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INTEGRATED APPROACHES TO SUSTAINABLE INFRASTRUCTURE

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Table of Contents

Foreword

Infrastructure and sustainable development are completely interlinked. Approximately 70% of greenhouse gases are linked to the construction and operation of infrastructure, and buildings alone are estimated to account for more than 30% of global resource consumption and energy end use. As a result, the achievement of environmental SDGs such as climate action (Goal 13), life below water and life on land (Goals 14 and 15, respectively) is inextricably linked to present and future infrastructure assets.

At the same time, we rely upon diverse forms of infrastructure to deliver essential services and support our economies. Human well-being depends upon water and sanitation infrastructure, just as quality education and productivity depend on access to energy. Purposefully-planned urban infrastructure including smart public transportation, green and energy-efficient buildings as well as green spaces are vital to ensure that the world's fast-growing cities are in line with the 2030 Agenda.

The urgency of addressing this complex nexus is highlighted by both the projected scale of infrastructure investments and the longevity of infrastructure assets. According to the Organisation for Economic Cooperation and Development, US$6.9 trillion investment in infrastructure is required every year from now until 2030 in order to meet global development and climate objectives. The long lifespan of newly built assets means that today's decisions will have long-lasting impacts on our planet and future generations.

Against this backdrop, policy discourse on infrastructure for development has focused on a variety of angles, including the infrastructure financing gap, Nature-based Solutions, and tools for project-level assessment such as environmental and social impact assessments or the integration of sustainability considerations into cost-benefit analyses.

Building on existing work, this report analyses the discourse and tools available for making infrastructure more sustainable and identifies the need for more systems-level approaches. It raises awareness about the need to use existing solutions in a complementary way at the outset of infrastructure projects so that they yield cross-sectoral co-benefits while minimising detrimental lock-in effects for the environment.

We hope that this report will help to place integrated, upstream-level infrastructure planning at the core of global policy agendas. In addition to scaling up the application of existing tools, we also hope to spur institutional capacity building at the country level. It is only through working collaboratively across various policy levels, sectors, planning phases and jurisdictions that we can reinforce the cross-cutting nature of infrastructure systems to scale up people- and planet-centred development.

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Abbreviations and Acronyms

2030 Agenda	2030 Agenda for Sustainable Development
CAT-I	Capacity Assessment Tool for Infrastructure
CBA	Cost-benefit analysis
CO_2	Carbon dioxide
EIA	Environmental impact assessment
ESIA	Environmental and social impact assessment
GDP	Gross domestic product
GHG	Greenhouse gas
ICT	Information and communication technology
IDB	Inter-American Development Bank
IEA	International Energy Agency
ILO	International Labour Office
ITRC	UK Infrastructure Transition Research Consortium
MDB	Multilateral development bank
MDGs	Millennium Development Goals
NbS	Nature-based Solutions
NCRIP	National Climate Resilient Investment Plan of Belize
NDCs	Nationally Determined Contributions
NISMOD	National Infrastructure Systems Model
OECD	Organization for Economic Cooperation and Development
Rio+20	United Nations Conference on Sustainable Development in Rio de Janeiro
SDGs	Sustainable Development Goals
SEA	Strategic environmental assessment
UNFCCC	UN Framework Convention on Climate Change
UNOPS	United Nations Office for Project Services

Executive Summary

This paper takes stock of sustainable infrastructure initiatives and argues for more integrated approaches to sustainable infrastructure in support of the 2030 Agenda for Sustainable Development (2030 Agenda). Integrated approaches to infrastructure have the following characteristics:

1. They consider the interconnections among infrastructure systems, sectors, levels of governance, spatial scales, and the environmental, social, and economic aspects of sustainability across the entire life-cycle of infrastructure systems (i.e. early planning to decommissioning);

2. They do so as far upstream in decision-making processes as possible, when alternatives are still technically, politically and economically feasible; and

3. They incorporate stakeholder consultation and public participation from the outset, so that as wide a range of potential opportunities and challenges as possible are captured in the analysis.

In doing so, it considers diverse forms of infrastructure, including systems for energy, transport, buildings, food, water and sanitation, waste management, industrial facilities, telecommunications, and natural infrastructure such as ecosystems and landscapes, often referred to as Nature-based Solutions (NbS) (Global Commission on the Economy and Climate, 2018). It considers sustainable infrastructure to be that which is "planned, designed, constructed, operated, and decommissioned in a manner to ensure economic and financial, social, environmental (including climate resilience), and institutional sustainability over [its] entire life cycle…" (IDB, 2018b). It should be noted, however, that this definition focuses implicitly on the project level, whereas the approaches that this paper advocates place greater emphasis on infrastructure as a set of inter-connected systems. Further work on definitional issues, therefore, may be necessary.

The paper's objective is to motivate development planners to urgently invest in governments' technical and institutional capability to apply integrated approaches, to match the rapid expansion of infrastructure worldwide. To do this, it raises three points:

1. Infrastructure is central to the delivery of all the Sustainable Development Goals (SDGs). It underpins the socio-economic goals and has impacts on the environmental goals.

2. Integrated approaches will allow for the optimization of the benefits and trade-offs of infrastructure development, allowing it to contribute most effectively to the SDGs.

3. The international community must act to advance integrated approaches globally, by supporting the development of the necessary technical and institutional capacity at the local and national level, building on existing legal instruments, tools, and guidance where possible.

The links between infrastructure and global development have been recognized for at least the last 25 years. Analysis conducted by the World Bank, the Organization for Economic Cooperation and Development (OECD), the G20, and the Global Commission on the Economy and Climate, among others, has identified infrastructure as a key driver of development (World Bank, 1994; OECD, 2007; G20 Argentina 2018, n.d.; Global Commission on the

Economy and Climate, 2018), and in recent years, the focus has shifted to sustainable infrastructure. It is estimated that trillions of US dollars of annual infrastructure investments will be needed in order to reach the SDGs, and current projections fall short of the amounts required (Global Infrastructure Hub, n.d.; McKinsey Global Institute, 2017; OECD, 2018b).

Historically, analytical tools such as cost-benefit analyses (CBA), environmental impact assessments (EIA), and environmental and social impact assessments (ESIA) have been used to assess the sustainability of infrastructure projects. There has also been a proliferation of tools created specifically for assessing and rating the sustainability of infrastructure projects. However, amongst them, there is a general lack of guidance on incorporating sustainability concerns at the upstream planning phase of infrastructure development, which limits the effectiveness with which sustainability can be incorporated during later phases (IDB, 2018a). The Inter-American Development Bank Group Framework for Planning, Preparing, and Financing Sustainable Infrastructure Projects aims to close this gap by consolidating the key principles of existing tools into one set of holistic criteria that covers the entire project cycle (Ibid.), but has yet to be applied to multi-sector infrastructure planning. The Zofnass Program for Sustainable Infrastructure has developed a set of sustainable planning guidelines that, when used with the Envision rating system, is intended to support integrated approaches to planning infrastructure, mainly at the municipal-level (Zofnass Program, n.d.).

Strategic environmental assessments (SEAs) aim to integrate environmental considerations into strategic, programme-level planning and to consider their interlinkages with social and economic impacts (OECD, 2006a). However, despite their potential for informing systems-level (i.e. multi-sector) planning, SEAs are often applied only to specific infrastructure sectors, in isolation of other related sectors, which can result in missed cross-sectoral synergies. This is due to the design of planning processes and is not a reflection of SEA's potential to support more integrated planning processes (World Bank, 2011). It would be beneficial to enhance not only a more systematic but also a more holistic application of SEAs to all infrastructure development planning, as a means for preventing and mitigating their possible adverse environmental impacts early at the planning stage.

The Evidence-Based Infrastructure approach, developed by the United Nations Office for Project Services (UNOPS) and the Infrastructure Transition Research Consortium (ITRC) at the University of Oxford, is designed to account for the interconnections among infrastructure systems and environmental, social, and economic factors, and is intended for use in developing country contexts (Hall et al., 2016). Its application is supported by a suite of analytical tools, including a Capacity Assessment Tool for Infrastructure (CAT-I) and the National Infrastructure Systems Model (NISMOD), which utilizes a "system-of-systems" approach to ensure that cross-sectoral interdependencies are identified, and synergies optimized (Ibid., 2016).

These existing tools and approaches together form a complementary "tool box" that planners and policymakers can use to adopt integrated approaches to the planning and development of sustainable infrastructure that supports the 2030 Agenda.

Integrated approaches have three main advantages over "siloed" infrastructure approaches that consider infrastructure projects, systems, and sectors in isolation from others. First, they allow for optimizing infrastructure development by considering the services that infrastructure systems deliver, and not just the assets created. Second, they result in longer-lasting infrastructure that is more resilient to climate change risks and human-made/technological disasters. Third, by identifying and addressing potential risks early in the planning process they increase the bankability of infrastructure projects, making them more attractive to investors.

Adopting integrated approaches requires specialized knowledge and technical capacity to adapt and apply the available tools in diverse national contexts. It also requires particular institutional arrangements that support combined top-down and bottom-up processes. National institutions need to enable cooperation between different government ministries, while allowing for inclusive, transparent, and ongoing stakeholder consultation and public participation to feed into all phases of the infrastructure development cycle.

The paper recommends three ways that the international community can promote the use of integrated approaches to sustainable infrastructure at a system scale:

First, there is a need to make visible infrastructure's centrality to the 2030 Agenda, place integrated approaches to sustainable infrastructure on the global policy agenda as a distinctive item, to mobilize the research community in demonstrating the benefits of upstream, macro-level, integrated infrastructure planning, and to assemble and provide access to the data necessary to inform decision-making.

Second, there is a need to consolidate existing tools available for sustainable infrastructure development, analyze and address gaps where tools are lacking for integrated approaches, and provide guidance for their use in different contexts. Such an assessment would result in streamlined normative and technical guidance for using existing tools and approaches in support of different sustainable development priorities in diverse national contexts.

Third, there is a need to work together to strengthen the technical and institutional capacity of developing countries and countries with economies in transition to adopt and apply integrated approaches to sustainable infrastructure in support of the 2030 Agenda.

Introduction

Infrastructure is central to development. It underpins any economy and delivers the services that are essential to human health and well-being. Complex and diverse forms of infrastructure make up the basic physical and organizational structures needed to support development. These include systems for energy, transport, buildings, food, water and sanitation, waste management, industrial facilities, and telecommunications. This report also considers natural infrastructure – such as ecosystems and landscapes (often referred to as biological or ecological infrastructure) – to be included under this term, as well as hybrid solutions that include biological components in the design of built infrastructure (e.g. green roofs) (Global Commission on the Economy and Climate, 2018).

The worldwide drive for economic growth and development has led to an increase in the infrastructure demands of both developing and developed nations, with the gap between the global demand and supply of infrastructure growing by around US$1 trillion annually (IDB, 2018a). Meeting this demand in a sustainable manner will be key to the success of global development initiatives such as the United Nations' 2030 Agenda for Sustainable Development (2030 Agenda). This is mainly due to the long life-span of most infrastructure assets, a characteristic which produces a "lock-in" effect where the impacts of infrastructure policies and investments last for decades. Therefore, the infrastructure choices we make now will determine to a large extent how equitable, resilient and polluting society will be for future generations. To this end, it is vital that the international community grasps the current infrastructure gap as an opportunity to build sustainable infrastructure that supports global development goals.

There are many different definitions for sustainable infrastructure, but they have several key principles in common, such as socio-economic and environmental sustainability, resilience, and effective governance. Taking these into account, for the purposes of this paper sustainable infrastructure is considered to be that which is "… planned, designed, constructed, operated, and decommissioned in a manner to ensure economic and financial, social, environmental (including climate resilience), and institutional sustainability over [its] entire life cycle…" (IDB, 2018b). It should be noted, however, that this definition focuses implicitly on project level sustainability, whereas this paper promotes sustainability considerations beyond individual projects. Further definitional discussion may, therefore, be necessary.

This paper raises three points. Firstly, it shows infrastructure's centrality to the delivery of the Sustainable Development Goals (SDGs) and the 2030 Agenda. Secondly, it identifies integrated approaches as essential for enabling infrastructure to contribute holistically to the SDGs. Thirdly, it proposes ways to advance integrated approaches globally. The paper's objective is to motivate development planners to urgently invest in governments' technical and institutional capability to apply integrated approaches, to match the rapid expansion of infrastructure worldwide.

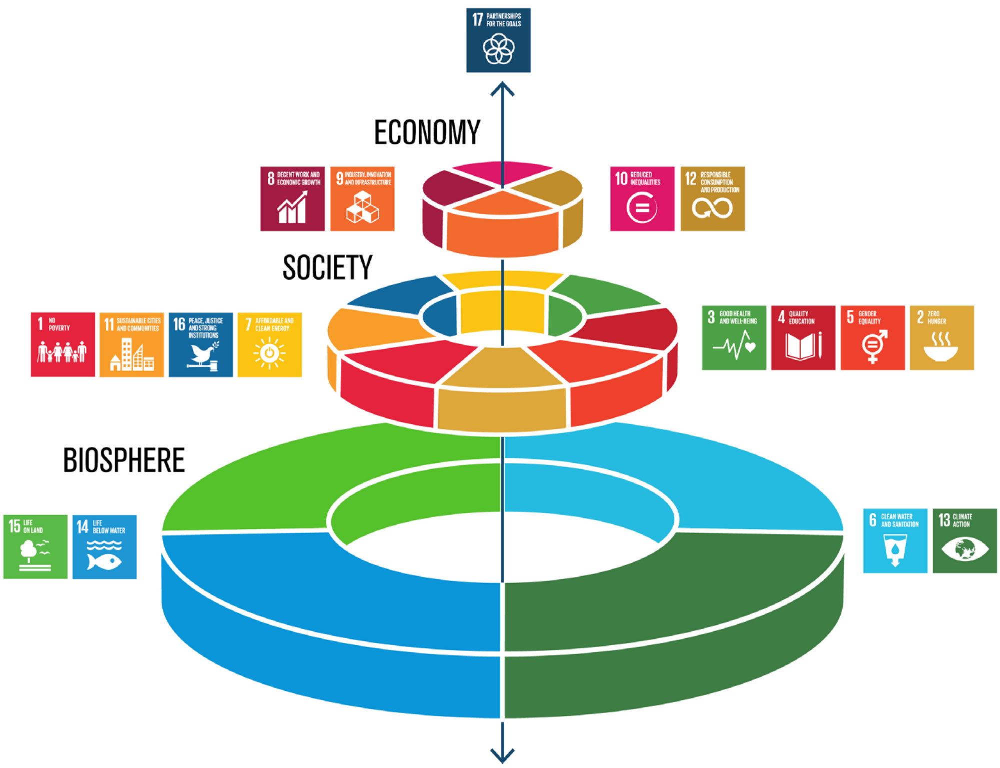
The 2030 Agenda and Infrastructure

The 2030 Agenda is a shared global vision that was initially developed at the Rio+20 Conference in 2012 (European Commission, 2017). It was adopted by UN Member States in 2015 with the inclusion of the seventeen SDGs. Although there are other relevant global policy frameworks, such as the UN Framework Convention on Climate Change (UNFCCC) and its constituent Paris Agreement on Climate Change, this paper takes the 2030 Agenda and the SDGs as the defining and overarching policy framework for global sustainable development. This section will discuss how infrastructure – itself a cornerstone component of SDG 9: industry, innovation and infrastructure – underpins many of the SDGs.

2.1 INFRASTRUCTURE'S CENTRALITY TO THE SDGS

The seventeen SDGs cover three salient aspects of global development: poverty eradication, shared prosperity, and the protection of the planet, premised on peace and partnerships. The goals include specific targets that are to be addressed by 2030 by governments, the private sector, and civil society (UN, n.d.). Figure 1 illustrates the relationship between these three areas of focus, highlighting the environment as the foundation that supports society and the economy.

Figure 1: The SDGs divided by a focus on the economy, society and the biosphere (i.e. environment) (Stockholm Resilience Centre, n.d.)

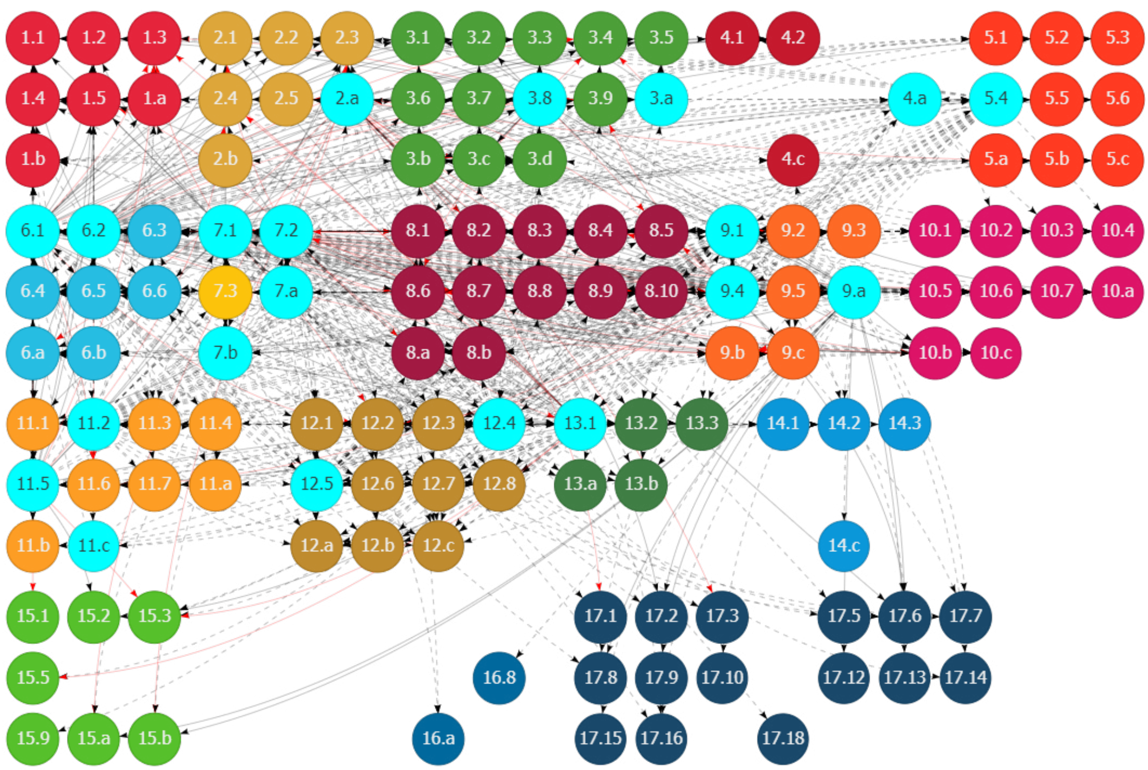


Infrastructure is highly relevant to all the SDGs, and the interdependencies between infrastructure and SDGs are complex. Thacker et al. (2018) show that infrastructure has a direct influence on more than 80% of the 169 individual SDG targets. Figure 2 is an output of the SDG Interlinkages Analysis and Visualization Web Tool created by the Institute for Global Environmental Strategies (Zhou et al., 2017a). It illustrates the complexity of the relationships between different SDGs and the related infrastructure.

It is important to recognize, however, that infrastructure is not necessarily sustainable simply by virtue of contributing to one or more of the SDG targets. For example, a hospital that contributes to achieving SDG 3 on good health and well-being may be sited in the middle of a sensitive and high-value ecosystem and run on electricity generated from fossil fuels, making it environmentally unsustainable. In this sense, the sustainability of infrastructure can be guaged by the extent to which it contibutes to one or more goals without undermining others.

In making the case for integrated approaches to infrastructure, this section does not aim to give examples of sustainable infrastructure solutions, but rather to demonstrate the centrality of infrastructure to the SDGs as they relate to society, the economy and the environment.

Figure 2: Interconnections among SDGs in Bangladesh (Zhou et al. 2017)



2.2 INFRASTRUCTURE AND SHARED WEALTH: THE ECONOMIC DIMENSIONS OF THE SDGS

Economic outcomes have historically been the focus of policy dialogue around infrastructure, which is described by the Organization for Economic Cooperation and Development (OECD) (2007) as a "means for ensuring the delivery of goods and services that promote prosperity and growth." Once built, infrastructure serves as a foundation for the local economy. The literature indicates that higher investment in infrastructure generally results in an increase in aggregate economic output (Calderón & Serven, 2004; Roller & Waverman, 2001; World Bank, 1994). Other studies also point to a positive correlation between increased infrastructure investment and productivity. Fernald (1999) found that the construction of the interstate highway system in the United States led to a considerable increase in the productivity of transport intensive industries. An investigation by Pineda and Rodríguez (2006), meanwhile, found cuts to infrastructure investment to be detrimental to society as a whole in the Venezuelan context.

In addition, according to the Global Commission on the Economy and Climate (2018), addressing climate change through strategic urban infrastructure investment could result in US$17 trillion in economic savings by 2050.

Investing in infrastructure provides opportunities for inclusive growth through employment creation, income generation, and the creation of assets and services (**see Box 1**). The construction and maintenance of infrastructure creates employment directly while the assets themselves can improve access to services, income, employment, and trade opportunities. The optimal use of local labour and materials can have further backward and forward linkages, which can stimulate the local economy and contribute to poverty reduction. Analysis by the McKinsey Global Institute found that, in the short term, an increase of one percentage point of Gross Domestic Product (GDP) in infrastructure investment could result in an "additional 3.4 million direct and indirect jobs in India, 1.5 million in the United States, 1.3 million in Brazil, and 700,000 in Indonesia" (Woetzel et al., 2016). In this sense, infrastructure remains an untapped resource for job creation (Estache & Garsous, 2012), which underpins many of the targets enshrined in SDG 8: Decent work and economic growth.

Infrastructure also supports developing countries seeking to integrate into the global economy by facilitating international trade. Well-functioning transportation and intermodal infrastructure enables domestic producers to export goods abroad. The choice of transportation mode for traded goods, however, is critical in determining the overall carbon footprint of trade. According to the International Transport Forum (2015), CO_2 emissions from trade-related international freight account for 30% of all transport-related CO_2 emissions. Shifting freight transport activity from road to rail, for example, can significantly increase energy efficiency and lower the greenhouse gas (GHG) emissions from trade (IEA, 2019).

BOX 1

The Employment Intensive Investment Program in the ILO and water and sanitation projects in Nicaragua, Panama and Paraguay

The Employment Intensive Investment Program applied Local Resource Based approaches in Latin America to plan, build and manage water resources with indigenous and dispersed rural communities under a Spanish-funded programme in support of the achievement of the Millennium Development Goals (MDGs). The impact of the applied methodologies was assessed to have been effective and sustainable in improving rural communities' access to water. Integrated Rural Accessibility Planning guidelines were used to identify investment priorities, while the communities used community contracting to increase participation and ownership. Local agencies and regional governments were supported to provide drinking water to distant communities that experience annual droughts. The Local Resource Based approaches and experiences were integrated into the UN World Water Development Report for 2016 under the title "Water and Jobs".

The nexus between infrastructure and trade can also facilitate efforts to meet SDG 7: providing affordable and clean energy. It can do so by altering the economics of green energy infrastructure through an expansion of the potential market size. This is particularly the case for large-scale renewable energy projects, where the potential to export energy to neighboring countries can vastly increase the financial attractiveness of such projects. This financial logic is even more applicable to developing countries, where lower rates of electricity use mean that a larger customer base is required to generate the same level of demand as in developed countries. Energy trade can also increase the affordability of renewable energy in developing countries with relatively high energy prices, as they can benefit from both economies of scale and the ability to import cheaper clean energy from other countries.

The transition away from linear models of production towards circular economies is also dependent to some extent on infrastructure being designed and constructed to support circularity. Diverse infrastructure systems, including those for food, water, energy, buildings, industrial activities, transport, and communications, amongst others, have high potential to support a sustainable redefinition of our growth models by helping to close material loops. For example, efficient urban spatial planning can decrease the cost of waste management and transportation of materials between source and user, enabling industrial symbiosis, whereby waste streams from some industrial processes are used as inputs in others. This is illustrated by Kalundborg eco-industrial park in Denmark, where over thirty material exchanges occur across multiple sectors of infrastructure, including water, energy and waste (Kalundborg Symbiosis, n.d.). Similarly, appropriate siting and design of potentially hazardous infrastructure, such as chemical facilities or mining operations, is essential to ensure the safety and security of nearby populations.

While infrastructure brings many economic benefits, it is important to also acknowledge that there are economic risks associated with it that need to be considered to avoid any negative impacts on the fulfillment of the SDGs. Notably, debt and fiscal sustainability needs to be ascertained, and cost-benefit analysis that adequately evaluates all (positive and negative) externalities should be applied (IDB, 2018b).

2.3 INFRASTRUCTURE AND PEOPLE: THE SOCIAL DIMENSIONS OF THE SDGS

Sustainable infrastructure underpins the delivery of all the social SDGs. Perhaps most pertinent is infrastructure's role in alleviating poverty (SDG 1), which is crucial to global development, given that 3.5 billion people are still living below the poverty line (Atamanov et al., 2018). Improved access to basic services is one of the fundamental objectives of infrastructure development, and sustainable infrastructure that integrates electricity, transport, clean water and sanitation services is closely associated with poverty alleviation, through providing not only increased access but also via the expansion of economic opportunities and streamlined information channels (Bhattacharya et al., 2016).

One of the basic human rights underpinning poverty eradication is the right to an adequate standard of food. The targets enshrined in SDG 2: Tackling world hunger and food insecurity can also be addressed by infrastructure that ensures good quality water with a reliable supply for agriculture. Sustainability of design is crucial to ensuring the sustained provision of water in the context of increasing variability in extreme weather conditions (Bhattacharya et al., 2016). The interdependent relationship between water and agriculture is a pertinent example of the cross-cutting nature of infrastructure. Namara, Regassa & Van Koppen (2010) point out that for investments in water infrastructure to contribute to poverty alleviation, they should be complemented by investments in other key areas, including agricultural science and technology, policies and institutions, and economic reform.

Improved health and well-being, the focus of SDG 3, is addressed through adequate food sources, and the delivery of critical health services. Suitable and durable infrastructure is again vital in this regard. For example, in Benghazi, Libya, most of the local clinics and hospitals were destroyed by heavy bombardment during the Second Civil War that started in 2014. Investment in infrastructure reconstruction, including buildings, electrical systems, and heating and ventilation, has been key to bringing health services back into operation (UNDP, 2018). In addition, the safety and security of infrastructure, especially considering climate change and extreme weather events, is crucial to prevent and minimize the potential effects of disasters (both natural and technological/industrial) on human health and well-being.

Increased access to education, the focus of SDG 4, also relies on the appropriate infrastructure. In addition to the basic physical structures (i.e. schools, colleges, universities, and other educational facilities), access to services such as heating and lighting, water, sanitation, and transportation, as well as to digital infrastructure, greatly improves students' performance and employment opportunities (Thacker et al., 2018).

Access to energy (SDG 7), is considered a key enabler of poverty alleviation (SDG 1) and many other SDGs. Infrastructure that provides clean, reliable, and affordable energy to households, schools, agriculture, and industry can lead to significant benefits in terms of health, economic growth, education, and gender equality (**see Box 2**). New technologies are also making clean and renewable energy more accessible and affordable, often with other co-benefits (IEA, 2017). The installation of biogas plants in rural parts of Sri Lanka, for example, has enabled farming families to intercept agricultural waste streams to produce gas used for cooking and lighting. This not only reduces the environmental impact of biomass usage, but also detracts from the burden of firewood collection by rural families (Practical Action, 2018).

There are also gender dimensions to infrastructure, as a lack of infrastructure can disproportionately impact women in multiple ways. For instance, inadequate water and energy infrastructure can lead to the increased burden of resource collection, where safety is compromised through increased

Access to ICT infrastructure at all levels of schooling fosters digital skill development, which is increasingly important for employment and entrepreneurship opportunities.

BOX 2 **Geothermal energy in Kenya**

Kenya's Olkaria power plant is one of the largest geothermal investment projects worldwide, and has increased the proportion of geothermal energy to 51% of the Kenyan national energy mix (World Bank, 2015).

Olkaria was built as part of Kenya's national plan to reduce the country's reliance on hydropower, an intermittent source that fluctuates along with rainfall and, as a result, has decreased dependency on diesel generators for base load (Ibid., 2015).

Development of geothermal power is also key to Kenya's strategy for alleviating poverty through increased access to reliable and clean energy. The World Bank's country director for Kenya, Diarietou Gaye, commented on how the energy sector is "a key infrastructure investment in the fight against poverty." He added that affordable electricity can transforms lives as "kids can learn at school and do homework at night [and] [b]usinesses can flourish and create new jobs" (Ibid., 2015).

risk of violence (International Center for Research on Women, 2005). Therefore, it is vital that gender is incorporated into infrastructure planning. The US$206 million Second Rural Infrastructure Improvement Project in Bangladesh has sought to improve livelihood opportunities for women through building marketplaces specifically for female merchants, and providing them with training in management and other income-generating skills (ADB, 2017).

It is also crucial to assess, evaluate, and preserve tangible and non-tangible cultural heritage in infrastructure development and to manage any potential impact on indigenous and traditional peoples. Community safety, security and crime prevention should be assessed, evaluated and managed at all stages of the project cycle (IDB, 2018b).

Stakeholder engagement is particularly important to ensure that all the potential social benefits and impacts of infrastructure development are captured in decision-making processes. The commitment to promote transparency and inclusive and effective public participation in decision-making is reflected in SDG 16, which stipulates that stakeholder and public concerns are to be addressed in the planning and implementation of new infrastructure projects. There are also several legal instruments that support these processes, such as the Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters (Aarhus Convention). Lack of adequate consultation, especially with local communities, was found to be one of the most important drivers of conflict in infrastructure in Latin America (IDB, 2017a).

2.4 INFRASTRUCTURE AND THE PLANET: THE ENVIRONMENTAL DIMENSIONS OF THE SDGS

It is widely acknowledged that the ambitions set out by the Paris Agreement on Climate Change will only be met by a transition towards sustainable energy requiring large investments in new infrastructure, and that limiting climate change to any level (e.g. 1.5° or 2° above baseline) will require that global net emissions of GHGs are reduced to zero by 2050 (IPCC, 2013). To this end, the development of sustainable infrastructure is particularly crucial for action on climate change, the focus of SDG 13. The "lock-in" effect of infrastructure makes it a long-term source of carbon emissions, with an estimated 60% of the global carbon budget taken up by its construction and operation (Müller et al., 2013). According to Chatham House (2018), the production of cement alone accounts for approximately 8% of CO_2 emissions worldwide. Emissions from transportation and buildings each represent around one fifth of global anthropogenic carbon emissions, while around two-thirds can be attributed to the energy sector (IEA, 2012). The International Energy Agency (IEA) predicts that infrastructure investments in more efficient energy systems, appliances, and lighting can contribute to a reduction of around half of the total emissions by 2050 (Ibid., 2012).

Investing in sustainable energy also makes economic sense. Estimates released by the Inter-American Development Bank (IDB) (2017b), for example, suggest that the extension of existing power grids and renewable energy investments could save more than US$20 billion in Latin America alone.

In addition to mitigation, climate resilience becomes a critical criterion for both the retrofitting of existing infrastructure as well as for the construction of new infrastructure assets. The construction of roads, bridges, pipelines, power transmission lines, industrial facilities, and other infrastructure assets should consider unexpected and unpredictable future climatic conditions and natural hazards. For example, where possible, avoiding infrastructure development in locations that are most exposed to climate-related hazards (e.g. mountain slopes, floodplains, and low-lying coastlines) helps to manage climate threats to infrastructure. The 2012 Cloudburst Plan in Copenhagen, Denmark, for example, adopted a mix of green and grey infrastructure to adapt to the increased likelihood of extreme rainfall periods. Tunnels and roads designed to increase drainage capacity and water discharge into the sea were combined with the installation of anti-flooding mechanisms in buildings, and with the restoration of natural waterways and green spaces to enhance storm water flows (The City of Copenhagen, 2014).

Landscapes and ecosystems provide many of the same services as built infrastructure assets. Wetlands, for example, provide water filtration and flood protection services, among others.

Furthermore, infrastructure projects should also be planned to account for transition risks. Infrastructure assets should be designed to be durable and flexible, allowing for easy reconfiguration, deconstruction, and recycling of project components (IDB, 2018b). This also supports the development of circular economies.

Infrastructure also has an essential role to play in the realization of SDG 12, which addresses sustainable consumption and production. For example, concrete is made of cement, water, gravel and sand, and in 2016 30 billion tons of sand and gravel were extracted globally to construct infrastructure such as roads, buildings, and dams. This has led to detrimental impacts on coastal landscapes, changes in tides and currents, and subsequent loss of biodiversity. Applying circular economy principles to find alternative solutions in sand use – recovery, recycling, and alternative designs that use less sand and gravel (through development of new concrete mixes), for example – can help to minimize the negative environmental impacts of infrastructure (Peduzzi, 2015).

An important consideration related to sustainable consumption is water, which is reflected in SDG 6. Lack of basic water and sanitation provisions are linked to poor health and loss of productivity (Pouliquen, 2000; Brenneman & Kerf, 2002; Zhang, 2012), and approximately 844 million people still do not have access to a reliable water supply (Bhattacharya et al., 2016; Water.org, 2018). Sustainable water infrastructure, complemented by the efficient use of water resources, helps to ensure the durability and accessibility of clean and safe water for all (Gleick, 1998), while also having benefits in other sectors. Solar powered water pumping systems, for example, can be used to replace fuel powered systems in refugee camps, helping to combat fossil fuel consumption and the associated high costs for humanitarian organizations (Kraehenbuehl, Ibanez, et al., 2015). Similarly, increasing the sustainability of infrastructure in other sectors (agriculture, for example) can help improve water quality and availability for health and sanitation.

Sustainable and resilient infrastructure also plays an important role in preventing water pollution related to industrial accidents. The failure of industrial infrastructure, such as tailings dams that store hazardous waste, can have disastrous effects on the environment and human health, both within and across countries. The Brumadinho Dam failure in Brazil in 2019, for example, killed dozens of people and is threatening local ecosystems and water supplies.

The sustainability of infrastructure also impacts terrestrial and marine ecosystems, covered under SDG 14 and SDG 15, respectively. All types of infrastructure can pollute air, land, and water, and thus pose direct and indirect threats to ecosystems and biodiversity, within and across country borders. The construction of linear infrastructure can lead to the fragmentation of natural habitats. Similarly, point source pollution can destroy habitats, and climate change caused by GHG emissions can result in the loss of habitat, shifts in species distribution, and changes to migration and breeding patterns, among other things. In addition, the opening of new transportation routes can lead to issues such as an increased pressure on natural resources and biodiversity, including through deforestation, increased illegal wildlife trafficking, and the introduction of invasive species.

Nature-based Solutions (NbS) can help to reduce the environmental footprint of the construction industry, while simultaneously providing infrastructure services such as carbon sequestration and land stabilization, thus maintaining ecosystem service benefits and providing long-term mitigation effects (IUCN, 2016). Natural ecosystems such as forests and mangroves play important ecological infrastructural functions, which need to be given greater recognition. A proper valuation of natural ecosystems can contribute to their preservation, and thereby the maintenance of the infrastructural services they provide to society.

The incorporation of NbS (such as introducing more trees and vegetated areas in cities) into the design of traditional "hard" infrastructure can not only increase the resilience of the infrastructure itself, but also reduce impacts on ecosystems and biodiversity. For example, increasing the quantity of green spaces through the introduction of green walls and roofs will help to address the increased Urban Heat Island Effect in cities while also increasing wildlife habitat. This strategy has been shown to reduce near-surface temperature significantly in the metropolitan area of Baltimore-Washington (Li, Bou-Zeid, & Oppenheimer, 2014). Green infrastructure also contributes to flood reduction and helps to curb the demand for natural resources (the use of sand for concrete, for example).

Given the cross-cutting nature of the SDGs, careful consideration of multiple goals and their associated targets at the outset of infrastructure planning processes has the potential to alleviate poverty and mitigate environmental impacts. The Shardara water infrastructure project in South Kazakhstan is an example of how one sub-sector of infrastructure can provide multiple environmental and economic benefits across several SDGs (**see Box 3**). To this end, taking a "siloed" approach to infrastructure planning can create negative impacts later in the life-cycle of infrastructure. This is particularly true of large-scale projects (**see Box 4** for an example of road infrastructure in Myanmar).

BOX 3 Multi-purpose water infrastructure in Kazakhstan

UN-Water (2018) highlights the potential co-benefits associated with multi-purpose water infrastructure: poverty and hunger reduction; promotion of sustainable economic growth; resilient infrastructure and cities; sustainable consumption and production; abatement of climate change; and protection of marine and terrestrial ecosystems.

The Shardara multi-purpose water infrastructure project, located in South Kazakhstan, has the potential to provide many of these co-benefits. In addition to hydropower and irrigation, it will provide services such as drought mitigation, flood control, drinking water supply, and transport and navigation services. Positive indirect economic impacts such as job creation could be catalyzed, alongside an increase in food security in the long-term through durable and sustainable agricultural water supply (OECD, 2018a).

BOX 4 Road infrastructure in Myanmar

Myanmar is in a strategic location for accessing several important economic corridors. There are currently proposals in place to implement road and port projects across the country, all of which present both opportunities and risks to the country's people and natural environment (WWF, 2017).

The coordinated planning of different projects can ensure that socio-economic benefits, such as increased domestic and international connectivity, improved access to jobs, education and health, and increased economic productivity are jointly achieved (Ibid., 2017). However, the proposed projects also involve the reduction of natural capital that could increase the risks of landslides, water pollution, and flooding. The proposed road corridors intercept parts of the Ayeyarwady River Basin, home to around 24 million people who rely on critical ecosystem services such as the filtration of drinking water and mitigation of the impacts of natural disasters (Ibid., 2017). Proper planning will be essential to mitigating these potential environmental impacts.

Sustainable Infrastructure: What Has Been Done?

3.1 MAJOR INITIATIVES ON INFRASTRUCTURE

Infrastructure is not a new topic. In 1994, the World Bank devoted its World Development Report to the theme of "Infrastructure for Development," highlighting the potential of infrastructure to "deliver major benefits in economic growth, poverty alleviation, and environmental sustainability" (World Bank, 1994). In 2007, the OECD report Infrastructure 2030 reiterated the significant projected growth in infrastructure demand, catalyzed by global trends such as urbanization and climate change. It also outlines ageing infrastructure systems and increasingly stringent and complex public finances as major challenges (OECD, 2007).

Outputs from recent G20 summits have highlighted the urgent need for the development of sustainable infrastructure worldwide (**see Box 5**). During Argentina's Presidency in 2018, the G20 highlighted "infrastructure for development" as one of its three priority areas. Although the Argentine Presidency put greater focus on mobilizing finance to reduce the infrastructure deficit, it also placed emphasis on the importance of a consensual approach in international policy coordination, and on the need to improve tools and instruments developed for project funding and project preparation (G20 Argentina 2018, n.d.).The Japanese G20 Presidency in 2019, based on the Ise-Shima Principles for Promoting Quality Investment, has been highlighting the concept of "Quality Infrastructure", which can be thought of as being broadly in line with the concept of sustainable infrastructure.

Prominent figures in environmental economics have repeatedly called for a shift in focus from infrastructure investment to sustainability. Professor Lord Nicholas Stern, for example, has emphasized the importance of sustainable infrastructure within the climate action movement,

BOX 5

G20 Infrastructure Initiatives

The Global Infrastructure Hub is a multi-year global infrastructure initiative created by the G20 in 2014 in recognition of the importance of infrastructure for economic development. The Hub collaborates with governments, multilateral development banks, the private sector and other international organizations to help promote the development of resilient and sustainable infrastructure (Global Infrastructure Hub, 2018).

The Global Infrastructure Connectivity Alliance was formed at the 2016 G20 summit held in Chengdu, China. The objective of the forum is to "enhance cooperation and synergies of existing and future global infrastructure and trade facilitation programs to improve connectivity within, between and among countries" (GICA Secretariat, 2017:2). Their main activities include identifying resources and gaps, sharing good practices, mapping connectivity initiatives, and monitoring and assessing connectivity (Ibid., 2017).

The last G20 summit in Argentina in 2018 continued to place great emphasis on the role of infrastructure as a "key driver of economic prosperity, sustainable development and inclusive growth" (G20, 2018). To this end, the summit endorsed the "Roadmap to Infrastructure as an Asset Class" and the "G20 Principles for the Infrastructure Project Preparation Phase". In line with these initiatives, the Japanese G20 Presidency in 2019 highlights the importance of the Quality Infrastructure Investment Agenda and its potential to reap economic, social and environmental co-benefits that extend beyond the physical value of infrastructure assets (Ministry of Finance, Japan, 2018).

as well as its centrality to the 2030 Agenda, stating that "in particular, sustainable infrastructure holds the key to achieving many of the 17 SDGs, ranging from making cities and human settlements resilient and sustainable, to ensuring access to affordable and clean energy for all" (Stern, 2016).

Additionally, the New Climate Economy Report of 2018 describes the next 10-15 years as a "use it or lose it" moment in history, where the sustainability of infrastructure projects will be a "critical determinant of future growth and prosperity" (Global Commission on the Economy and Climate, 2018). The report also highlights five key economic systems as priorities areas: clean energy systems, smarter urban development, food and land use, wise water management, and a circular industrial economy. Infrastructure is repeatedly cited as an intrinsic component of these systems.

A report recently published by the OECD, UN Environment and the World Bank identifies seven key policy areas that will help to embed environmental considerations into financial flows for infrastructure. The report elaborates on the need to decarbonise, overcome short-term policy making, innovate, and adapt (OECD et al., 2018).

3.2 EXISTING SYSTEMS AND TOOLS FOR PROMOTING SUSTAINABLE INFRASTRUCTURE

The increasing international recognition of sustainable infrastructure's importance and the establishment of knowledge-sharing platforms have resulted in a multitude of tools designed to ensure the sustainability of infrastructure projects (**see Figure 3**). Historically, the most commonly used project-level tools have been cost-benefit analyses (CBA), environmental impact assessments (EIA), and environmental and social impact assessments (ESIA). While the original theoretical framework of CBAs did not include environmental sustainability, subsequent iterations have incorporated it, mainly through the valuation of "environmental assets" (OECD, 2006b). On the other hand, sustainability is a foundational premise in the theory of EIAs and ESIAs, which are designed to influence formal decision-making processes with clear objectives and a transparent process (Sheate, 2010). The primary function of CBAs, EIAs, and ESIAs, however, is at the single project level.

In addition to these general tools, there are several project-level sustainability assessment and rating tools. The IDB (2018a) conducted a review of existing tools of this type and found that amongst them, there is a lack of guidance on incorporating sustainability concerns at the policy and upstream planning phases of infrastructure development, which limits the effectiveness with which sustainability can be incorporated during later phases. As shown in Figure 3, each sustainability rating system is applicable to particular phases of the project-cycle.

Figure 3: The infrastructure sustainability rating systems along with the project stage for which they were designed (Inter-American Development Bank, 2018a, p.21)

Sustainability rating systems and tools	Applicability
Envision Rating System for Sustainable Infrastructure (Envision)	Design
Infrastructure Sustainability Rating Scheme (IS)	Design
Infrastructure Voluntary Evaluation Sustainability Tool (INVEST)	Upstream Planning, Design
Standard for Sustainable and Resilient Infrastructure (SuRe)	Design
Sustainable Transport Appraisal Rating (STAR)	Upstream Planning, Design
Hydropower Sustainability Assessment Protocol (HSAP)	Upstream Planning, Design
SE4All Regulatory Indicators for Sustainable Energy Tool (RISE)	Upstream Planning, Design
Inter-American Development Bank (IDB) Safeguards and Policies	Design, Financing
International Finance Cooperation (IFC) Performance Standards	Design, Financing
World Bank (WB) Environmental and Social Framework and Policies	Design, Financing

In recognition of the need for a more systemic approach, the newest version of the Envision Rating System for Sustainable Infrastructure helps multiple stakeholders analyse the implementation of sustainable infrastructure and incorporates best practices from industry (ISI, 2018b). The Zofnass Program for Sustainable Infrastructure is also developing Sustainable Planning Guidelines to be used in tandem with Envision, to provide a more integrated approach to sectors of infrastructure at the municipal level (Zofnass Program, n.d.).

To address the gaps identified in its comparative analysis of the existing project sustainability rating tools, the IDB has also developed the IDB Group Framework for Planning, Preparing, and Financing Sustainable Infrastructure Projects, which aims to consolidate the key principles of the tools that were reviewed into a more holistic set of criteria that covers the entire infrastructure project-cycle. This new framework includes guidelines for upstream planning, and has been designed for use in different sectors and regions (IDB, 2018a). While its use is still being piloted, it has high potential for application to multi-sector, multi-project infrastructure planning.

Strategic environmental assessments (SEAs) aim to integrate environmental considerations into strategic, programme-level planning and to consider their interlinkages with social and economic impacts (OECD, 2006a). SEAs can be particularly effective when applied to policy and sector reform (World Bank, 2011), and their effectiveness depends on their application early in decision-making processes (Sheate, 2010). However, despite their potential for informing systems-level (i.e. multi-sector) planning, SEAs are often applied only to specific infrastructure sectors, in isolation of other related sectors, which can result in missed cross-sectoral synergies. This is due to the design of planning processes and is not a reflection of SEA's potential to support more integrated planning processes (World Bank, 2011). Recent evidence suggests that amongst countries that are Parties to the Protocol on Strategic Environmental Assessment to the Convention on Environmental Impact Assessment in a Transboundary Context (Espoo Convention), there is an increase in the multi-sector application of SEAs, particularly related to regional development and land-use planning (UNECE, 2018).

The Evidence-Based Infrastructure approach, developed by the United Nations Office for Project Services (UNOPS) and the Infrastructure Transition Research Consortium (ITRC) at the University of Oxford, is designed to account for the interconnections among infrastructure systems and environmental, social, and economic factors, and is intended for use in developing country contexts (UNOPS, n.d.). Its application is supported by a suite of analytical tools, including a *Capacity Assessment Tool for Infrastructure* (CAT-I) and the National Infrastructure Systems Model (NISMOD), which utilizes a "system-of-systems" approach to ensure that cross-sectoral interdependencies are identified, and synergies optimized (Hall et al., 2016).

These existing tools and approaches together form a complementary "tool box" that planners and policymakers can use to deliver sustainable infrastructure that supports the 2030 Agenda.

3.3 THE ROLE OF FINANCE

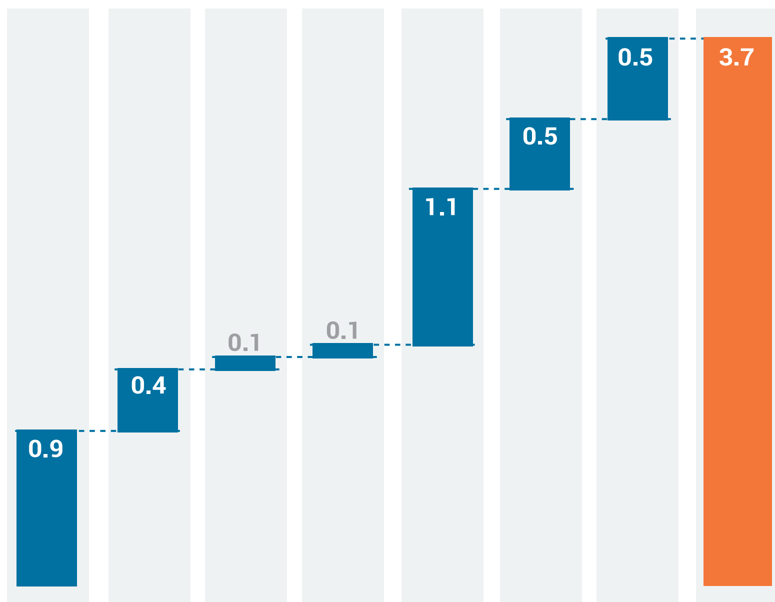
In international policy discourse on finance and infrastructure, there has been a major focus on financing the closure of the "infrastructure investment gap", the size of which is subject to many estimates. According to the Global Infrastructure Outlook, the amount of infrastructure investment needed in 50 countries and across 7 sectors to support projected economic growth will reach US$94 trillion by 2040, with a further US$3.5 trillion needed to meet the SDGs for universal household access to drinking water and electricity by 2030, bringing the total to US$97.5 trillion. The analysis estimates a shortfall in spending of US$15 trillion (Global Infrastructure Hub, n.d.). According to the McKinsey Global

Institute (2017), US$3.7 trillion will have to be invested annually in economic infrastructure until 2035 to match the needs resulting from projected economic growth rates (**see Figure 4**). The OECD suggests even higher numbers will be required, with US$6.9 trillion/year investment in infrastructure needed until 2030 to meet the objectives of the 2030 Agenda (OECD et al., 2018).

Regardless of its exact size, closing the gap and meeting the SDGs will require the mobilisation of all available resources – public, private, domestic and international – and innovative financial instruments and mechanisms are of vital importance in this respect. Historically, sustainable infrastructure finance initiatives have tended to focus on incentivising private sector investment.

This has resulted in infrastructure investment that is poorly aligned with wider climate goals (OECD et al., 2018). Financial instruments need to be located appropriately within a broader framework to ensure the integration of long-term climate objectives into all aspects of society (Ibid., 2018). This notion is well-aligned with the World Bank's new "Maximizing Finance for Development" agenda, which calls for the deployment of development finance in key transformational sectors within developing countries to leverage additional private finance for investments that support capacity development and economic growth. The World Bank sees this as a key opportunity to supplement development aid which, by itself, has not been sufficient (World Bank, 2018).

Figure 4: Projected investment gap concerning economic infrastructure based on projected global economic growth, 2017-2030 (McKinsey Global Institute, 2017)



	Roads	Rail	Ports	Airports	Power	Water	Telecom	Total
Annual spending, % of GDP	1.0	0.4	0.1	0.1	1.3	0.5	0.6	4.1
Annual spending, 2017-35, $ trillion	18.0	7.9	1.6	2.1	20.2	9.1	10.4	69.4

Although private and blended finance are indeed important, the role of public finance in delivering sustainable infrastructure is also essential. Sustainable public procurement policies can be used to ensure that publicly financed infrastructure integrates sustainability considerations and helps drive markets towards sustainability. Fiscal policies can also play an important role in mobilising resources for sustainable infrastructure in different sectors. For example, fiscal reforms and pricing policies in the water sector can mobilize domestic resources for investment in water infrastructure, helping to expand coverage, improve water quality, and increase poor communities' access to services. Furthermore, fiscal measures can help leverage private financing towards sustainable infrastructure by improving the enabling environment for private investment. Carbon pricing policies and fossil fuel subsidy reforms, for instance, can help to level the playing field between sustainable and unsustainable options and incentivise private investment in sustainable infrastructure (Global Commission on the Economy and Climate, 2016).

Innovative financing solutions – such as sovereign green bonds, tax exemptions and credit enhancement – are needed to incorporate biodiversity, climate mitigation and adaptation, inclusivity, and other elements of sustainability within infrastructure investments, and to engage the private sector. At the same time, better upstream planning is crucial to identify and reduce social and environmental risks in order to create well-developed pipelines of sustainable and bankable projects, which improve access to project financing (OECD, 2018b). In this regard, blending public capital and concessional climate finance with private capital can help to reduce risks for private investors. In such cases, multilateral development banks (MDBs) can serve as cornerstone investors in new markets, signalling to other investors that the risks are often less than perceived.

Despite the importance of financing infrastructure gaps, however, simply relying on environmental and social safeguards linked to financing will not be enough to ensure that these gaps are filled with sustainable infrastructure. To redirect financial flows towards resilient and sustainable infrastructure, enabling conditions must exist. Financing mechanisms must align with and support integrated approaches to infrastructure, which are explored further in the next section.


Many infrastructure systems deliver essential public services, such as access to clean water. Public finance plays an important role in the development of such infrastructure.

Integrated Approaches to Infrastructure

The impacts of infrastructure investments are context- and sector-specific. However, there are significant interconnectivities and interdependencies among different infrastructure systems and sectors at various spatial scales, the institutions that plan, design, build, and operate them, and the various communities that depend on the services they provide. Integrated approaches to infrastructure seek an optimal balance between the social, environmental, and economic dimensions of sustainability by considering these interconnections for all phases of the infrastructure development cycle, and they do so as far upstream in the decision-making process as possible. Stakeholder consultation and public participation are also important components of integrated approaches.

4.1 INTEGRATING INFRASTRUCTURE SYSTEMS AND SECTORS

To deliver services most effectively, efficiently, and sustainably, the many sectors of infrastructure (as outlined in Section 1) must be considered as interconnected systems. This is because the degree of sustainability of certain infrastructure systems can have direct and indirect impacts on others.

The energy sector provides an illustrative example of complex interlinkages with infrastructure in other sectors. Meeting the targets set out in SDG 7 will require investment in infrastructure that ensures all populations have reliable, secure access to affordable, environmentally sustainable energy. Access to reliable and sustainable energy is also critical to ensuring the sustainability of infrastructure in other sectors, such as transport, water, agriculture, or buildings. At the same time, infrastructure built in those sectors can have crossover impacts on energy infrastructure. For example, technological advances in the transport sector (e.g. increased fuel efficiency, electrification) can affect the demand for energy and the related infrastructure (Thacker et al., 2018).

It is important to adopt integrated approaches at the local, regional, national, and transnational levels. However, the challenges and opportunities of doing so at the urban level, where there is a high density of closely linked infrastructure systems, are particularly pronounced (IRP, 2018). Transportation and building infrastructure, for example, must be considered together during land-use planning. Compact and dense cities present an opportunity to develop more economically viable transportation systems, particularly in the shift in modality from vehicles to more active transport options such as cycling and walking. Public investment in the extension of cycling infrastructure within metropolitan areas, for instance, not only reduces transport-related GHG emissions, but also has positive consequences for local air quality and traffic congestion, thereby improving community and individual health and quality of life.

Cities also provide many examples of integrated infrastructure solutions in practice. District energy systems, for example, create synergies between infrastructure for heating and cooling, electricity, sanitation, waste management, and transport (District Energy Initiative, n.d.). The design of DHA City Karachi utilized creative spatial planning policies to incorporate social, economic, and environmental factors (**see Box 6**).

BOX 6

DHA City Karachi

Situated just outside of Karachi, the most populous city of Pakistan, DHA City Karachi is the first of its kind in the nation to be planned, designed and constructed with urban sustainability principles at its core. The spatial proximity incorporated into design addresses both environmental and social aspects through reducing carbon emissions and ensuring that community facilities are close to each citizen. This is implemented through a collection of 10-12 communities with their own distinct sectors within society, including healthcare, business and cultural districts (RMJM, 2018).

At the other end of the spectrum, spatial integration of infrastructure systems at the broadest scale – often transboundary – is also required to accurately manage the associated risks and impacts. Projects that have large or wide-ranging footprints, such as dams, or linear infrastructure such as roads, railways, and transmission lines, have direct and indirect impacts on ecosystems and biodiversity, as well communities, and are subject to increased risks related to climate change and other disasters. Integrated planning at the landscape scale can help to avoid oversupply of infrastructure, limit the footprint of impacts, avoid sensitive ecosystems, and increase resilience and safety of infrastructure through proper siting.

Development of cycling infrastructure in urban areas has cross-cutting benefits in terms of the economy, climate, transportation, and human health.

› INTEGRATED APPROACHES TO INFRASTRUCTURE

4.2 INTEGRATING INSTITUTIONS

To support integration between different project phases and sectors of infrastructure, a restructuring of institutional arrangements is necessary (**see Box 7**). Government bodies responsible for different infrastructure sectors must be integrated horizontally across sectors, as well as vertically, so that national-level policy can be effectively translated into regional and local-level implementation. These institutions can constitute commissions, councils, ministries, or boards, and should focus on the upstream institutional context, including policies, plans, regulations and legislation (IDB, 2018b). This top-down approach to infrastructure is essential for a strategic assessment of long-term economic infrastructure needs across sectors (International Transport Forum, OECD, & UK National Infrastructure Commission, 2017). Laying down a foundational policy framework that links national-level planning with local level implementing institutions ensures that subsequent projects are in line with national priorities, through incentivizing and regulating good corporate governance and transparency (IDB, 2018b). At the local level, factors such as budget constraints, poor implementation capacity and absence of maintenance systems should be addressed to avoid service deficiencies that undermine the effectiveness of service delivery.

Scotland's infrastructure planning model has been successful in achieving this. It uses the United Kingdom's overarching National Planning Framework in tandem with the independent National Infrastructure Commission to break down government "siloes" and ensure a "plan-led" approach across the country (**see Box 8**) (Infrastructure New Zealand, 2017).

BOX 7 Key attributes for infrastructure planning institutions

Integrated approaches should be supported by independent planning bodies that provide politicians and other stakeholders with consolidated and essential information upon which to base policy decisions. They play a critical role in ensuring that decisions are made across sectors, taking into account those issues that might not factor into short-term political decision-making, and to reduce the cost of projects by assessing costs and benefits at a systems-level. Key attributes for infrastructure planning institutions to be fit for purpose include the following:

- Must include sustainability as a primary guiding concept.
- Must provide an integrated plan for infrastructure development across sectors.
- Must be independent, but cannot be too removed from political decision-making.
- Must be anchored in clearly defined and long-term objectives. This can take the form of a national plan or policy with sustainability as its focus.
- Should be open and collaborative, seeking stakeholder engagement from the outset of the process. This is crucial to encourage openness and transparency and to add credibility to the planning exercise. At the same time, stakeholder engagement helps to inform policy makers about relevant business models and technological innovations.
- Should have greater-than-advisory powers in that the government must justify rejecting recommendations.

(International Transport Forum, OECD, & National Infrastructure Commission, 2017).

BOX 8 The Scotland Infrastructure Planning Model

The Scottish institutional model utilizes an overarching framework alongside an independent commission to ensure that the United Kingdom's nation-wide objectives are incorporated at the project level.

National Infrastructure Commission

The National Infrastructure Commission identifies long-term demand for infrastructure and monitors performance against these already established objectives. It is independent from the government and has "greater-than-advisory" powers, in that Parliament must provide a justification for any rejection of its recommendations.

National Planning Framework

The National Planning Framework sets out a spatial plan for the country, with sustainable development prioritized. By outlining national priorities, the framework encourages integrated decision-making and ensures that sustainability is embedded into strategic plans.

4.3 INTEGRATING COMMUNITIES

It is essential that top-down approaches are supported by bottom-up processes that facilitate meaningful stakeholder consultation and public participation. Such processes are a means for ensuring that the widest range of social, economic, and environmental opportunities and challenges associated with infrastructure development are fully captured in the analysis. Furthermore, this should be done as far upstream in the decision-making process as possible, when alternatives are still technically, politically, and economically viable.

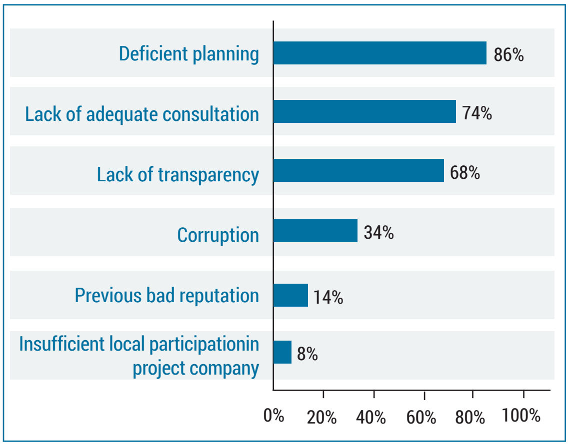
In the case of Latin America and the Caribbean, an analysis of 200 conflict-affected infrastructure projects from the last four decades found deficient planning and lack of adequate consultation and transparency to be the most common drivers of conflict (**see Figure 5**) (IDB, 2017a). In Belize, the incorporation of social and economic considerations into the National Climate Resilient Investment Plan (NCRIP) means that key national poverty alleviation objectives can be addressed through infrastructure projects (**see Box 9**). The integration between the planning and implementation phases of the project cycle has, in this case, ensured the durability and success of the project.

BOX 9 **Belize Climate Resilient Infrastructure Project**

To address the impact of climate change on social and economic development, the government of Belize has developed the National Climate Resilient Investment Plan (NCRIP). Its purpose is to integrate disaster management and climate change adaptation into national development planning processes and actions.

The NCRIP has financed the Belize Climate Resilient Infrastructure Project, which will make all critical roads in the country more resilient to flood risk and climate variability. The prioritized networks were selected due to economic importance, with due consideration of access for poor populations. Additionally, construction impacts such as noise, pollution and disturbance to wildlife have been accounted for with appropriate mitigation measures (International Association for Impact Assessment & Netherlands Commission for Environmental Assessment, 2017).

Figure 5: Summary of governance drivers of conflict for all projects included in the study (IDB, 2017a)



To summarize, the gaps identified in upstream planning for infrastructure reveal a need for analysis and planning to involve integration across the following dimensions:

I. Sectoral: the relationships between different infrastructure systems and sectors – energy, water, transport and communication, for example – should be analyzed even when only one sub-sector or project is being considered.

II. Spatial: interconnections between infrastructure systems and sectors should be considered at the local, regional, national, and international scales.

III. Institutional: cooperation between government entities at the local, national, and regional levels should be institutionalized, and capacity of institutions to undertake strategic infrastructure planning should be developed. This should include mechanisms for public participation.

IV. Governance: national and local-level governance and regulatory frameworks must be aligned to support vertical integration of planning that ensures that local-level implementation is aligned with national-level plans and priorities. Conversely, national-level policies and plans need to be in line with local needs.

› INTEGRATED APPROACHES TO INFRASTRUCTURE

V. Sustainability: the environmental, social, and economic sustainability of infrastructure should be considered in relation to one another.

VI. Project phases: sustainability of the planning, design, construction, operations, maintenance, and decommissioning phases of infrastructure should all be considered from the start of the planning cycle, when alternatives are still economically and politically feasible.

Integrated approaches have three main advantages over “siloed” infrastructure approaches that consider infrastructure projects, systems, and sectors in relative isolation from others. First, they allow for the optimization of the environmental, social, and economic challenges and opportunities associated with infrastructure development, by considering the services that infrastructure systems deliver, and not just the assets created. This results in infrastructure that optimizes outcomes vis-a-vis the SDGs and minimizes trade-offs between different goals. Second, they result in longer-lasting infrastructure that is more resilient to risks, for example to those associated with climate change or human-made/ technological disasters. Third, by identifying and addressing potential risks early in the planning process, they increase the bankability of infrastructure projects, making them more attractive to investors.

Decommissioned rail infrastructure in Manhattan has been turned into public green space.

The Way Forward

The gaps articulated in this paper relate to multiple dimensions of integration in infrastructure implementation and the adoption of systems-based, integrated approaches. The most persistent barriers to the adoption of integrated approaches are often human barriers, and particularly with regards to planning, inclusive and effective public participation, and transparency. This means that a concerted effort is needed to develop human-centric approaches that develop the mindset, competencies, processes and tools necessary for integrated planning. To this end, this paper proposes three major areas of focus for the international community.

The first relates to the visibility of these gaps on the international stage. Although the importance of integrated and systems-based approaches has been increasingly acknowledged, there are limited efforts to apply such approaches on the ground, especially at the national scale. To capture the attention of policy makers, there is an urgent need for the issue of sustainable infrastructure development to be placed as a distinctive item on the global policy agenda, with an emphasis on its centrality within the 2030 Agenda. Mobilization of the research community is also necessary in demonstrating the benefits of upstream, macro-level, integrated infrastructure planning, and to assemble and provide access to the data necessary to inform decision-making.

The second area of focus is on ensuring the availability of the tools that can support integrated approaches. In many cases, this will mean creating synergies among existing tools and scaling up their application in support of integrated approaches. While there are a number of existing assessment and analytical tools for guiding infrastructure development, the lack of a comprehensive comparative analysis and recommendations for their use to meet different needs can limit their uptake. What is required is an overall framework that sets out the major tools and approaches and identifies gaps and complementarities. This will assist the international community in recognizing the suitability of different tools for meeting different needs in diverse country contexts.

The process associated with this objective would be to convene relevant experts and potential users to consolidate existing tools and to make this tool-box accessible in different regions and countries. This exercise will also help to identify any gaps where new tools are needed. This is perhaps most relevant where quantitative modelling tools are concerned. Understanding the interdependencies among infrastructure systems requires the development and use of such models, and the personnel and expertise to operate them and interpret their outputs.

The third area of focus is in generating international support for strengthening the technical and institutional capacity of developing countries and countries with economies in transition, so that they can apply more integrated approaches to the planning and development of sustainable infrastructure that supports their national sustainable development priorities.

There is currently an imbalance in the uptake of institutionalized integrated approaches between developed and developing nations, mainly owing to the former's higher levels of funding and longer exposure to the complexities of diversified economies (Linde, 2018). Technical assistance and capacity building is needed to help countries make appropriate institutional arrangements that can manage integrated approaches.

UN Environment recognises the fundamental importance of sustainable infrastructure in delivering its mandate within the context of the 2030 Agenda and under the Sustainable Infrastructure Resolution adopted at the 4th United Nations Environmental Assembly, which took place during 11-15 March 2019 (UNEP/EA.4/L.6). The cross-cutting nature of infrastructure demands a multi-stakeholder approach. To this end, UN Environment proposes to facilitate collaboration across multiple organisations, in order to build up the momentum for making infrastructure investment sustainable, promoting the sharing of knowledge and experiences, building up institutional capacity, and ensuring that the massive infrastructure development expected in the coming decades is supported by strong planning and implementing institutions. It is only through this international, concerted effort that sustainable and durable infrastructure can contribute to shared prosperity for the planet and its people.

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