To scale up support for sustainable infrastructure, each MDB should set out explicit assistance strategies for sustainable infrastructure linked to INDC commitments and plans. Towards this end they should set targets for own lending and for co-financing with other lenders including the private sector. They should enhance de-risking and credit enhancement mechanisms. They should undertake *ex ante* and *ex post* sustainability assessments based on harmonized standards and guidelines. They should provide targeted and concessional financing to promote the adoption of innovative technologies. They should give greater attention to climate resilience and adaptation financing needs. In all of these areas they should promote enhanced collaboration and common platforms. The MDBs are already moving in this direction. A good example is the Global Infrastructure Facility which has been established in 2014 as a joint platform with other MDBs in order to facilitate the preparation and structuring of complex infrastructure public-private partnerships (PPPs) to enable mobilization of private sector and institutional investor capital (Box 23). Multilateral development banks can also help promote and support scalable investment platforms at the country level in partnership with local institutions. Such platforms can help identify

and tackle policy impediments, increase the deal flow of viable and sustainable projects, ensure sound governance and implementation, encourage and support adoption of best available technologies, develop models for proper risk sharing and mitigation, and help mobilize and bring down the costs of financing—both in the early stages and once the project reaches the operating phase.

## 8.4 Leveraging official development assistance and climate finance

### 8.4.1 Official development assistance

ODA is likely to remain relatively modest compared to the scale of investment needs for sustainable infrastructure in low- and lower-middle income countries. However, it can play a critical role in closing financing gaps in the poorest countries including by crowding-in other sources of finance and in improving access and affordability for the poor.

ODA levels have increased significantly in recent years rising from $54 billion in 2000 to $135 billion in 2013. Around 30 percent of ODA has been targeted to the least developed countries. Historically, less than 15 percent was allocated for infrastructure spending despite the fact that it has been a large component of the recipient governments' capital spending. Since the 2008 global financial crisis, following an initial decline, there has been an increase in concessional financing for infrastructure, with the total exceeding $22 billion in 2013.

Yet these magnitudes are small compared to the scale of the needs. The most urgent and compelling need for ODA is to support poverty reduction and buttress basic social investments in the poorest countries. The additional annual financing requirements to meet minimum social investments such as education, health, and access to social infrastructure implied by the SDGs have been estimated to be on the order of $40 billion. To meet growth and development targets, infrastructure investment in low-income countries will need to at least double from its present level of around $150 billion a year. It will also be essential to address the growing unmet need for climate adaptation in both low-income and vulnerable countries, which, by some estimates, could amount to another $60-$100 billion a year.

Although the world should continue to push for all rich countries to live up to the internationally agreed targets, the total pool of ODA will remain constrained and relatively small going forward. Given that the pool of ODA is constrained, it is essential that official development capital mobilizes private finance for sustainable infrastructure investments in low and lower-middle income countries.

### 8.4.2 Delivering on climate finance

In the UNFCCC context, public climate finance is delivered either via public financial institutions such as MDBs and NDBs, bilaterally as part of aid programs or through multilateral and bilateral climate funds. In terms of UNFCCC climate finance, governments have expressed a preference for a significant portion of it to be delivered through multilateral climate funds (UNFCCC 2011).

At the Paris climate meeting it was decided that the Green Climate Fund, the Global Environment Facility and the Least Developed Country Fund and the Special Climate Change Fund that are administered by the GEF, shall serve the Paris Agreement (UNFCCC 2016). The does not limit the climate funds that countries can use to deliver their UNFCCC climate finance. The Climate Investment Funds (CIFs) in particular are another large multilateral climate fund with experience delivering climate finance for climate-related infrastructure projects.

**Box 24 The Multilateral Climate Funds**

*The Green Climate Fund*. The Green Climate Fund (GCF) was established at the 2010 COP 16 as a formal fund of the UNFCCC. The GCF receives guidance from and is accountable to the COP. The GCF has commenced operating and currently has paid in capital of $10.2 billion (GCF 2015a).

*The GEF*. The GEF funds include the Least Developing Countries Funds, the Special Climate Change Fund and the GEF Trust Fund. The GEF invests directly as well as through accredited institutions. Such institutions include the World Bank but also include other regional partners. As an entity of the UNFCCC the GEF receives guidance from and is accountable to the COP.

*The CIFs.* created in 2008, the CIFs are multilateral climate funds that comprise the Clean Technology Fund (CTF) and the Strategic Climate Fund (SCF) – the later which comprises the Pilot Project for Climate Resilience (PPCR), the Forest Investment Program (FIP) and the Scaling Up Renewable Energy Program (SREP) The CIFs work exclusively with the MDBs, which are the key implementing agencies of CIF funding. Funds pledged to the CIFs total $8.3 billion.

There are also a number of bilateral funds such UK's International Climate Fund, Germany's International Climate Initiative and Norway's International Climate and Forest Initiative, through which public climate finance will continue to be channeled.

Ultimately, how countries channel climate finance will reflect a range of considerations, such as perceptions of the legitimacy of the various climate funds, their governance and responsiveness to recipient countries (Nakhooda et al. 2013).

Table 8 lists the multilateral climate funds. Over $26 billion has been pledged to these funds and over $10 billion of finance has been approved, with $2bn in disbursements in 2014. These figures will increase substantially as progress is made towards the $100 p.a. billion pledge a significant share of this climate finance is expected to be channeled through multilateral climate funds. For instance, $10.2bn has been pledged to the Green Climate Fund and the Fund's aim is to disburse approximately $2.25 billion in 2016.

**Table 8 Multilateral Climate Funds**

| Fund | Administrator | Funds Pledged | Funds Deposit | Funds Approved |
|---|---|---|---|---|
| | | US$ millions | | |
| **Adaptation Funds** | | | | |
| MDG Achievement Fund | UN | 90 | 90 | 90 |
| Adaptation Fund (AF) | AFB | 487 | 483 | 325 |
| Adaptation for Smallholder Agriculture Programme (ASAP) | IFAD | 366 | 326 | 239 |
| Pilot Program for Climate Resilience (PPCR) | CIF | 1125 | 1125 | 857 |
| Least Developed Countries Fund (LDCF) | GEF | 964 | 962 | 795 |
| Special Climate Change Fund (SCCF) | GEF | 350 | 344 | 278 |
| *Adaptation Total* | | *3382* | *3329* | *2583* |
| **Mitigation Funds** | | | | |
| Global Environment Facility (GEF4) | GEF | 1083 | 1083 | 953 |
| Global Energy Efficiency and Renewable Energy Fund (GEEREF) | EIB | 170 | 164 | 89 |
| Clean Technology Fund (CTF) | CIF | 5299 | 5128 | 4101 |
| Global Environment Facility (GEF5) | GEF | 1350 | 777 | 865 |
| Global Environment Facility (GEF6) | GEF | 1101 | 1078 | 197 |
| Partnership for Market Readiness (PMR) | WB | 127 | 107 | 52 |
| Scaling-Up Renewable Energy Program for Low Income Countries (SREP) | CIF | 528 | 528 | 168 |
| *Mitigation Total* | | *9657* | *8864* | *6425* |
| **REDD+ Funds** | | | | |
| Amazon Fund | Brazil | 1034 | 917 | 553 |
| Biocarbon Fund | WB | 361 | 361 | |
| Congo Basin Forest Fund (CBFF) | AfDB | 186 | 165 | 82 |
| Forest Investment Program (FIP) | CIF | 583 | 528 | 333 |
| Forest Carbon Partnership Facility | WB | 826 | 688 | 211 |
| UN REDD Programme | UNDP | | | |
| *REDD+ Total* | | *2990* | *2659* | *1179* |
| **Multiple Foci Funds** | | | | |
| Global Climate Change Alliance (GCCA) | EU | 326 | 326 | 347 |
| Green Climate Fund (GCF) | GCF | 10204 | 974 | 172 |
| Indonesia Climate Change Trust Fund (ICCTF) | ICCTF | 21 | 11 | 10 |
| *Multiple Foci Total* | | *10551* | *1311* | *529* |
| | | | | |
| ***All Total*** | | ***26580*** | ***16163*** | ***10717*** |

*Source: UNFCCC (2014)*

### 8.4.3 Leveraging climate finance

The following analyzes how the multilateral climate funds can use climate finance to support the development of LCR infrastructure.

*Develop an enabling environment.* The enabling environment refers to the range of policy and regulations that supports investment in infrastructure projects. This includes general legal and regulatory issues such as rule-of-law, investment protection, political stability and corruption issues. Lack of a robust enabling environment increases sovereign risk and the cost of financing infrastructure (de Nevers 2013). The lack of a strong enabling environment is particularly acute in developing countries with less developed political and legal institutions.

Having in place the right enabling environment is important for infrastructure projects due to their large upfront capital costs, long-term and illiquid nature makes investors particularly sensitive to political and legal risks affecting such investments. In addition, climate-related infrastructure often relies on some form

of policy support (such as feed-in-tariffs or tax breaks) to be commercially viable, making such projects particularly sensitive to the risk of regulatory changes.

Climate finance will need to play a role in financing improvements in a country's enabling environment as the costs and uncertain payback of support for improving the enabling environment in developing countries limits the scope for private sector finance (Kato et al. 2014). Specifically, climate finance should be used to support the following:

*Develop strong institutions, including key climate policies* such as a carbon price and phasing out fossil fuel subsidies. For example, CIF finance for the development of large-scale concentrated solar power in Morocco, was linked to the gradual removal of fossil fuel subsidies (de Nevers 2013).

*Sector-specific market-based interventions*: such as reform of government monopolies in the energy sector that discourage competition and feed-in tariffs for renewable energy. CIF financing of geothermal development in Tanzania included support to revise Tanzania's geothermal laws to improve the regulatory framework governing private power generation (Box 26).

*Mainstream climate goals into national development plans and NDCs.* Linking infrastructure projects to INDCs would help align infrastructure investment with country's climate goals and help mainstream climate infrastructure needs into broader development plans (Ellis et al. 2013). Such an approach would also signal long term government commitment to a course of action, helping to reduce investor perception of the risk of policy change. The GCF has also identified the need for "readiness and preparatory support" as an area for support (GCF 2015b). For instance, Zambia mainstreamed its climate goals into the country's Sixth National Development Plan which lead to increased political buy-in for climate resilience programs and greater allocation of domestic resources (alongside support from the CIF) for climate resilience projects (CIF 2015).

The Paris Agreements commitment that countries will prepare NDCs and the promise of support for developing such NDCs provides an opportunity government's to take a broader view of the regulatory and policy changes needed to support low carbon development and for climate finance to support such efforts.

*Support developing a pipeline of bankable sustainable infrastructure projects.* This requires building government capacity to undertake project preparation and planning including the negotiation of complex public-private partnerships, standardizing contracts and project evaluation procedures (Kaminker et al. 2013). This is important as project preparation can add 5-10 percent to total infrastructure costs (World Bank 2013-1). Climate finance could be used to develop these skills and capacities. For example, the World/IFC Scaling Solar program helps countries develop a rapid pipeline of solar energy projects by providing support with tendering, developing bankable project documents.

*Develop co-financing packages.* Climate finance can also reduce the cost of financing climate-related infrastructure investments by investing or blending climate finance alongside other sources of MDB and private sector finance to bring down overall project risks. The CIFs have been particularly focused here on providing such risk capital. For example, the development of the geothermal market globally has been in large part due to the use of the CIF finance to support the earliest and riskiest stages of geothermal projects at the exploration and test-drilling stages (CIF 2015).

Blending CIF funds with MDB finance has also enabled the MDBs to structure higher risk transactions than would have been possible using only MDB balance sheets (ibid). The GEF has also blended GEF finance with other public and private capital to reduce risk. For example, to finance a renewable energy project in Africa co-financed with the Africa Renewable Energy Fund (managed by the AfDB), the GEF accepted a capped return on its equity, enabling increased returns to be offered to private sector partners. In a land restoration project in Latin America, the GEF provided guarantees and subordinated loans that reduced risk and along with IADB funding crowded-in private sector finance.

*Support local banks.* Climate finance can also be used in a wholesale manner to support financing by local financial institutions in climate-related infrastructure projects. Domestic banks play an important intermediation role at the earlier infrastructure project preparation and construction phase, particularly in middle income countries where over half of the private and PPP sources of infrastructure funds are local. Local banks can also provide funding in their local currency, thereby reducing currency risk.

Local banks are well positioned to address barriers to investing in sustainable infrastructure in developing countries. For instance, domestic banks are often best placed to understand and manage risk due to a more detailed understanding of local conditions which allows them to more accurately assess the creditworthiness of project developers. Building up this local experience can further develop bank's ability to assess risk, reducing transaction costs and the overall costs of financing sustainable infrastructure (IFC 2013).

Climate finance can play a role here by directly financing local financial institutions, reducing the cost of finance for sustainable infrastructure project. A challenge here is identifying the relevant institutions with climate-related infrastructure expertise. This includes the experience in terms of accounting, financial reporting and monitoring, where the absence of such capacity can require duplicative systems that increases transaction costs (Ellis et al. 2013).

The GCF is positioning itself to invest directly in local financial institutions by allowing intermediaries in recipient countries to become accredited to receive climate finance (Canfin and Grandjean 2015). This process should be used to encourage accreditation by private financial institutions in each country and be used as a form of due diligence to assess capacity to further leverage additional capital into sustainable (particularly energy) infrastructure.

*Support development of financial instruments.* As discussed, developing infrastructure as an asset class is a key part of the financing framework. Securitizing infrastructure projects at the operating stage and selling them as green bonds can transform LCR infrastructure into a low risk, liquid asset that can be attractive to institutional investors, allowing the capital from governments, project developers and banks that is invested at the earlier, riskier stage of infrastructure projects to be recycled into new LCR infrastructure projects (UNEP 2015b). When green bonds are backed by the AAA credit rating of issuing institutions such as the World Bank, this further reduces the risk of investing in LCR infrastructure (Farid et al. 2016).

There has been some use of climate finance to develop the green bond market, such as the IDB Green Bond Securitization Project supported by CTF and GCF finance. However, climate finance should be more active in this space, including developing green bond standards to ensure that bonds are clearly linked to climate change outcomes (UNEP and BNEF 2015).

There are already steps being taking here. Green bond indices have been created to help determine what qualifies as "green." For example, the Barclays-MSCI Green Bond Index launched in November 2014 goes beyond the emerging voluntary standards such as the Green Bond Principles and includes specific about the use of proceeds. The Oslo Securities Exchange crated the first separate green bond listing in 2015.

Another way to reassure investors over the use of the proceeds have been through incorporation into the issuance of an independent second opinion of the 'greenness" of the bond - approximately 60% of issuers to data have done this. While this may help boost investor confidence it has added to verification costs, which could prevent rapid scaling of issuance.

**Box 25 China's Green Bond Market**

China's People's Bank established a green bond market in December 2015 to complement the green bank lending. China's green bond market is expected to grow to $230 billion within the next 5 years.

China has also published guidelines on the issuance of green bonds, the first country to do so. The Shanghai Stock Exchange in 2016 announced a pilot program for trades of corporate green bonds that will encourage firms to seek independent assessments of green qualifications.

*Develop low-carbon technology.* Another role for climate finance is to invest in the deployment of low-carbon technologies. The IEA estimates that existing technologies can reduce global GHG emission by around 60 percent of what is needed to achieve the 2 degree goal (IEA 2015c). This highlights the importance of intensified RD&D for new low carbon technologies such as clean fuels for transport and CCS. Climate finance can be used to cover the technology risk from deployment of as new technologies, where there are particularly challenges in assessing risk and building financing plans at an acceptable cost (IFC 2013). Here, the role for climate finance is to mitigate these risks to support the demonstration and scaling of new technologies.

Small amounts of targeted climate finance in the form of a grant can help bring down the costs of such investments in climate technologies, enabling public funds from MDBs and private capital to come on board. For example, CTF finance, finance supported the development in South Africa of the first developing world concentrated solar power plant with storage.

Channeling climate finance through local financial institutions is another complementary approach to addressing technology risk. Local institutions are often better able to assess the application of new technologies to local conditions, such as the willingness of regulators to pass on the costs of clean energy technologies through increased rates, public acceptance of new technologies such as CCS and the political durability of subsidies.

*Strengthen Monitoring of Outcomes.* Monitoring investments and learning from experience is another important role for climate finance. Improving data and information on LCR infrastructure investments is needed to allow investors to properly assess risk, determine what works and can be scaled (Kaminker et al. 2013). It is also important to have mechanisms in place to monitor and evaluate the effectiveness of climate finance to assess the costs and benefits of more ambitious action and to establish an evidence base of what policies and interventions are needed (Ellis et al. 2013). The programmatic approach of the CIFs has supported monitoring and reporting across sectors of outcomes. To ensure accountability, learning, and progress toward investment goals, the CIF requires all countries to report annually on results achieved. Monitoring and reporting systems are country-led and build on the CIFs' programmatic approach, engaging stakeholder groups across sectors, including government institutions at national, sub-national and local levels, as well as civil society, local communities and the private sector, to jointly analyze and discuss results achieved and lessons learned in the implementation of investment plans.

The GCF is working to develop ways for countries to share experience and learning, but so far this appears limited to sharing experiences of gaining accreditation under the GCF (GCF 2015a). This could be broadened to address the need for learning as to what financing models and policies have successfully produced sustainable infrastructure. Tying climate finance to improved measuring, reporting and verification under a UN climate change agreement can facilitate this information gathering process.

*Improve coordination amongst climate funds.* Another issue is the need to improve coordination amongst climate funds. Currently, climate finance is being delivered by a multitude of funds and institutions. Preventing overlap, duplicative processes for accessing funds and consistent criteria will increase the

impact such finance can have. This also requires developing the capacity of governments to effectively manage climate finance as well as coordinate with international donors (Ellis et al. 2013).

Improving coherence and cooperation across the climate finance funds within and outside the UNFCCC can also improve experience-sharing and dissemination of lessons learnt, increasing the scope for climate finance to be targeted, effective and catalytic.

*Finance Infrastructure for Adaptation.* The Paris Climate Agreement emphasizes the importance of adaptation and developing an agenda that should increase action and support for adaptation. The Agreement establishes a global adaptation goal – "strengthening resilience and reducing vulnerability to climate change, with a view to contributing to sustainable development and ensuring an adequate adaptation response in the context of the temperature goal referred to in Article 2." (UNFCCC 2016). To make progress on this goal, each Party is encouraged to engage in an adaptation planning process that includes formulating national adaptation plans and prioritizing actions in light of each countries assessment of their vulnerability to climate change.

Under the Paris Agreement there is also recognition of the need for support for international cooperation on adaptation efforts, including strengthening institutional arrangements, and assisting developing countries identify adaptation needs and to improve adaption effectiveness (UNFCCC 2016).

The Paris Agreement stresses the vital role of climate finance in helping developing countries adapt to climate change, particular in the poorest countries where there will be limited scope for private sector funding (GCF 2015c). The Paris Agreement also includes the aim of balancing the provision of climate finance between mitigation and adaptation. The GCF already aims to achieve such a balance. In addition, there are three other UNFCCC climate funds focused on adaptation – the $934 million Least Developed Countries Fund, the $349 million Special Climate Change Fund, the Adaptation Fund which is financed through proceeded from sales of certified emissions reductions under the Kyoto Protocol. The CIF Pilot Program on Climate Resilience is also adaptation focused.

For many adaptation projects there will be limited scope for generating returns while will limit the prospect for involving private sector finance. In these cases public finance will need to play the dominant role, including climate finance.

There is, however, a growing recognition that adapting to climate change involves risk that the private sector should be responding to. For instance, ratings agency Standard and Poors has identified climate change as a threat to private sector infrastructure and that making such infrastructure resilient to climate change should involve private sector finance.

In the cases where there is scope for private investment, targeted climate finance can help overcome barriers and reduce risks. For instance, there has been some success in leveraging private sector investment in adaptation has been in the provision of insurance from climate-related events. Insurance can spread the costs of LCR events, communicate risk, offer new and innovative risk management solutions and directly invest in sustainable infrastructure (IFC 2013). For example, the African Risk Capacity Insurance company offers drought insurance to African states. It was financed by private capital and finance from German and UK development agencies (KfW and DFID). The Caribbean Catastrophic Risk Insurance Facility is a public-private partnership multi-country risk pool that seeks to mitigate the effects of hurricanes and earthquakes (CFSG 2015).

**Box 26 Natural gas energy infrastructure in Tanzania**

Current gas exploitation in Tanzania is geared towards electricity production to meet domestic power demands, relieve the national electricity utility, TANESCO, from expensive power generation, and contribute towards energy security, particularly by reducing reliance on hydropower. Tanzania's immediate plans are to invest in electricity generation and meet domestic needs in the industry, connect 30 percent of the population to meet thermal needs in big cities of Tanga, Arusha, and Mwanza; the target is to produce 9,000 MW of electricity from natural gas by 2021. Although household use of natural gas has a huge potential for widening electricity access, which is currently low, it may not be very financially attractive to private sector investors, especially compared to the competitive returns that can be gained from investing in the export market. Indeed, an 'anchor' project in the gas sub sector that is expected to generate revenue for developing both domestic and regional infrastructure is a public-private partnership targeting exports of LNG to Asian countries where demand is high. With this project, one option would be to sell all of the gas in liquefied form on the international market. The second option would be to use a portion of the resource for domestic gas-based industries, and export the rest.

In the medium term, export of gas is targeted after 2025 to East Africa region. As part of the East Africa Community (EAC) Power Master Plan, there is a proposal for the construction of a Natural Gas Pipeline project. Its aims are to: facilitate easier and faster supply of gas to Tanga and Mombasa and in particular ensure the provision of natural gas as an alternative fuel to a number of thermal power plants located in Mombasa as well as supplying gas to industries, commercial institutions and other consumers in Mombasa; promote diversification of the energy sources in the region and reduce dependence on imported fossil fuels; strengthen the integration process as Partner States share a locally available energy resource in the region and the associated infrastructural facilities; and enable further exploitation of the gas resources in Tanzania for regional development.

There are a number of policies and legislation guiding such decisions about how best to exploit natural gas resources for the benefit of all Tanzanian citizens. The 2013 Natural Gas Policy makes an explicit link to existing overall national development policies, in particular the long-term plan, Vision 2025. Meanwhile, the natural gas policy focuses on how natural gas is to benefit the population of Tanzania through institutional frameworks, regulatory frameworks and systems that ensure strategic participation. The 2015 Oil and Gas Revenue Management Act legislates how benefits are to be shared and the government is in the process of developing a Natural Gas Utilisation Master Plan. In addition, a Model Production Sharing Agreement, 2008 (MPSA) between the Government, the TPDC and the Oil Companies, and a Model Power Purchase Agreement (PPA) has been developed for seven subsectors including the natural gas sub-sector. Yet, there remains no agreement between the GoT and private sector companies on the investment framework for oil and gas. Previous deadline to conclude this framework by 2015 has been revised, with a new deadline for its implementation now postponed to 2019 (Bushell – DFID). It is not a surprise therefore that close to five major development partners and philanthropic foundations are directly or indirectly on supporting the setting up or reforms to strengthen the legislative framework for oil and gas. These include DFID, NORAD, FINNIDA, UNDP, the World Bank, AfDB, EADB and the Bill & Melinda Gates Foundation (BMGF).

Beyond the physical infrastructure and governance architecture guiding natural gas development pathways, Tanzania still requires huge investment skills and knowledge capacity within the oil and gas sector to ensure that developments in the sector result in development of local capabilities. Without such capabilities, the employment opportunities and long-term competitiveness that could be fostered will be stifled. There are several initiatives funded by the government, industry and some donors for petroleum-related education at higher education level, technical level and vocational education and training institutions, such as the establishment of a vocational training center in Mtwara which offer natural gas technical courses and the new Masters training on Natural Gas at the University of Dar es Salaam and the UONGOZI Institute which is a government leadership training institute established with the support of the Government of Finland is providing support to the government in formulation of various policies. However, there are still major skills gaps at both professional and technical levels.

**Lessons Learn and Way Forward**

The following issues emerge as findings and lessons learnt from this brief analysis of the gas sub-sector;

- Attracting private sector investments in infrastructure in the gas industry is difficult. Firstly, many of the current, if not the majority of the infrastructure projects are either solely financed through

public funds, or through a blending arrangement with significant government investments through guarantees, equity and loans. The focus on generating gas for domestic consumption complicates investment opportunities, in cases where economic returns may not be as competitive as exports.

- The country still needs substantial investment in the sector through 'anchor' projects to be able to realize considerable local benefits. As nearly 80 percent of the reserves are located in the deep sea, exploration and exploitation of these reserves will be key to generating enough gas for meeting domestic needs as well as exports, but will be more costly and hence will rely more on private rather than public investments. This may be challenging especially since falling price of oil has negatively affected investments in new capital intensive oil and gas exploration.
- There is a need to sustain and grow the ongoing capacity building processes towards enhancing the local skills, expertise and knowledge base in the oil and gas sector through higher education and technical and vocational training. This is important to ensure that adequate and sufficient capacity is developed locally. Increased and sustained attention to promote positive social impacts of gas exploitation especially among the locals is needed. For example, training to ensure local benefits through employment opportunities for locals in gas production areas. The initiative to establish a vocational training center in Mtwara which offer natural gas technical courses is a positive feature.
- It is important to encourage corporate social responsibility within gas infrastructure projects. Some have already planned and implemented community projects to develop public social services in the water and power sectors.

*Source: SEI 2016*

# 9. Strengthen technology development and deployment

The INDCs conveyed by countries in the run up to COP21 make it clear that demand-side curbs on emissions will not be sufficient to meet the 2°C Scenario (2DS). These efforts will need to be complimented with deployment of low-carbon technologies to achieve the recommended emissions target. There is need to build a stronger platform for cooperation and actions on technology and on building more efficient and sustainable infrastructure. There is tremendous scope to accelerate and benefit from innovation.

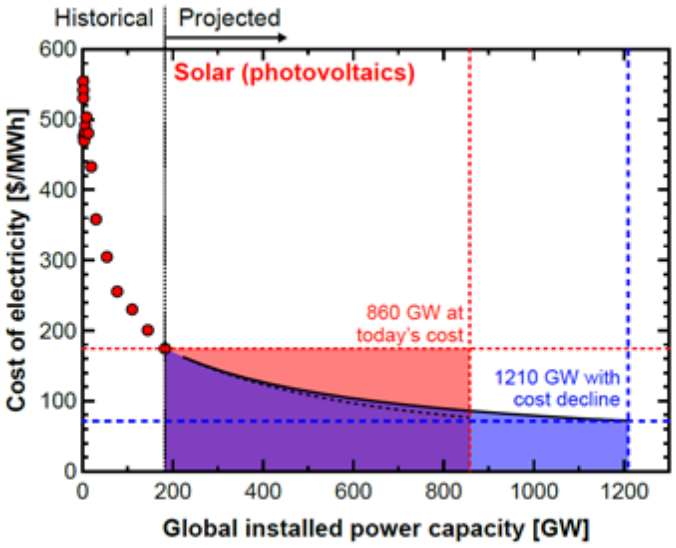
The International Energy Agency (IEA) estimates that if system-level innovation is achieved, renewables such as wind and solar PV have the potential to provide 22% of annual electricity sector emissions reduction in 2050 under the 2DS. Overall, renewables are projected to reduce global emissions by 31 percent by 2050 under 2DS. While the price of solar energy has fallen very rapidly over the last few years, the IEA conservatively projects that it could fall by a further 40 percent over the next 5 years, or even further by 50 percent for solar (PV) and up to 25 percent for wind according to a latest MIT study. For renewables to be deployed on a large scale, system-level innovation requires enabling technologies that allow demand-side integration, improved energy storage, smart grid infrastructure and perhaps more importantly reduced variability of wind and solar PV and/or increased flexibility of power systems. Innovations such as Tesla's Powerwall to advance the storage of photovoltaic energy, the concentrated solar plant in the Atacama Desert that can generate continuous electricity even when the sun is not shining demonstrate the direction of innovation in development of renewables.

The transportation sector accounts for just under a third of global final energy demand. Two-thirds of transport-related emissions are attributable to road transport fueled primarily by fossil fuels. Improvements in vehicle design and efficiency, introduction of alternative low-carbon fuels and electricity can substantially reduce transportation sector emissions. A standout example of technological innovation in the transportation sector is the Google driverless car. It is estimated that driverless autonomous cars when used on a wide scale as cabs have the potential to reduce emissions per mile by 94 percent than a conventional gasoline car of today. Similarly, vehicles powered by electricity reduce final energy use by more than a factor of three, as compared to gasoline-powered vehicles. IEA estimates the total cost of low-carbon transport investments from 2010-2030 is approximately $3.8 trillion, whereas between 2030-2050 the incremental need increases to $12 trillion.

Improvements in energy efficiency of buildings can lead to a reduction in heating and cooling energy requirements by half and in some projections by even 90%. LED lighting and energy efficiency both in generation and use all hold the promise of a major transformation. Such investments are projected to contribute to a 3 percent reduction in global emissions in the residential buildings sector alone. According to IEA, the estimated cost of low-carbon investments in the buildings sector (residential and commercial) is $3 trillion between 2010-2030.

Technological innovation can unlock a virtuous cycle of action to transition to a low-carbon economy that can meet the aspirations on both development and elimination of poverty as well as manage the risks of climate change. Developing better networks such as smart grids, and capturing other co-benefits such as clean air and healthy eco-systems will help speed up the process of innovation. There have also been tremendous strides in improving management practices that contribute to greater deployment of clean technologies. A part of this virtuous cycle of innovation is demonstrated in Figure 42. As countries and firms invest more in developing clean energy sources, their cost falls at a high rate, helping investors embark on low-carbon pathways.

**Figure 42 Technology improvement enables greater emissions reductions**




*Source: Trancik et al. 2015*

For innovation and uptake of technologies to speed up, a few important challenges will have to be confronted. These are,

- First, market failures such as the availability of information will need to be corrected. Emerging economies in particular can benefit from reduced cost of acquiring the expertise for deployment of clean energy technologies if knowledge-sharing is encouraged. While there is precedent of international cooperation on energy efficiency standards (for example, IPEEC, SE4ALL and CEM initiatives), knowledge-sharing efforts that support private sector in developing clean energy need to be strengthened.
- Second, reduction of upfront costs will be essential in incentivizing early high-risk research, as well as in the building of infrastructure in both advanced economies but also in countries like China and Turkey that can benefit all countries. Better public support, public-private initiatives, and enhanced international cooperation can help accelerate these and other innovations. Promising efforts include the recently unveiled "Mission Innovation" initiative started by nineteen governments that commits them to a doubling of public investments in basic energy research over the next five years. In the private sector, the "Breakthrough Energy Coalition" led by Bill Gates brings together 28 major investors from 10 countries with a collective net worth of more than $350 billion. This initiative will provide capital for research on high-risk but most promising clean energy technologies.
- Third, for a wider uptake of renewables, investments in system-level innovative technologies are crucial, in particular investments that help reduce variability of renewables and increase flexibility of power systems.
- Fourth, alignment of price incentives is crucial for encouraging innovation. Implicit and explicit fossil fuel subsidies make it harder for clean energy to be competitive. Recently renewed attention to fossil fuel subsidies and reforms currently being considered in a number of countries should be encouraged.

It will be important to set out a concrete action plan beyond Paris that can lay the basis for actions country-by-country supported by a strong platform of international cooperation on policy improvements and capacity building, technology and innovation and on strengthening the financing framework.

## *References*


Agenor, Pierre-Richard. (2012). *Public Capital, Growth and Welfare: Analytical Foundations for Public Policy*. Princeton University Press.

Agenor, Pierre-Richard, & Canuto, Otaviano. (2015). Gender Equality and Economic Growth in Brazil: A Long-run Analysis. *Journal of Macroeconomics*, 43: 155-172.

Ahmad, Ehtisham. (2015). Public Finance Underpinnings for Infrastructure Financing in Developing Countries. *Infrastructure Finance in the Developing World Working Paper Series*. Washington, DC: Intergovernmental Group of Twenty-Four and Global Green Growth Institute.

Alcazar, Lorena., Rogers, F. Halsey., Chaudhury, Nazmul., Hammer, Jeffrey., Kremer, Michael., & Muralidharan, Karthik. (2006). Why are Teachers Absent? Probing Service Delivery in Peruvian Primary Schools. *International Journal of Educational Research*, 45(3): 117-136.

APMG. (2016). *The APMG Public-Private Partnerships Certification Program*. A project funded by Asian Development Bank (ADB), European Bank for Reconstruction and Development (EBRD), Inter-American Development Bank (IDB), Islamic Development Bank (IsDB), Multilateral Investment Fund (MIF), World Bank Group (WBG), and Public-Private Infrastructure Advisory Facility (PPIAF). Buckinghamshire, UK: APM Group Ltd

Araya, Gonzalo, Schwartz, Jordan., & Andres, Luis. (2013). The Effects of Country Risk and Conflict on Infrastructure PPPs. *World Bank Policy Research Working Paper* 6569. Washington, DC: The World Bank Group.

Arezki, Rabah., Bolton, Patrick., Peters, Sanjay., Samama, Frederic., & Stiglitz, Joseph. (2016). From Global Savings Glut to Financing Infrastructure: The Advent of Investment Platforms. *IMF Working Paper* WP/16/18. Washington, DC: International Monetary Fund.

Arezki, Rabah & Obstfeld, Maurice. (2015). *The Price of Oil and the Price of Carbon*. Blog, December 2, 2015. Washington, DC: International Monetary Fund.http://blog-imfdirect.imf.org/2015/12/02/the-price-of-oil-and-the-price-of-carbon/.

Arlinghaus, Johanna. (2015). Impact of Carbon Prices on Indicators of Competitiveness: A Review of Empirical Findings. *OECD Environmental Working Papers* No. 87. Paris: Organisation for Economic Cooperation and Development.

Arze del Granado, Javier., Coady, David., & Gillingham, Robert. (2012). The Unequal Benefits of Fuel Subsidies: A Review of Evidence for Developing Countries. *World Development*, Vol. 40, No. 11.

ASCE. (2013). *2013 Report Card for America's Infrastructure*. Reston, VA: American Society of Civil Engineers. http://www.infrastructurereportcard.org/grades/

Aschauer, David Alan. (2000). Public Capital and Economic Growth: Issues of Quantity, Finance, and Efficiency. *Economic Development and Cultural Change*, 48(2): 391-406.

ASI. (2014). *Assessment of the Effectiveness of Project Preparation Facilities in Asia*. Adam Smith International.

B20. (2015). *B20 Infrastructure & Investment Taskforce Policy Paper*. B20 Turkey. http://b20turkey.org/policy-papers/b20turkey_infra.pdf

Baladi, Gilbert., Svasdisant, Tunwin., Van, Thomas., Buch, Neeraj., and Chatti, Karim. (2002). Cost-Effective Preventive Maintenance: Case Studies. *Transportation Research Record* 1795(02-3026): 17-26.

Banerjee, Abhijit., Cole, Shawn., Duflo, Esther., & Linden, Leigh. (2007). Remedying Education: Evidence From Randomized Experiments in India. *The Quarterly Journal of Economics* 122(3): 1235-1264.

Barro, Robert J. (2000). Inequality and Growth in a Panel of Countries. *Journal of Economic Growth* 5(1): 5-32.

Barro, Robert J. (1990). "Government Spending in a Simple Model of Endogenous Growth". *Journal of Political Economy*, 98(5), Part 2.

Batten, S., Sowerbutts R., & Tanaka M. (2016). Let's talk about the weather: the impact of climate change on central banks. *Staff Working Paper*, No. 603, Bank of England.

Ben-Amar, W., & McIlkenny, P. (2015). Board Effectiveness and the Voluntary Disclosure of Climate Change Information. *Business Strategy and the Environment*. 24, 704-719

Bhattacharya, Amar., Chattopadhyay, Soumya., & Nagrah, Aatika. (forthcoming). *Framework for Assessing the Role of Sustainable Infrastructure*. Washington DC: Brookings Institution.

Bhattacharya, Amar., & Holt, Rachel. (forthcoming). Assessing the Changing Infrastructure Needs in Emerging Markets and Developing Countries. *Working Paper*. Washington, DC: Brookings Institution.

Bhattacharya, Amar., & Holt, Rachel. (2015).*Meeting the Infrastructure Financing Challenge in Emerging Markets and Developing Countries*. Mimeo.

Bhattacharya, Amar. Oppenheim, Jeremy., & Stern, Nicholas. (2015). Driving Sustainable Development through Better Infrastructure: Key Elements of a Transformation Program. *Global Economy and Development Working Paper* No. 91. Washington, DC: Brookings Institution.

Bhattacharya, Amar. Romani, Mattia., & Stern, Nicholas. (2012). *Infrastructure for Development: Meeting the Challenge*. Centre for Climate Change Economics and Policy, Londres. www.cccep.ac.uk/Publications/Policy/docs/PP-infrastructure-for-development-meeting-the-challenge.pdf. Consultado el, vol. 15.

Bielenberg, Aaron., Kerlin, Mike., Roberts, Melissa., & Oppenheim, Jeremy. (2016). *Financing Change: Mobilizing Private Sector Financing for Sustainable Infrastructure*. McKinsey and Company.

Blackrock. (2015). *The Price of Climate Change, Global Warming's Impact on Portfolios*. Blackrock Investment Institute, p. 6.

BNEF. (2016). *Clean Energy Investment: By the Numbers – End of Year 2015*. Bloomberg New Energy Finance. http://www.bloomberg.com/company/clean-energy-investment/

BNEF. (2015). *CLIMATESCOPE 2015: The Clean Energy Country Competitiveness Index.* Bloomberg New Energy Finance. https://www.bnef.com/dataview/climatescope-2015/index.html.

Boissinot, J., Doryane, H., & Lame, G. (2015), Finance and Climate: The Transition to a Low-Carbon and Climate-Resilient Economy from a Financial Sector Perspective. *OECD Journal: Financial Market Trends*, Vol 2015/1, p. 8. Paris: Organisation for Economic Cooperation and Development.

Bom, Pedro., & Ligthart, Jenny. (2014). What Have We Learned from Three Decades of Research on the Productivity of Public Capital. *Journal of Economic Surveys* 28(5): 889-916.

Bourguignon, François. (2003). The Growth Elasticity of Poverty Reduction: Explaining Heterogeneity across Countries and Time Periods. In Eicher, Theo S., & Turnovsky, Stephen J. (eds.). *Inequality and Growth: Theory and Policy Implications*, 3-26. Cambridge, MA: MIT Press.

Brenneman, Adam, & Kerf, Michel. (2002). *Infrastructure & Poverty Linkages: A Literature Review*. Washington, DC: The World Bank Group. (http://www.ilo.org/wcmsp5/groups/public/---ed_emp/---emp_policy/---invest/documents/publication/wcms_asist_8281.pdf)

Bruck, Nicholas. (2005). Future Role of National Development Banks in the Twenty First Century. *Background Paper for Ad-Hoc Expert Group Meeting on Rethinking the Role of National Development Banks*. New York: United Nations-Department of Economic and Social Affairs. (http://www.un.org/esa/ffd/msc/ndb/ndb%20background-document.pdf)

Buckberg, Elaine, Kearney, Owen., & Stolleman, Neal. (2015). *Expanding the Market for Infrastructure Public-Private Partnerships; Alternative Risk and Profit Sharing Approaches to Align Sponsor and Investor Interests*. U.S. Department of the Treasury Office of Economic Policy White Paper, April 2015.

Burke, Marshall., Hsiang, Solomon M., & Miguel, Edward. (2015). Global Non-linear Effect of Temperature on Economic Production. *Nature*, 527: 235–239.

Calder, Jack. (2015). Administration of a Carbon Tax. In Parry, Ian., Morris, Adele., & Williams, Roberton III. (eds.). *Implementing a U.S. Carbon Tax: Challenges and Debates*. New York: Routledge.

Calderon, Cesar., & Serven, Luis. (2014). Infrastructure, Growth, and Inequality: An Overview. *World Bank Policy Research Working Paper*, No. 7034. Washington, DC: The World Bank Group.

Calderon, Cesar., & Serven, Luis. (2004). The Effects of Infrastructure Development on Growth and Income Distribution. *World Bank Policy Research Working Paper*, No. 270. Washington, DC: The World Bank Group.

Callen, Michael., & Long, James. (2015). Institutional Corruption and Election Fraud: Evidence from a Field Experiment in Afghanistan. *American Economic Review*, 105(1): 354-381.

Canfin, Pascal., & Grandjean, Alain. (2015). *Mobilizing Climate Finance a Roadmap to Finance a Low Carbon Economy*. Report of the Canfin-Grandjean Commission. http://www.elysee.fr/assets/Report-Commission-Canfin-Grandjean-ENG.pdf

Canning, David., & Bennathan, Esra. (2000). The Social Rate of Return on Infrastructure Investments. *World Bank Policy Research Working Paper*, No. 2390. Washington, DC: The World Bank Group.

Canning, David, & Pedroni, Peter. (2008). Infrastructure, Long-run Economic Growth and Causality Tests for Cointegrated Panels. *Manchester School*, 76(5): 504-527.

Carney, Mark. (2015). *Breaking the Tragedy of the Horizon – Climate Change and Financial Stability*. Speech at Lloyd's of London, 29 September, 2015.

Carrillo, Paul E., Onofa, Mercedes., & Ponce, Juan. (2011). Information Technology and Student Achievement: Evidence from a Randomized Experiment in Ecuador. *IDB Working Paper Series*, No. IDB-WP-223. Washington, DC: Inter-American Development Bank.

CBI. (2015).*Bonds and Climate Change: The State of the Market in 2015*. Climate Bond Initiative. http://www.climatebonds.net/files/files/CBI-HSBC%20report%207July%20JG01.pdf

CCFLA. (2015). *The State of City Climate Finance 2015*. Cities Climate Finance Leadership Alliance.

CDP. (2015). *Putting a Price on Risk: Carbon Pricing in the Corporate World*. Climate Disclosure Project.

CDP. (2015). *CDP Global Climate Change Report 2015*. Climate Disclosure Project.

CEA. (2016). *Economic Report of the President, 2016. Chapter 6: The Economic Benefits of Investing in U.S. Infrastructure.* Council of Economic Advisers. The White House, February 2016.

Celik, Serdar & Isaksson, Mats. (2013). Institutional Investors as Owners: Who Are They and What Do They Do? *OECD Corporate Governance Working Papers*, No. 11. Paris: OECD.

CEPA. (2012). *Assessment of Project Preparation Facilities in Africa*. Cambridge Economic Policy Associates, in collaboration with Nodalis Conseil.

Cervigni, Raffaello, Liden, Rikard., Neumann, James E., & Strzepek, Kenneth M. (Eds). (2015). *Enhancing the Climate Resilience of Africa's Infrastructure: The Power and Water Sectors*. Washington, DC: World Bank.

CFSG. (2014). *Report to the Finance Ministers*. G20 Climate Finance Study Group. September 2014

Chandrasekhar, C. P. (2007). Financial Policies. *National Development Policy Notes*. UNDESA Financing for Development Office. New York: United Nations-Department of Economic and Social Affairs. (http://esa.un.org/techcoop/documents/pn_financialpolicynote.pdf)

Chelsky, Jeff., Morel, Claire., and Kabir, Mabruk. (2013). Investment Financing in the Wake of the Crisis: The Role of Multilateral Development Banks. *PREM Network Economic Premise*, No. 121, June. Washington, DC: The World Bank Group. (http://documents.worldbank.org/curated/en/2013/06/17938866/investment-financing-wake-crisis-role-multilateral-development-banks)

Christiano, Lawrence., Eichenbaum, Martin., and Rebelo, Sergio. (2011). When is the Government Spending Multiplier Large. *Journal of Political Economy*, 119(1): 78-121.

Carney, Mark. (2015). *Breaking the Tragedy of the Horizon – climate change and financial stability*. Speech by Governor of the Bank of England at Lloyd's of London, 29 September 2015.

CBI. (2012). *Unburnable Carbon – Are the World's Financial Markets Carrying a Carbon Bubble?*. Carbon Tracker Initiative.

Chapman, Sarah., Inouye, Lauren., Smith, James., & Toriello, Carlos. (2016). Infrastructure for sustainable development: Central America renewable energy case study. IWANA.

CIF. (2015). *Climate Investment Funds: An Assessment of its Accomplishments, Transformational Impact, and Additionality in the Climate Finance Architecture*. Climate Investment Funds. CTFSCF/TFC.15/3, November 2, 2015, p. 24.

CISL. (2015). *Unhedgeable Risk: How Climate Change Sentiment Impacts Investment*. Cambridge Institute for Sustainability Leadership, University of Cambridge, UK.

Coady, David., Parry, Ian., Sears, Louis., & Shang, Baoping. (2015). How Large Are Global Energy Subsidies?. *IMF Working Paper* WP/15/105. Washington, DC: International Monetary Fund.

CPI. (2015a). *The Global Landscape of Climate Finance 2015*. San Francisco: Climate Policy Initiative. (http://climatepolicyinitiative.org/wp-content/uploads/2015/11/Global-Landscape-of-Climate-Finance-2015.pdf)

CPI. (2015b). Renewable Energy Platform for Institutional Investors (REPIN). *The Global Innovation Lab for Climate Finance.* San Francisco: Climate Policy Initiative. http://climatepolicyinitiative.org/wp-content/uploads/2015/02/Renewable-Energy-Platform-for-Institutional-Investors-REPIN-Lab-Phase-2-Analysis-Summary.pdf

CPI. (2013). *Risk Gaps*. San Francisco: Climate Policy Initiative. Available at: http://climatepolicyinitiative.org/publication/risk-gaps/

Cortina, Juan Jose., Didier, Tatiana., & Schmukler, Sergio L. (2015). How Long Do Corporates Borrow? Evidence from Capital Raising Activity. *Mimeo*.

Covington, H. and Thamotheram, R. (2014). How Should Investors Manage Climate-Change Risk?. *Rotman International Journal of Pension Management*, 7(2).

CTI. (2013). *Unburnable Carbon 2013: Wasted Capital and Stranded Assets*. Carbon Tracker Initiative, in collaboration with Grantham Research Institute, London School of Economics.

CUTS. (2012). *Government Procurement in India: Domestic Regulations and Trade Prospects*. Centre for International Trade, Economics & Environment.

CVF. (2012). *A Guide to the Cold Calculus of a Hot Planet: Climate Vulnerability Monitor*. 2nd Edition. Madrid: Climate Vulnerability Forum and DARA International.

D'Addario, Patrick. (2013). The European Bank for Reconstruction and Development's Industrial Energy Efficiency Audit Program. *Case Study*. Institute for Industrial Productivity. http://www.iipnetwork.org/EBRD-case-study.pdf2

Dardick, Hal. (2013). Chicago credit rating takes major hit. *Chicago Tribune*. http://www.chicagotribune.com/news/local/politics/chi-chicago-credit-rating-takes-major-hit-20140304-story.html

Dasgupta, Susmita., Laplante, Benoit., Meisner, Craig M., Wheeler, David., & Yan, Jianping. (2007). The Impact of Sea Level Rise on Developing Countries: A Comparative Analysis. *World Bank Policy Research Working Paper*, No. 4136. Washington, DC: The World Bank Group.

DDPP. (2015). *Pathways to Deep Decarbonization 2015 Report*. Deep Decarbonization Pathways Project, SDSN-IDDRI. Available at: http://deepdecarbonization.org/about/

de Nevers, Michele. (2013), Private Funding in Public-led Programs of the CTF: Early Experience. *Climate Investment Funds*, p. 11.

Deau, Thierry. (2011). How to Foster Investments in Long-Term Assets such as Infrastructure. *OECD Journal: Financial Market Trends*, Vol. 2011/1. 2011. Paris: OECD Publishing.

Dechezleprêtre, Antoine, Martin, Ralf. & Bassi, Samuela. (2016). Climate change policy, innovation and growth. *Policy Brief*. The Grantham Research Institute on Climate Change. http://www.lse.ac.uk/GranthamInstitute/wp-content/uploads/2016/01/Dechezlepretre-et-al-policy-brief-Jan-2016.pdf

Delgado, Christopher., Wolosin, Michael., and Purvis, Nigel. (2015). Financing Conservation and Restoration of Degraded Agricultural and Forest Landscapes in Developing Countries. *NCE Working Paper.* Available at: http://2015.newclimateeconomy.report/wp-content/uploads/2015/12/NCE-restoring-protecting-ag-forest-landscapes-increase-ag.pdf

Della Croce, Raffaele., & Gatti, Stefano. (2014). Financing Infrastructure – International Trends. *OECD Journal: Financial Market Trends*, 2014/1. Paris: OECD Publishing.

Della Croce, Raffaele., & Yermo, J. (2013). Institutional Investors and Infrastructure Financing. *OECD Working Papers on Finance, Insurance and Private Pensions*. No. 36, p. 27. Paris: OECD Publishing.

Derviş, Kemal. (2015). A Balance-Sheet Approach to Fiscal Policy. *Project Syndicate*, August 18, 2015

Devoto, Florencia., Duflo, Esther., Dupas, Pascaline., Pariente, William., & Pons, Vincent. (2011). Happiness on Tap: Piped Water Adoption in Urban Morocco. *NBER Working Paper*, No. 16933. Boston: National Bureau of Economic Research.

Dezember, Ryan. (2014). Taking a Ride on Private Equity. *The Wall Street Journal*. May, 16 2014. http://www.wsj.com/articles/SB10001424052702303851804579558191162062668

DFID. (2002). *Making Connections: Infrastructure for Poverty Reduction*. London: Department for International Development (http://www.eldis.org/vfile/upload/1/document/0708/DOC10660.pdf).

Dinan, Terry. (2015). Offsetting a Carbon Tax's Burden on Low-Income Households. In Parry, Ian., Morris, Adele., and Williams, Roberton III. (eds.). *Implementing a US Carbon Tax: Challenges and Debates*. New York: Routledge.

Dobbs, R., Pohl, H., Lin, D.Y., Mischke, J., Garemo, N., Hexter, J., Matzinger, S., Palter, R. and Nanavatty, R. (2013). Infrastructure productivity: How to save $1 trillion a year. *McKinsey Global Institute Report*. McKinsey and Company. (http://www.mckinsey.com/insights/engineering_construction/infrastructure_productivity)

Dole, Randall., Hoerling, Martin ., Perlwitz, Judith., Eischeid, Jon., Pegion, Philip., Zhang, Tao., Quan, Xiao-Wei., Xu, Taiyi., & Murray, Donald. (2011). Was There a Basis for Anticipating the 2010 Russian Heat Wave? *Geophysical Research Letters*, 38(6).

Dreibelbis, Robert., Greene, Leslie E., Freeman, Matthew C., Saboori, Shadi., Chase, Rachel P., & Rheingans, Richard. (2013). Water, Sanitation, and Primary School Attendance: A Multi-level Assessment of Determinants of Household-reported Absence in Kenya. *International Journal of Educational Development*, 33(5): 457-465.

Duggal, Vijaya G., Saltzman, Cynthia., & Klein, Lawrence R. (1999). Infrastructure and Productivity: A Nonlinear Approach. *Journal of Econometrics*, 92(1): 47-74.

Eberhard, Anton., Kolker, Joel., & Leigland, James. (2014). South Africa's Renewable Energy IPP Procurement Program: Success Factors and Lessons. PPIAF. Washington, DC: The World Bank Group.

EBRD. (2015). *Policy Issues in Infrastructure PPPs*. Paper prepared for G20 Investment and Infrastructure Working Group.

Eggertsson, Gauti. (2011). What Fiscal Policy is Effective at Zero Interest Rates. In Acemoglu, Daron., & Woodford, Michael. (eds.), *NBER Macroeconomics Annual* 2010 25: 59-112.

Ehlers, Torsten. (2014)."Understanding the Challenges for Infrastructure Finance. *BIS Working Papers*, No. 454. Basel: Bank for International Settlements. Available at: http://www.bis.org/publ/work454.pdf

Ekins, P., & McGlade, C. (2014). Climate science: unburnable fossil-fuel reserves. *Nature*, Vol. 517, No. 7533, p.150-152

Eliasch, J. (2008). *Climate Change: Financing Global Forests – the Eliasch Review*. Her Majesty's Government. London: The Stationery Office Limited. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/228833/9780108507632.pdf.

Ellis, Jane., Caruso, Randy., & Ockenden, Stephanie. (2013). Exploring Climate Finance Effectiveness. *Climate Change Expert Group Paper* No. 2013(4), p. 21. Paris: OECD Publishing.

Estache, Antonio., & Fay, Marianne. (2007). Current Debates on Infrastructure Policy. *World Bank Policy Research Working Paper*, No. 4410. Washington, DC: The World Bank Group.

Estache, Antonio., Wodon, Quentin., & Lomas, Kathryn. (2014). *Infrastructure and Poverty in Sub-Saharan Africa*. New York: Palgrave Macmillan.

EC. 2014. Infrastructure in the EU: Developments and Impact on Growth. *European Economy: Occasional Papers*, No. 203. European Commission (EC). (http://ec.europa.eu/economy_finance/publications/occasional_paper/2014/pdf/ocp203_en.pdf)

Falconer, A., Parker, C., Kennlyside, P., Dontenville, A. & Wilkinson, J. (2015). *Three Tools to Unlock Finance for Land-Use Mitigation and Adaptation*. Climate Policy Initiative and Climate Focus.

Farid, Mai, Michael Keen, Michael Papaioannou, Ian Parry, Catherine Pattillo, Anna Ter-Martirosyan, and other IMF staff. (2016). "After Paris: Fiscal, Macroeconomic, and Financial Implications of Climate Change". *IMF Staff Discussion Note* SDN/16/01.Washington, DC: International Monetary Fund.

FAO. (2015). *Water uses dataset*. Rome: Food and Agriculture Organization of the United Nations. Available at: http://www.fao.org/nr/water/aquastat/water_use/index.stm#tables

FAO. (2011). *The State of the World's Land and Water Resources for Food and Agriculture-Managing Systems at Risk (SOLAW)*. Rome: Food and Agriculture Organization of the United Nations. Available at: http://www.fao.org/nr/solaw/.

Fay, Marianne., Leipziger, Danny., Wodon, Quentin., & Yepes, Tito. (2005). Achieving Child-health-related Millennium Development Goals: The Role of Infrastructure. *World Development*, 33(8): 1267-1284.

Ferree, Karen., Gibson, Clark., Jung, Danielle F., Long, James D., and McIntosh, Craig. (2015). Using Technology to Promote Participation in Emerging Democracies: VIP: Voice and the 2014 South African Election. Paper presented at *Trade and Development Workshop Series*, Institute for International Economic Policy, George Washington University, October 27. (http://scholar.princeton.edu/sites/default/files/ictandgov/files/paper_panel_2_mcintosh.pdf).

Fernald, John G. (1999). Roads to Prosperity? Assessing the Link between Public Capital and Productivity. *American Economic Review*, 89(3): 619-638.

Fischer, Carolyn., Morgenstern, Richard., & Richardson, Nathan. (2015). Carbon Taxes and Energy-Intensive, Trade-Exposed Industries: Impacts and Options. In Parry, Ian., Morris, Adele., & Williams, Roberton III. (eds.), *Implementing a U.S. Carbon Tax: Challenges and Debates*. New York: Routledge.

Fischer, Stanley. (2015). What Have We Learned from the Crises of the Last 20 Years?. Remarks at the *International Monetary Conference*, Toronto, Ontario, June 1.

Flues, Florens., & Thomas, Alastair. (2015). The Distributional Effects of Energy Taxes. *OECD Taxation Working Papers* No. 23. Paris: OECD.

Foster, Vivien., & Briceño-Garmendia, Cecilia (Eds). (2009). *Africa's Infrastructure: A Time for Transformation*. Washington, DC: The World Bank Group. (http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2009/12/10/000333037_20091210012143/Rendered/PDF/521020PUB0EPI1101Official0Use0Only1.pdf)

Frank, Jonas., & Martínez-Vázquez, Jorge. (2016). *Decentralization and Infrastructure in the Global Economy: From Gaps to Solutions.* New York: Routledge.

Frayne, Bruce., & McCordic, Cameron. (2015). Planning for Food Secure Cties: Measuring the Influence of Infrastructure and Income on Household Food Security in Southern African Cities. *Geoforum*, 65: 1-11.

Friel, S., Bowen, K., Campbell-Lendrum, D., Frumkin, H., McMichael, A.J. & Rasanathan, R. (2011). Climate Change, Noncommunicable Diseases, and Development: The Relationships and Common Policy Opportunities. *Annual Review of Public Health*, 32: 133-147.

G7. (2016). *G7 Ise-Shima Principles for Promoting Quality Infrastructure Investment*. Ise-Shima, Japan: Group of Seven. http://www.mofa.go.jp/files/000160272.pdf

G20. (2014). *Report on Infrastructure Agenda and Response to the Assessment of Project Preparation Facilities in Asia and Africa*. G20 Development Working Group. Group of Twenty.

G20. (2013). *G20 Action Plan on the Development of Local Currency Bond Markets, Implementation Report to G20 Finance Ministers and Central Bank Governors*. July 2013. Group of Twenty.

G30. (2013). *Long-Term Finance and Economic Growth*. Washington, DC: Group of Thirty.

Garcia, L. E., Matthews, J. H., Rodriguez, D. J., Wijnen, M., DiFrancesco, K. N., & Ray, P. (2014). *Beyond Downscaling - A Bottom-up Approach to Climate Adaptation for Water Resources Management*. Washington, D.C.: The World Bank Group. Retrieved from https://itunes.apple.com/us/book/beyond-downscaling/id919023357?mt=11&ign-mpt=uo%3D4

Garcia-Escribano, Mercedes, Goes, Carlos. & Karpowicz, Izabela. (2015). Filling the Gap: Infrastructure Investment in Brazil. *IMF Working Paper* WP/15/180. Washington, DC: International Monetary Fund.

Garemo, Nicklas., Hjerpe, Martin., and Mischke, Jan. (2015). The infrastructure conundrum: Improving productivity. In *Rethinking Infrastructure*. McKinsey Global Institute.

Gartner, T., McGray, H., Mulligan, J., Epstein, J., & Dinshaw. (2014). Forests as water infrastructure in a changing climate. In *Forest conservation and management in the Anthropocene: Conference proceedings* (pp. 313–327). Fort Collins, CO: US Department of Agriculture, Forest Service. Rocky Mountain Research Station.

GCEC. (2016). *The Sustainable Infrastructure Imperative: Financing For Better Growth And Development. The 2016 New Climate Economy Report.* Washington, D.C*:* The Global Commission on the Economy and Climate, The New Climate Economy. Available at: http://newclimateeconomy.report/2016/

GCEC. (2014). *Better Growth, Better Climate: The New Climate Economy report. The Synthesis Report*. New York: The Global Commission on the Economy and Climate, The New Climate Economy. Available at: http://2014.newclimateeconomy.report/

GCF. (2015a). *Fourth Report of the Green Climate Fund to the Conference of the Parties to the United Nations Framework Convention on Climate Change*. GCF/B.10/08, 26 June2015, p. 5. Green Climate Fund.

GCF. (2015b). *Detailed Programme of Work on Readiness and Preparatory Support*. GCF/B.06/15, 11 February 2015, p. 1. Green Climate Fund.

GCF. (2015c). *Analysis of the Expected Role and Impact of the Green Climate Fund*. GCF.B.09/06, 28 February 2015. Green Climate Fund.

GEF. (2016). *Catalyzing Climate-Smart Land Use for a Sustainable Future.* Washington DC: The Global Environment Facility.

Gehle, J. (2014). Spain and Italy reduce feed-in tariffs. June 26, 2014. *Sun & Wind Energy.* Available at: http://www.sunwindenergy.com/photovoltaics/spain-and-italy-reduce-feed-tariffs

Geurs, Karst T., & Van Wee, Bert. (2004). Accessibility Evaluation of Land-use and Transport Strategies: Review and Research Directions. *Journal of Transport Geography* 12(2): 127-140.

Gachiri, John. (2013). AfDB approves another Sh2.4bn for wind power. *Business Daily*. http://www.businessdailyafrica.com/AfDB-approves-another-Sh2-4bn-for-wind-power/-/539552/2017898/-/owf2w9z/-/index.html

GIH. (2016). *Global Infrastructure Hub fact sheet.* Sydney: Global Infrastructure Hub. *http://globalinfrastructurehub.org/reports/*

Gillingham, Robert, & Keen, Michael. (2012). Mitigation and Fuel Pricing in Developing Economies. In de Mooij, Ruud., Parry, Ian., & Keen, Michael (Eds.), *Fiscal Policy to Mitigate Climate Change: A Guide for Policymakers*. Washington, DC: International Monetary Fund.

Granoff, Ilmi., Eis, Jason., McFarland, Will., Hoy, Chris., Watson, Charlene., de Battista, Gaia., Marijs, Cor., Khan, Amina., & Grist, Natasha. (2015). *Zero Poverty, Zero Emissions: Eradicating Extreme Poverty in the Climate Crisis*. London: Overseas Development Institute.

Goulder, Lawrence. (2013). Climate Change Policy's Interactions with the Tax System. *Energy Economics*, 40.

Gouldson, A.P., Colenbrander, S., Sudmant, A., Godfrey, N., Millward-Hopkins, J., Fang, W. & Zhao, X. (2015). Accelerating Low Carbon Development in the World's Cities. *NCE Working Paper*.

Grigoli, Francesco & Kapsoli, Javier. (2013). Waste Not, Want Not: The Efficiency of Health Expenditure in Emerging and Developing Countries. *IMF Working Paper* 13/87. Washington, DC: International Monetary Fund.

Gupta, Sanjeev, Kangur, A. Papageorgiou, C., & Wane, A. (2014). Efficiency-Adjusted Public Capital and Growth. *World Development*, Vol. 57.

Gutman, Jeffrey., Sy, Amadou., & Chattopadhyay, Soumya. (2015). *Financing African Infrastructure: Can the World Deliver?*. Washington, DC: The Brookings Institution. (http://www.brookings.edu/~/media/Research/Files/Reports/2015/03/financing-african-infrastructure-gutman-sy-chattopadhyay/AGIFinancingAfricanInfrastructure_FinalWebv2.pdf)

Guyatt, D.J., Ambachtsheer, J. & Bourqui, E. (2012). Thinking Strategically About Climate Change: Risks and Opportunities. *Rotman International Journal of Pension Management*, 5(1), p.58.

Haines, Andy., Kovats, R. Sari., Campbell-Lendrum, Diarmid., & Corvalán, Carlos. (2006). Climate Change and Human Health: Impacts, Vulnerability and Public Health. *Public Health*, 120(7): 585-596.

Hallegatte, Stephane., Green, Colin., Nicholls, Robert J., & Corfee-Morlot, Jan. (2013). Future flood losses in major coastal cities. *Nature Climate Change* 3, no. 9, 802-806.

Hanson, C., Talberth, J., & Yonavjak, L. (2011). Forests for water: exploring payments for watershed services in the U.S. South. *Southern Forests for the Future Incentives Series*, Issue Brief 2. Washington, DC: World Resources Institute. Retrieved from http://www.wri.org/sites/default/files/pdf/forests_for_water.pdf

Haugh, D., Ollivaud, P., & Turner, D. (2009). What Drives Sovereign Risk Premiums?: An Analysis of Recent Evidence from the Euro Area. *OECD Economics Department Working Papers*, No 718. Paris: OECD.

Heggie, Ian Graeme., & Vickers, Piers. (1998). Commercial Management and Financing of Roads. *World Bank Technical Papers*, No. 409. Washington, DC: The World Bank Group.

HSBC. (2014). "Sizing energy efficiency investment". HSBC Global Research.

Hsiang, Solomon M., Burke, Marshall., Miguel, Edward. (2013). Quantifying the Influence of Climate on Human Conflict. *Science*, 341(6151): 1235367.

Hulten, Charles R. (1996). Infrastructure Capital and Economic Growth: How Well You Use It May Be More Important Than How Much You Have. *NBER Working Paper*, No. 5847. Boston: National Bureau of Economic Research.

Hulten, Charles., & Schwab, Robert M. (2000). Does Infrastructure Investment Increase the Productivity of Manufacturing Industry in the US? In Lau, Lawrence J. (Ed.). *Econometrics and the Cost of Capital*. Cambridge, MA: MIT Press.

Humphrey, Chris. (2015). Challenges and Opportunities for Multilateral Development Banks in 21st Century Infrastructure Finance. *Infrastructure Finance in the Developing World Working Paper Series*. Washington, DC: Intergovernmental Group of Twenty-Four on Monetary Affairs Development, and Global Green Growth Institute.

IBRD. (2015). *Financial Statement, September 30, 2015*. Washington, DC: The World Bank Group

ICA. (2013). *Infrastructure Financing Trends in Africa – 2013*. Tunis: The Infrastructure Consortium for Africa (http://www.icafrica.org/fileadmin/documents/Annual_Reports/ICA-Infra-Fin-Trends-Africa-2013-Final-WEB.pdf)

IEA. (2015a). *Key World Energy Statistics 2015*. OECD/IEA. Paris: International Energy Agency.

IEA. (2015b). *Energy Technology Perspectives 2015: Mobilizing Innovation to Accelerate Climate Action*. OECD/IEA. Paris: International Energy Agency.

IEA. (2015c). *Energy and Climate Change, World Energy Outlook Special Report*. p. 105. Paris: International Energy Agency.

IEA. (2014). *World Energy Investment Outlook Special Report.* OECD/IEA. Paris: International Energy Agency.

IEA. (2012). *Energy Technology Perspectives 2012: Pathways to a Clean Energy System*. Paris: International Energy Agency.

IEA. (2011). *World Energy Outlook 2011*. Paris: International Energy Agency.

IFC. (2013). *Mobilizing Public and Private Funds for Inclusive Green Growth Investment in Developing Countries*. International Finance Corporation. p. 37.

ILO. (2011). *A Review of Global Fiscal Stimulus*. Geneva: International Labour Organisation.

IMF. (2015). *Making Public Investment More Efficient*. Washington, DC: International Monetary Fund. (http://www.imf.org/external/np/pp/eng/2015/061115.pdf)

IMF. (2014a). *World Economic Outlook, October 2014*. Chapter 3: Is it Time for an Infrastructure Push? The Macroeconomic Effects of Public Investment. Washington, DC: International Monetary Fund.

IMF. (2014b). Fiscal Monitor: Public Expenditure Reform, Making Difficult Choices. Washington, DC: International Monetary Fund.

IMF. (2006). Global Demographic Trends. *Finance and Development*, Vol. 43, No. 3. September. Washington, DC: International Monetary Fund. (http://www.imf.org/external/pubs/ft/fandd/2006/09/picture.htm)

IMF and OECD. (2015). *Fiscal Policy and Growth: Why, What, and How, paper prepared for G20*. Washington, DC: International Monetary Fund.

IMF and World Bank. (2015). *World Bank and IMF Launch Joint Initiative to Support Developing Countries in Strengthening Tax Systems*. Press Release, July 10, 2015. Washington, DC: International Monetary Fund. http://www.imf.org/external/np/sec/pr/2015/pr15330.htm.

Inderst, Georg. (2016). Infrastructure Investment, Private Finance, and Institutional Investors: Asia from a Global Perspective. *ADBI Working Paper Series*, No. 555, January. Manila: Asian Development Bank Institute

Inderst, Georg. (2010). Infrastructure as an Asset Class. *European Investment Bank Papers*, Vol 15, No. 1.

Inderst, Georg., Stewart, Fiona. (2014). *Institutional Investment in Infrastructure in Emerging Markets and Developing Economies.* PPIAF.Washington, DC: The World Bank Group.

IPCC. (2014). *Summary for Policymakers. In Climate Change 2014: Mitigation of Climate Change*. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Edenhofer, O., Pichs-Madruga, R., Sokona, Y., Farahani, E., Kadner, S., et al. (Eds.). Cambridge University Press, Cambridge, UK, and New York. 2014. Available at: http://www.mitigation2014.org.

Kaminker, C., Kawanishi, O., Stewart, F., Caldecott, B. and Howarth, N. (2013). Institutional investors and green infrastructure investments: selected case studies. *OECD Working Papers on Finance, Insurance and Private Pensions*, (35), p.1. Paris: OECD Publishing.

Kato, T., Ellis, J. & Clapp, C. (2014). The Role of the 2015 Agreement in Mobilising Climate Finance. *Climate Change Expert Group*, Paper No. 2014(7). Paris: OECD Publishing.

Khandker, Shahidur R., & Koolwal, Gayatri B. (2010). How Iinfrastructure and Financial Institutions Affect Rural Income and Poverty: Evidence from Bangladesh. *Journal of Development Studies*, 46(6): 1109-1137.

Kharas, Homi., & Gertz, Geoffrey. (2010).The New Global Middle Class: A Cross-Over from West to East. *Brookings Working Paper*. Washington, DC: Brookings Institution. (http://www.brookings.edu/~/media/research/files/papers/2010/3/china%20middle%20class%20kharas/03_china_middle_class_kharas.pdf)

Kochhar, M.K., Pattillo, M.C.A., Sun, M.Y., Suphaphiphat, M.N., Swiston, A., Tchaidze, M.R., Clements, M.B.J., Fabrizio, M.S., Flamini, V., Redifer, M.L. & Finger, M.H. (2015). Is the Glass Half Empty Or Half Full?: Issues in Managing Water Challenges and Policy Instruments. *IMF Staff Discussion Note* SDN/15/11. Washington, DC: International Monetary Fund.

Kortekass, Brendon. (2015). Infrastructure Pipeline and Need for Robust Project Preparation. *Infrastructure Finance in the Developing World Working Paper Series*. The Intergovernmental Group of Twenty-Four on International Monetary Affairs and Development (G-24 Secretariat), Washington, DC. (http://g24.org/wp-content/uploads/2015/06/MARGGK-WP04.pdf)

Lagarde, Christine. (2015). The Right Price for Preserving Our Climate. *Project Syndicate*, November 30, 2015.

Layard, Richard. (2015). To Find the Energy to Save the Earth, Shoot for the Moon. *Project Syndicate*, November 16, 2015.

Ledec, G., & Quintero, J. D. (2003). Good Dams and Bad Dams: Environmental Criteria for Site Selection of Hydroelectric Projects. *Sustainable Development Working Paper* 16. Washington, DC: The World Bank Group.

Leduc, Sylvain., & Wilson, Daniel. (2012). Roads to Prosperity or Bridges to Nowhere? Theory and Evidence on the Impact of Public Infrastructure Investment. *NBER Macroeconomics Annual* 27(1): 89-142.

Leipziger, David., & Lefevre, Benoit. (forthcoming). Overcoming Barriers to Private Investment in Low-Carbon Transport: Cases from Brazil. WRI/EMBARQ.

León, Gianmarco., & Valdivia, Martín. (2015). Inequality in school resources and academic achievement: Evidence from Peru. *International Journal of Educational Development*, 40: 71-84.

Luna-Martínez, José de., & Vicente, Carlos Leonardo. (2012). Global Survey of Development Banks. *World Bank Policy Research Working Paper*, No. 5969. Washington, DC: The World Bank Group. (http://elibrary.worldbank.org/doi/pdf/10.1596/1813-9450-5969)

Marcelo, Darwin., House, Schuyler., Mandri-Perrot, Cledan ., & Schwartz, Jordan. (2015). *Prioritization of Infrastructure Projects: A Decision Support Framework*. World Bank PPP Group, Working Paper for G20 Investment and Infrastructure Working Group. Washington, DC: The World Bank Group.

McAdam, Jane. (2011). Swimming Against The Tide: Why a Climate Change Displacement Treaty is not the Answer. *International Journal of Refugee Law*. Eeq045.

McCright, A. M., Xiao, C., & Dunlap, R. E. (2014). Political polarization on support for government spending on environmental protection in the USA, 1974–2012. *Social Science Research*, 48, 251-260.

McKibbin, Warwick., Morris, Adele., & Wilcoxen, Peter. (2015). Pricing Carbon. In *COP21 at Paris: What to Expect*. Washington, DC: Brookings Institution. http://www.brookings.edu/research/reports2/2015/11/17-paris-climate-talks.

McKinsey Global Institute. (2016). *Bridging global infrastructure gaps.* In collaboration with Mckinsey's Capital Projects and Infrastructure Practice. McKinsey & Company.

McKinsey Global Institute. (2013). *Infrastructure Productivity: How to Save $1 Trillion a Year*. McKinsey & Company.

MDBs (AfDB, AsDB, EBRD, IDB, IsDB & WBG). (2016). *PPP Knowledge Lab*. African Development Bank, Asian Development Bank, European Bank for Reconstruction and Development, Inter-American Development Bank Group, Islamic Development Bank, & World Bank Group.

MDBs (AsDB, EBRD, IDB & WBG). (2015a). *MDB Presentation on Evaluating Readiness and Capacity for Infrastructure Public Private Partnerships: INFRASCOPE*. Prepared in collaboration with Economist Intelligence Unit, G20 Summit, Antalya, November 2015. Asian Development Bank, European Bank for Reconstruction and Development, Inter-American Development Bank Group, & World Bank Group.

MDBs (AfDB, AsDB, EBRD, EIB, IDB, IFAD, IsDB, WBG). (2015b). *Partnering to Build a Better World: MDBs' Common Approaches to Supporting Infrastructure Development*. Paper prepared for G20 Development Working Group. African Development Bank, Asian Development Bank, European Bank for Reconstruction and Development, European Investment Bank, Inter-American Development Bank Group, International Fund for Agricultural Development, Islamic Development Bank, & World Bank Group.

MDBs (AfDB, AsDB, EBRD, EIB, IDB & WBG). (2015c). *Joint Report on Multilateral Development Banks' Climate Finance, 2014*. African Development Bank, Asian Development Bank, European Bank for Reconstruction and Development, European Investment Bank, Inter-American Development Bank Group, & World Bank Group.

Meinzen-Dick, R. (2009). Property Rights for Poverty Reduction?. *DESA Working Paper*, No. 91. New York: United Nations-Department of Economic and Social Affairs.

Meltzer, Joshua P. (2016). *Financing Low Carbon, Climate Resilient Sustainable Infrastructure: The Role of Climate Finance and Green Financial Systems*. Washington DC: Brookings Institution.

Moody's. (2015). *Default and Recovery Rates for Project Finance Bank Loans, 1983-2013*. Moody's Investor Services. March 3, 2015.

Moors, E.J., Groot, A., Biemans, H., van Scheltinga, C.T., Siderius, C., Stoffel, M., Huggel, C., Wiltshire, A., Mathison, C., Ridley, J. & Jacob, D. (2011). Adaptation to changing water resources in the Ganges basin, northern India. *Environmental Science & Policy*, 14(7), pp.758-769.

Morris, Adele. (2015). *Why the Federal Government Should Shadow Price Carbon*. Washington, DC: Brookings Institution.http://www.brookings.edu/blogs/planetpolicy/posts/2015/07/13-carbon-footprint-governement-shadow-prive-morris

Mu, Ren., van de Walle, Dominique. (2007). Rural Roads and Poor Area Development in Vietnam. *World Bank Policy Research Working Papers*, No. 4340. Washington, DC: The World Bank Group.

Mulier, Thomas. (2014). Norway Wealth Fund Targets $3 Billion in Green Technology Stakes. *Bloomberg*. http://www.bloomberg.com/news/articles/2014-12-01/norway-wealth-fund-targets-3-billion-in-green-technology-stakes

Nakhooda, Smita., Watson, Charlene. (2015). Adaptation finance and the infrastructure agenda. London: Overseas Development Institute.

Nakhooda, S., Fransen, T., Kuramochi, T., Caravani, A., Prizzon, A., Shimizu, N., Tilley, H., Halimanjaya, A. & Welham, B. (2013). *Mobilising international climate finance: Lessons from the fast-start finance period*. ODI, WRI and Institute of Global Environmental Strategies, & Open Climate Network. p.23

Narayan, Deepa. (1999). Bonds and Bridges: Social Capital and Poverty. *World Bank Policy Research Working Papers*, No. 9794. Washington, DC: The World Bank Group.

NTDPC. (2016). *India Transport Report: Moving India to 2032.* National Transport Development Policy Committee. New Delhi, India: Routledge.

Null, S.E., Medellín-Azuara, J., Escriva-Bou, A., Lent, M. & Lund, J.R. (2014). Optimizing the dammed: Water supply losses and fish habitat gains from dam removal in California. *Journal of environmental management*, 136, pp.121-131.

OECD. (2016). *DAC Members List*. Available at: http://www.oecd.org/dac/dacmembers.htm.

OECD. (2015a). *Towards a Framework for the Governance of Public Infrastructure*. OECD Report to G20 Finance Ministers and Central Bank Governors. Paris: OECD.

OECD. (2015b). *G20/OECD Report on Investment Strategies.* Rreport prepared for G20 Finance Ministers and Central Bank Governors. Paris: OECD.

OECD. (2015c). Size of Public Procurement. In *Government at a Glance 2015*. Paris: OECD.

OECD. (2015d). *Smart Procurement: Going Green – Better Practices for Green Procurement*. GOV/PGC/ETH(2014)1/REV1. Paris: OECD.

OECD. (2015e). *Taxing Energy Use: OECD and Selected Partner Countries*. Paris: OECD.

OECD. (2015f). *Mapping of Instruments and Incentives for Infrastructure Financing: A Taxonomy.* OECD Report to G20 Finance Ministers and Central Bank Governors, September 2015. Paris: OECD.

OECD. (2015g). *Effective Approaches to Support Implementation of the G20/OECD High-Level Principles on Long-Term Investment Financing by Institutional Investors*. Report to G20, November 2015. Paris: OECD.

OECD. (2015h). *Mapping Channels to Mobilize Institutional Investment in Sustainable Energy.* Paris: OECD.

OECD. (2015-2). Climate Finance in 2013-15 and the USD 100 billion goal. *Report by OECD in collaboration with CPI*, p. 10. Paris: OECD.

OECD. (2014a). *Infrastructure to 2030: Mapping Policy for Electricity, Water and Transport*. Paris: OECD.

OECD. (2014). *Pooling of Institutional Investors Capital – Selected Case Studies in Unlisted Equity Infrastructure*. Paris: OECD. OECD. (2014). *Private Financing and Government Support to Promote Long-Term Investments in Infrastructure*. P. 36. Paris: OECD.

OECD. (2014). *Report on Effective Approaches to Support Implementation of the G20/OECD High-Level Principles on Long-Term Investment Financing by Institutional Investors*. P.30. Paris: OECD.

OECD. (2014). *OECD Science, Technology and Industry Outlook 2014*. Paris: OECD.

OECD. (2013). What do we know about Multilateral Aid: The 54 billion dollar question. *OECD Policy Brief*. Paris: OECD. (http://www.oecd.org/development/financing-sustainable-development/13_03_18%20Policy%20Briefing%20on%20Multilateral%20Aid.pdf)

OECD. (2013*). Long-Term Investors and Green Infrastructure: Policy Highlights*. Paris: OECD. http://www.oecd.org/env/cc/Investors%20in%20Green%20Infrastructure%20brochure%20(f)%20[lr].pdf

OECD. (2012). *Strategic Transport Infrastructure Needs to 2030*. International Futures Programme. Paris: OECD.

OECD. (2008). *Is it ODA?*. Paris: OECD. Available at: http://www.oecd.org/dac/stats/34086975.pdf

OECD. (2006). *Infrastructure to 2030: Telecom, Land transport, Water and Electricity*. Paris: OECD

OECD, IEA, NEA, and ITF. (2015). *Aligning Policies for a Low-Carbon Economy.* Organisation for Economic Co-operation and Development, International Energy Agency, Nuclear Energy Agency and The International Transport Forum. Paris: OECD.

OECD and World Bank. (2015a). *The FASTER Principles for Successful Carbon Pricing: An Approach Based on Initial Experience*. Paris: OECD.

OECD and World Bank. (2015b). *Stock-Taking of Selected Policy Indicators on the Enabling Environment for Infrastructure Investment*. Paper prepared for G20 Development Working Group.

OECD and World Bank. (2015c). *Project Checklist for Public-Private Partnerships*. Paper prepared for G20 Investment and Infrastructure Working Group.

Ogutu, Sylvester Ochieng., Okello, Julius Jum., & Otieno, David Jakinda. (2014). "Impact of Information and Communication Technology-based Market Information Services on Smallholder Farm Input Use and Productivity: The Case of Kenya". *World Development*, 64: 311-321.

Ozment, S., DiFrancesco, K., & Gartner, T. (2015). *The Role of Natural Infrastructure in the Water, Energy and Food Nexus*. Gland, Switzerland: International Union for Conservation of Nature.

Pachauri, Shonali., van Ruijven, Bas J., Nagai, Yu ., Riahi, Keywan., van Vuuren, Detlef P., Brew-Hammond, Abeeku., & Nakicenovic, Nebojsa. (2013). Pathways to Achieve Universal Household Access to Modern Energy by 2030. *Environmental Research Letters*, 8(2): 024015.

Pandit, Arka., Minné, Elizabeth A., Li, Feng., Brown, Hillary., Jeong, Hyunju., James, Jean-Ann C., Newell, Joshua P., et al. (2015). Infrastructure Ecology: An Evolving Paradigm for Sustainable Urban Development. *Journal of Cleaner Production*.

Parham, Paul Edward., & Michael, Edwin. (2010). Modeling the Effects of Weather and Climate Change on Malaria Transmission. *Environmental Health Perspectives*, 118(5): 620.

Parker, C., Cranford, M., Oakes, N., & Leggett, M. ed. (2012). *The Little Biodiversity Finance Book*. Global Canopy Programme. Oxford. Available at: http://www.globalcanopy.org/sites/default/files/LittleBiodiversityFinanceBook_3rd%20edition.pdf.

Parry, Ian. (2015). The Right Price. *Finance and Development*, December 2015, Vol. 52, No. 4.

Parry, Ian., Veung, Chandara., & Heine, Dirk. (2014). How Much Carbon Pricing is in Countries' Own Interest? The Critical Role of Co-Benefits. *IMF Working Paper* 14/174. Washington, DC: International Monetary Fund.

Perera, Oshani., Uzsoki, David., & Silva, Mariana Hug. (2015). *Ideas and Solutions to Address the USD 50 Trillion Infrastructure Deficit*. International Institute for Sustainable Development.

Pereira, Luis Santos, Oweis, Theib., & Zairi, Abdelaziz. (2002). Irrigation Management Under Water Scarcity. *Agricultural Water Management*, 57(3): 175-206.

Pfeiffer, A., Millar, R., Hepburn, C., & Beinhocker, E. (2016). The '2 C capital stock'for electricity generation: Committed cumulative carbon emissions from the electricity generation sector and the transition to a green economy. *Applied Energy*.

Pisani-Ferry, Jean. (2015). Why Finance Can Save the Planet. *Project Syndicate*, September 29, 1025.

Pouliquen, Louis. (2000). Poverty and Infrastructure. *World Development Report 2001 Background Paper*, No. 27911. Washington, DC: The World Bank Group.

PPIAF. (2014). *South Africa's Renewable Energy IPP Procurement Program: Success Factors and Lessons*. PPIAF. http://www.gsb.uct.ac.za/files/PPIAFReport.pdf

Preqin. (2015). *Preqin Global Database*. https://www.preqin.com/

Preqin. (2015). *2015 Preqin Global Private Equity & Venture Capital Report*. (https://www.preqin.com/docs/reports/2015-Preqin-Global-Private-Equity-and-Venture-Capital-Report-Sample-Pages.pdf)

PRA. (2015). *The impact of climate change on the UK insurance sector*. London, UK: Prudential Regulation Authority.

PwC. (2015). Global Assets Under Management to Exceed $100 trillion by 2020 with nearly 50 percent Residing in North America. *PwC Press Release*, November 2015. New York: PwC. (http://www.pwc.com/us/en/press-releases/2014/pwc-global-assets-under-management.html).

Qureshi, Zia. (2016). *Meeting the Challenge of Sustainable Infrastructure: The Role of Public Policy*. Washington, DC: Brookings Institution.

Qureshi, Zia. (2016). Infrastructure for a Sustainable Future. *Project Syndicate*, February 24, 2016.

Qureshi, Zia. (2015). The Role of Public Policy in Sustainable Infrastructure. In *COP21 at Paris: What to Expect*. Washington, DC: Brookings Institution, http://www.brookings.edu/research/reports2/2015/11/17-paris-climate-talks.

Reed, Stanley. (2014).Norway's Sovereign Wealth Fund Ramps Up Investment Plans. *New York Times*. http://dealbook.nytimes.com/2014/06/24/norways-sovereign-wealth-fund-ramps-up-investment-plans/?_r=0

Rodriguez, Camila., Gallego, Juan Miguel., Martinez, Daniel., Montoya, Sergio., & Peralta-Quiros, Tatiana. (2015). Examining the Implementation and Labor Market Outcomes of Targeted Transit Subsidies: SISBEN Subsidy for Bogota's Urban Poor. *Transportation Research Record Paper*, 16-4349. Washington, DC: The World Bank Group.

Rönnbäck, P. (1999). The ecological basis for economic value of seafood production supported by mangrove ecosystems. *Ecological Economics*, 29(2), 235–252.

Röller, Lars-Hendrik., & Waverman, Leonard. (2001). Telecommunications Infrastructure and Economic Development: A Simultaneous Approach. *American Economic Review*, 91: 909–23.

Romp, Ward E., & De Haan, Jakob. (2005). Public Capital and Economic Growth: A Critical Survey. *EIB Papers*, 10(1): 41-70.

Roumeliotis, Greg. (2010). Analysis: Basel III rules could spell potholes, literally. *Reuters*. http://www.reuters.com/article/2011/04/19/us-basel-infrastructure-idUSTRE73I3VP20110419

Rutberg, L. (2013). "In the Northwest, innovative projects use trees to cool streams". *High Country News, February 13, 2013*. Retrieved from http://www.hcn.org/issues/45.2/in-the-northwest-innovative-projects-use-trees-to-cool-streams

Rydge, James. (2015).Implementing Effective Carbon Pricing. *New Climate Economy Working Paper.*

Sahoo, Anshuman, Nelson, David., & Goggins, Andrew. (2015). Models for Financing Clean Infrastructure in Middle Income Countries. *CPI Working Paper*. Washington DC: Climate Policy Initiative

SAI. (2012). R800m for South Africa's Green Fund. *South Africa Info*. May 3, 2012, http://www.southafrica.info/about/sustainable/green-fund-030512.htm#.Vnl4iV8o7cs

Schwab, Klaus., & Sala-i-Martín, Xavier. (eds.). (2015). *The Global Competitiveness Report, 2015-2016*. World Economic Forum.

SEC. (2010). *Guidance Regarding Disclosure Related to Climate Change*. Securities and Exchange Commission. February 8, 2010.

Shah, Tushaar., Verma, Shilp., Durga, Neha. (2015). Solar Power as Remunerative Crop (SPaRC): Exploring Alternative Architectures for India's Future Solar Economy. Rome, Italy: FAO HQ.

Siderius, C., Boonstra, H., Munaswamy, V., Ramana, C., Kabat, P., van Ierland, E., & Hellegers, P. (2015). Climate-smart Tank Irrigation: A Multi-year Analysis of Improved Conjunctive Water Use under High Rainfall Variability. *Agricultural Water Management*, 148: 52-62.

SIF. (2016). The International Infrastructure Support System (IISS). A joint project supported by African Development Bank, Asian Development Bank, O Banco Nacional de Desenvolvimento Econômico e Social, Development Bank of Southern Africa, European Bank for Reconstruction and Development, Inter-American Development Bank, and World Bank Group. Genève: Sustainable Infrastructure Foundation (SIF).

Smith, Stephen., & Braathen, Nils. (2015). Monetary Carbon Values in Policy Appraisal: An Overview of Current Practice and Key Issues. *OECD Environment Working Papers*, No. 92. Paris: OECD.

Sommer, T., Harrell, B., Nobriga, M., Brown, R., Moyle, P., Kimmerer, W., & Schemel, L. (2001). California's Yolo Bypass: Evidence that flood control can be compatible with fisheries, wetlands, wildlife, and agriculture. Fisheries, 26(8), 6–16.

Song, Shunfeng. (1996). Some Tests of Alternative Accessibility Measures: A Population Density Approach. *Land Economics*, 72(4): 474-482.

Standard and Poor's. (2015). "Global Infrastructure Investment: Timing is Everything (And Now is the Time). *Economic Research*, January 13, 2015.

Stern, Nicholas. (2016). *Climate Change and Central Banks.* Presentation at BIS Shanghai meeting, 29th February 2016.

Stern, Nicholas. (2015). *Why are we waiting? The logic, urgency, and promise of tackling climate change*. Cambridge, MA: MIT Press.

Stern, Nicholas., & Zenghelis, Dimitri. (2016). *The importance of looking forward to manage risks: submission to the Task Force on Climate-Related Financial Disclosures*. ESRC Centre for Climate Change Economics and Policy, and Grantham Research Institute on Climate Change and the Environment, London School of Economics and Political Science.

Studart, Rogerio., & Gallagher, Kevin P. (2016). Infrastructure for Sustainable Development: The Role of National Development Banks. *GEGI Policy Brief 007*, 10/2016. Global Economic Governance Initiative. Boston: Boston University.

TNC. (2012a). *Water Funds Business Case : Conservation as a Source of Competitive Advantage*. The Nature Conservancy .

TNC. (2012b). *Water funds - conserving green infrastrcuture*. The Nature Conservancy (TNC). Retrieved from http://www.nature.org/media/freshwater/latin-america-water-funds.pdf

TNC, China Three Gorges Corporation, Goldman Sachs Group, & et al. (2011). *Yangtze River Sustainable Hydropower*. The Nature Conservancy . Retrieved from http://www.greatriverspartnership.org/SiteCollectionDocuments/HydropowerProposal-Yangtze.pdf

Torvik, Ragnar. (2001). Learning by Doing and the Dutch Disease. *European Economic Review*, 45(2): 285-306.

Trancik, J., Brown, P., Jean, J., Kavlak, G., Klemun, M., Edwards, M., McNerney, J., Miotti, M., Mueller, J., Needell, Z., Qi, Y., Lu, J., Zhao, X., Wu, T. (2015). *Technology improvement and emissions reductions as mutually reinforcing efforts: Observations from the global development of solar and wind energy*. Massachusetts Institute of Technology. Available at: http://mitei.mit.edu/news/report-technology-improvement-and-emissions-reductions-mutually-reinforcing-efforts

UNCCD. (2012). *Desertification Land Degradation & Drought (Dldd) - Some Global Facts & Figures*. United Nations Convention to Combat Desertification. Available at: http://www.unccd.int/en/programmes/Event-and-

UNDESA. (2014). World Urbanization Prospects: The 2014 Revision. *Custom data acquired via website.* Population Division. New York: United Nations Department of Economic and Social Affairs.

UNDESA. (2006). Rethinking the Role of National Development Banks. *Background document for Ad-Hoc Expert Group Meeting on Rethinking the Role of National Development Banks*. Population Division. New York: United

Nations Department of Economic and Social Affairs. (http://www.un.org/esa/ffd/msc/ndb/NDBs-DOCUMENT-REV-E-151106.pdf)

UNDP. (1997). *World Development Report*. New York: United Nations Environment Programme.

UNEP. (2016a). *Cities and Coastal Areas*. *Factsheet.* New York: United Nations Environment Programme.

UNEP. (2016b). *The Adaptation Gap Report 2016: The adaptation finance gap.* Nairobi, Kenya: United Nations Environment Programme.

UNEP. (2015a). *The Emissions Gap Report 2015: A UNEP Synthesis Report*. New York: United Nations Environment Programme.

UNEP. (2015b). *From Disclosure to Action: The First Annual Report of the Portfolio Decarbonization Coalition*. New York: United Nations Environment Programme.

UNEP. (2015c). *The Financial System We Need: Aligning The Financial System With Sustainable Development*. p. 45. New York: United Nations Environment Programme.

UNEP. (2014). *Green Infrastructure Guide for Water Management: Ecosystem-Based Management Approaches for Water-Related Infrastructure Projects.* p. 75. New York: United Nations Environment Programme.

UNEP. (2013). *Sustainable Public Procurement: A Global Review*. Nairobi, Kenya: United Nations Environment Programme.

UNEP and BNEF. (2015). *Global Trends in Renewable Energy Investment*. Frankfurt School-UNEP Centre/BNEF. New York: United Nations Environment Programme.http://www.fs-unep-centre.org.

UNFCCC (2016). *Decisions adopted by the Conference of the Parties.* Conference of the Parties (COP) Report of the Conference of the Parties on its twenty-first session, held in Paris from 30 November to 13December 2015.

UNFCCC. (2014). Biennial Assessment and Overview of Climate Finance Flows. *UNFCCC Standing Committee on Finance*. New York. (http://unfccc.int/cooperation_and_support/financial_mechanism/standing_committee/items/8034.php)

UNFCCC. (2011). *Report of the Conference of the Parties*. On its seventeenth session, held in Durban from 28 November to 1 December 2011. UNFCCC/CP/2011/9/Add.1

UN-Habitat. (2013). *Planning and Design for Sustainable Urban Mobility: Global Report on Human Settlements 2013*. New York: The United Nations Human Settlements Programme.

Unilver. (2009). *Unilever Tea Kenya Limited Avifaunal Assessment Report*. London: Unilever Global.

USCOM. (2014). Climate Mitigation and Adaptation Actions in America's Cities: A 282-City Survey. *The United States Conference of Mayors*. http://usmayors.org/pressreleases/uploads/2014/0422-report-climatesurvey.pdf

van Vliet, Michelle TH, David Wiberg, Sylvain Leduc, and Keywan Riahi. (2016). Power-generation system vulnerability and adaptation to changes in climate and water resources. *Nature Climate Change*.

Waissbein, O., Glemarec, Y., Bayraktar, H., & Schmidt, T.S. (2013). Derisking Renewable Energy investment. A Framework to Support Policymakers in Selecting Public Instruments to Promote renewable Energy Investment in Developing Countries. New York, NY: United Nations Development Programme. www.undp.org/drei

Weber, Olaf. (2015). The Banking Sector's Contribution to Sustainable Growth–Risk Assessment, Sustainable Finance, Voluntary Initiatives and Regulations. *Sustainable Finance, Voluntary Initiatives and Regulations*.

WEF. (2016). *Accelerating Infrastructure Delivery: New Evidence from International Financial Institutions*. Geneva: World Economic Forum.

WEF. (2014). *Accelerating Infrastructure Delivery: New Evidence from International Financial Institutions*. Geneva: World Economic Forum.

Whitley, Shelagh., & van der Burg, Laurie. (2015a). "Fossil Fuel Subsidy Reform in Sub-Saharan Africa: From Rhetoric to Reality". *New Climate Economy Working Paper*.

Whitley, Shelagh and van der Burg, Laurie. (2015b). Fossil Fuel Subsidy Reform: From Rhetoric to Reality. *New Climate Economy Working Paper*.

Wilson, A. Meriwether W., Mugerauer, Robert., & Klinger, Terrie. (2015). Rethinking marine infrastructure policy and practice: Insights from three large-scale marina developments in Seattle. *Marine Policy,* 53 67-82.

World Bank. (2016a). *World Development Report, 2016: Digital Dividends*. Washington, DC: The World Bank Group.

World Bank (2016b). *High and Dry: Climate Change, Water, and the Economy*. Washington, DC: The World Bank Group

World Bank. (2015a). Transformation Through Infrastructure. *Infrastructure Strategy Update, FY2012-15*. Washington, DC: The World Bank Group.

World Bank. (2015b). Bangladesh: Bolstering Economic Growth to Reduce Poverty. Washington, DC: The World Bank Group. http://go.worldbank.org/ABPLPK3LB0.

World Bank. (2015c). *World Development Indicators*. October 2015. Washington, DC: The World Bank Group.

World Bank. (2015c). *Global Financial Development Report 2015/2016: Long-Term Finance*. Washington, DC: The World Bank Group.

World Bank. (2015d). From Billions to Trillions: Transforming Development Finance; Post-2015 Financing for Development - Multilateral Development Finance. *Development Committee Discussion Note*. Prepared jointly by MDBs and submitted to G20. Washington, DC: The World Bank Group.

World Bank. (2015e). *PPI Global Update, 2014*.Public Private Infrastructure Advisory Facility. Washington, DC: The World Bank Group. http://ppi.worldbank.org/~/media/GIAWB/PPI/Documents/Global-Notes/Global2014-PPI-Update.pdf

World Bank. (2015f). *Doing Business 2016: Measuring Regulatory Quality and Efficiency*. Washington, DC: The World Bank Group.

World Bank. (2015g). Global Infrastructure Facility. *Briefing Note.* Washington, DC: The World Bank Group.

World Bank. (2014). Practical Solutions and Models for Addressing Obstacles to Institutional Investment in Infrastructure in Developing Countries. *World Bank Staff for the G20 Investment and Infrastructure Working Group*. p. 6. Washington, DC: The World Bank Group.

World Bank. (2013a). *Planning and Financing Low-Carbon, Livable Cities*. Washington, DC: The World Bank Group

World Bank. (2013b). *Financing Sustainable Cities: How We're Helping Africa's Cities Raise Their Credit Ratings*. Washington, DC: The World Bank Group

World Bank. (2013a). *Planning and Financing Low-Carbon, Livable Cities*. Washington DC: The World Bank Group

World Bank. (2013b). *Financing for Development Post-2015*. Washington, DC: The World Bank Group. (https://www.worldbank.org/content/dam/Worldbank/document/Poverty%20documents/WB-PREM%20financing-for-development-pub-10-11-13web.pdf)

World Bank. (2012a). *Implementation Completion and Results Report (IBRD-72080 P060573).* http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2012/05/22/000333038_20120522232208/Rendered/PDF/ICR18120Gray0C05021020120Box369244B.pdf

World Bank. (2012b). Transformation Through Infrastructure. *World Bank Group Strategy Update, FY2012-15*. Washington, DC: The World Bank Group.http://siteresources.worldbank.org/INTINFRA/Resources/Transformationthroughinfrastructure.pdf

World Bank. (2012c). *Global Financial Development Report 2013: Rethinking the Role of the State in Finance*. Washington, DC: The World Bank Group.

World Bank. (2010a). Deep Wells and Prudence: Towards Pragmatic Action for Addressing Groundwater Overexploitation in India. Washington, DC: The World Bank Group.

World Bank. (2010). *Innovative Finance for Development Solutions: Initiatives of the World Bank Group*. Washington, DC: The World Bank Group.

World Bank. (2006). *Infrastructure at the Crossroads: Lessons from 20 years of World Bank Experience*. Washington, DC: The World Bank Group. (http://siteresources.worldbank.org/INTINFNETWORK/Resources/InfrastructureattheCrossroads.pdf)

World Bank. (1994). *World Development Report, 1994: Infrastructure for Development*. Washington, DC: The World Bank Group.

World Bank Group and ECOFYS (2015). *State and Trends of Carbon Pricing*. Washington, DC: The World Bank Group.

World Bank and PPIAF. (2016). *Benchmarking Public-Private Partnerships Procurement 2017: Assessing Government Capability to Prepare, Procure, and Manage PPPs*. Washington, DC: The World Bank Group

World Bank, Asian Development Bank, and Inter-American Development Bank. (2014). *Public-Private Partnerships Reference Guide Version 2.0*. Washington, DC: The World Bank Group.

WHO. (2015). Climate Change and Health. *Factsheet*. Geneva: World Health Organization. http://www.who.int/mediacentre/factsheets/fs266/en/

Zhang, Jing. (2012). The Impact of Water Quality on Health: Evidence from the Drinking Water Infrastructure Program in Rural China. *Journal of Health Economics*, 31(1): 122-134.

## *Notes*

[1] As defined by the World Bank World Development Indicators, October 2015 country classification.

[2] G20 projections include notable non-OECD countries such as Argentina, Brazil, China, India, Indonesia, Russia, Saudi Arabia, South Africa which have higher investment rates compared to the OECD countries.

[3] Argentina, Brazil, China, India, Indonesia, Mexico, South Africa, and Turkey.

[4] External expert interviews

[5] Interview with McKinsey infrastructure expert

[6] Expert interview with the head of asset management for a major investment bank based in South America

[7] Interview with Senior Investment Expert

[8] OECD, Mapping channels to Mobilise Institutional Investment in Sustainable Energy; McKinsey Global Institute, Infrastructure productivity: How to save $1 trillion a year; New Climate Economy report 2014; Expert interviews.

[9] "Basel III" is a comprehensive set of reform measures, developed by the Basel Committee on Banking Supervision in 2011, to strengthen the regulation, supervision, and risk management of the banking sector. "Solvency II" is an EU Directive that codifies and harmonizes EU insurance regulations with a primary focus on the amount of capital that EU insurance companies must hold to reduce the risk of solvency.

[10] OECD, Mapping channels to Mobilise Institutional Investment in Sustainable Energy; McKinsey Global Institute, Infrastructure productivity: How to save $1 trillion a year; New Climate Economy report 2014; Expert interviews.

[11] Interview with global operations professional

[12] Banks and investment Companies include: Bank, Investment Bank, Asset Manager, Wealth Manager, Family Office – Multi, Family Office – Single, Investment Trust, Investment Company.

[13] This conclusion assumes stable growth in AUM; that current investors increase allocation to infrastructure from 5.2 percent to 8 percent; and that 60 percent of institutional investors who are not investing in infrastructure began to invest at the current allocation level of 5.2 percent.

[14] Fourteen percent portfolio share for sustainable infrastructure inferred based on 34 percent of loan portfolio for climate finance and 42 percent of portfolio for infrastructure. This assumes that the share of the portfolio for climate finance is consistent across infrastructure and non-infrastructure projects.

[15] Energy efficiency sustainability premium is based on the percentage of construction costs that is required to attain a LEED platinum certification - 4.5 percent to 8.5 percent, according to a study by KEMA.