

GOOD PRACTICE GUIDANCE FRAMEWORK FOR SUSTAINABLE INFRASTRUCTURE

Integrated, systems-level approaches

Draft for Review

◀ May 2020

DRAFT

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Acknowledgements

The *Good Practice Guidance Framework for Sustainable Infrastructure* is being developed as part of the implementation of United Nations Environment Assembly (UNEA) Resolution 4/5 on sustainable infrastructure (UNEP/EA.4/Res.5). This draft was prepared by a team led by Rowan Palmer (UNEP-WCMC) under the guidance of Fulai Sheng (UNEP). Members of the team include Motoko Aizawa (Observatory for Sustainable Infrastructure), Giulia Carbone (IUCN), Steven Crosskey (UNOPS), Douglas Herrick (OECD), Lori Kerr (GIF), Kate Kooka (OECD), Maikel Lieuw-Kie-Song (ILO), Kate Newman (WWF), Daniel Taras (GIZ), Scott Thacker (UNOPS), Mito Tsukamoto (ILO), and Graham Watkins (IDB).

This draft has also benefitted greatly from the inputs of an Expert Working Group that helped to conceive of the guidelines, develop the original outline, and provided comments on early drafts. In addition to the team members mentioned above, the Expert Working Group includes Graham Alabaster (UN-Habitat), Scott Chapelow (CIFF), Cristina Contreras (Harvard University), Alison Davidian (UN Women), Achim Deuchert (GIZ), Alexandre Hedjazi (University of Geneva), Linda Krueger (TNC), Waleska Lemus (SIF), Oliver Lorenz (GIZ), Elizabeth Losos (Duke University), Katherine Lu (FoE), Virginie Marachal (OECD), Eva Mayerhoffer (EIB), Oshani Perera (IISD), Laura Platchkov (Swiss FOEN), Spiro Pollalis (Harvard University), Graham Pontin (FIDIC), Adina Relicovschi (EIB), Katharina Schneider-Roos (GIB), Tim Scott (UNDP), Shengping Shang (CHINCA), and Laurin Waunnenberg (IISD).

The authors are also grateful for additional contributions made by Nicholas Bonvoisin (UNECE), Till-Niklas Braun (UNEP), Yaxuan Chen (UNEP), Juan Garin (OECD), Colm Hastings (UNEP), Jinseok Kim (UNEP), Desiree Leon (UNEP), Joseph Price (UNEP), and Chengchen Qian (UNEP).

This draft has been prepared with financial support from the Global Environment Facility (GEF) and the Swiss Federal Office for the Environment (FOEN).

Acronyms

CHINCA – Chinese Overseas Contractors Association
CIFF – Children’s Investment Fund Foundation
EIB - European Investment Bank
FIDIC – International Federation of Consulting Engineers
FoE – Friends of the Earth
FOEN – Swiss Federal Office for the Environment
GDP – Gross domestic product
GEF – Global Environment Facility
GHG – Greenhouse Gas
GIB – Global Infrastructure Basel
GIF – Global Infrastructure Facility
GIZ - Deutsche Gesellschaft für Internationale Zusammenarbeit
IDB – Inter-American Development Bank
IFC - International Finance Corporation
IISD - International Institute for Sustainable Development
ILO - International Labour Organization
IMF – International Monetary Fund
InVEST - Integrated Valuation of Ecosystem Services and Tradeoffs
IUCN - International Union for the Conservation of Nature
MSMEs – Micro, small, and medium enterprises
NbS – Nature-based solutions
OECD – Organization for Economic Cooperation and Development
PBS – Performance-based specifications
PPP - Public Private Partnership
SDGs – Sustainable Development Goals
SEEA – System of Environmental-Economic Accounting
SIF – Sustainable Infrastructure Foundation
TEEB – The Economics of Ecosystems and Biodiversity
TNC – The Nature Conservancy
UNCTAD - United Nations Conference on Trade and Development
UNDESA - United Nations Department of Economic and Social Affairs
UNDP – United Nations Development Programme
UNEP – United Nations Environment Programme
UNEP-WCMC – World Conservation Monitoring Centre
UN-Habitat – United Nations Human Settlements Programme
UNOPS – United Nations Office for Project Services
WAVES – Wealth Accounting and the Valuation of Ecosystem Services
WWF – World Wildlife Fund/Worldwide Fund for Nature
IFRC - International Federation of Red Cross and Red Crescent Societies

Definitions

Infrastructure systems comprise physical assets (also referred to as “**hard**” infrastructure) plus the knowledge, institutions, and policy frameworks (also referred to as “**soft**” infrastructure) in which they exist and that enable them to function. These include both **built, or “grey”, infrastructure** in all sectors, and **natural, or “green”, infrastructure**.

Social infrastructure refers generally to those systems that deliver services upon which the health and well-being of societies depend, such as healthcare, education, housing, water and sanitation, rule of law, culture, and recreation, among others. **Economic infrastructure** refers generally to those systems that underpin the economy, including but not limited to energy, transport, and communication infrastructure. In many cases the lines between social and economic infrastructure are not well defined, since a given infrastructure system may serve both social and economic functions. For this reason, it is helpful to differentiate between social and economic infrastructures based on the needs that they are servicing, rather than by the type of service that is being provided or the type of asset or system used to do so.

Sustainable infrastructure systems are those that are planned, designed, constructed, operated, and decommissioned in a manner to ensure economic and financial, social, environmental (including climate resilience), and institutional sustainability over the entire infrastructure lifecycle.¹ Sustainable infrastructure can include built infrastructure, natural infrastructure, or hybrid infrastructure that contains elements of both (see below).

Implicit in the term “sustainability” are the concepts of inclusiveness, health and well-being, quality, service delivery, resilience, and value for money.

Other terms commonly used (and often misunderstood) when discussing sustainable infrastructure include ecological infrastructure, natural infrastructure, green infrastructure, and nature-based solutions. While relevant, these terms are not synonymous with sustainable infrastructure. **Natural infrastructure** (also sometimes called **ecological infrastructure, environmental infrastructure, or green infrastructure**) refers to “strategically planned and managed network[s] of natural lands, such as forests and wetlands, working landscapes, and other open spaces that conserves or enhances ecosystem values and functions and provides associated benefits to human populations”.² Natural infrastructure can be either naturally occurring or naturalized, but the key point is that it is actively managed; if it is not actively managed it is simply “nature”.³

Natural infrastructure can function on its own or be used to complement built infrastructure, and elements of natural infrastructure can be incorporated into the design of built infrastructure (e.g. green roofs and walls), resulting in “**hybrid infrastructure**”.

Nature-based solutions (NbS) is a broad term describing “actions to protect, sustainably manage and restore natural or modified ecosystems, which address societal challenges (e.g. climate change, food and water security or natural disasters) effectively and adaptively, while simultaneously providing human well-being and biodiversity benefits.”⁴ NbS are not limited to infrastructure, but are highly relevant and include the use of natural infrastructure and hybrid solutions to meet infrastructure service needs.

¹ This definition is adapted from the Inter-American Development Bank’s definition of sustainable infrastructure in: Inter-American Development Bank (IDB). *What is Sustainable Infrastructure? A Framework to Guide Sustainability Across the Project Cycle*. (Washington, DC, IDB, 2018).

² Benedict, M. and E. McMahon. *Green Infrastructure: Linking Landscapes and Communities*. 2nd ed. (Washington, DC, Island Press, 2006).

³ Roy, D. “The Multiple Benefits of Natural Infrastructure”, International Institute for Sustainable Development (IISD) Blog, August 27, 2018.

⁴ Cohen-Shacham, E., Walters, G., Janzen, C. and Maginnis, S., eds. *Nature-based Solutions to address global societal challenges*. (Gland, Switzerland, IUCN, 2016).

Introduction

This document seeks to address the gap in the provision of internationally applicable guidance on integrated, systems-level approaches to sustainable infrastructure planning and delivery. Recognizing that every country has a unique set of national circumstances, it presents policymakers with guiding principles for integrating environmental, social, and economic sustainability over the entire infrastructure lifecycle, in a way that they can be adapted and applied to any specific national context. In doing this, it aims to help governments move from simply “doing infrastructure right” to “doing the right infrastructure” that best meet service needs in a sustainable way.

Infrastructure and sustainable development

Infrastructure underpins human and economic development and is linked to all 17 of the Sustainable Development Goals (SDGs), either directly or indirectly influencing the attainment of 92% of the 169 individual SDG targets.⁵ Infrastructure systems—including those for transport, housing, energy, water and sanitation, waste management, food, natural resource use, industrial facilities, and telecommunications—are drivers of economic growth and enable access to the basic services and economic opportunities needed to improve livelihoods and well-being.

At the same time, infrastructure can have major negative impacts on people and the planet. Built infrastructure accounts for approximately 70% of global greenhouse gas (GHG) emissions⁶, and it can have direct and indirect impacts on ecosystems and biodiversity. Similarly, poorly planned infrastructure can exclude certain segments of society from access to services and benefits, and large-scale infrastructure development can lead to displacement of entire populations. Financial sustainability is also a concern, as expensive infrastructure projects can burden governments with unsustainable debt and create unsustainable business models for private participation and investments. In addition, poorly designed infrastructure can lead to high long-term maintenance or replacement costs during operation and have implications for decommissioning.

For infrastructure to serve a positive purpose, risks must be managed while societal, environmental, and economic benefits are enhanced. Making well-informed decisions is critical because infrastructure systems typically last for decades, defining our collective future by locking in decisions that are made in the present.

This is particularly important because of the scale of infrastructure investment that is expected in the coming decades. Increasing demand for infrastructure services in both developed and developing countries means that trillions of dollars will need to be invested in new and existing infrastructure. The Organization for Economic Cooperation and Development (OECD), for instance, has estimated that an annual average of US\$6.9 trillion in climate-compatible infrastructure investment is required over the next decade to meet global development needs.⁷

The COVID-19 pandemic has added to the urgency to the issue. Governments are enacting massive economic recovery packages that in the medium term are likely to involve significant investments in infrastructure as a means of stimulating the economy and addressing gaps that are hindering long-term development.⁸

In order to achieve the SDGs and objectives of the Paris Climate Agreement, and safeguard our societies and economies against future crises, it is imperative that these infrastructure investments do not follow “business-as-usual” approaches, which have proven to be unable to deliver sustainable infrastructure at the scale required. Norms must shift toward improved infrastructure planning, preparation, financing, delivery, and management that makes use of the best available evidence to create infrastructure systems that can effectively, efficiently, inclusively, and sustainably deliver services.

⁵ Thacker S., Adshead D., Morgan G., Crosskey S., Bajpai A., Ceppi P., Hall J.W. & O'Regan N. *Infrastructure: Underpinning Sustainable Development* (Copenhagen, Denmark, UNOPS, 2018).

⁶ Saha, D. “Low Carbon Infrastructure: an essential solution to climate change?”, World Bank Blogs, April 18 2018.

⁷ Organization for Economic Cooperation and Development (OECD). *Investing in Climate, Investing in Growth: A Synthesis*. (Paris, 2017). Note: this figure includes only investments in four sectors: energy, transport, water, and telecoms. The amount of infrastructure investment needed for achieving the SDGs will be significantly higher and include additional sectors.

⁸ Davisson, K., Losavio, J. “How Sustainable Infrastructure Can Aid the Post-COVID Recovery”, World Economic Forum website, April 28 2020.

A Good Practice Guidance Framework for integrated, systems-level approaches

The relationship between different types of infrastructure systems and economies, societies, and the environment are complex and multidimensional. For infrastructure investments to contribute to the SDGs, sustainability must be integrated into infrastructure planning and development from the earliest stages in the planning cycle in a way that considers the interlinkages between different infrastructure systems and sectors, their locations, relevant governance frameworks, and the three pillars of sustainability (economic, social, and environmental) throughout the entire infrastructure lifecycle. This type of integrated, systems-level approach⁹ can increase governments' abilities to meet service needs with less infrastructure in fewer locations, that is more resource efficient, pollutes less, is more resilient, more cost effective, and has fewer risks than "business-as-usual" approaches.

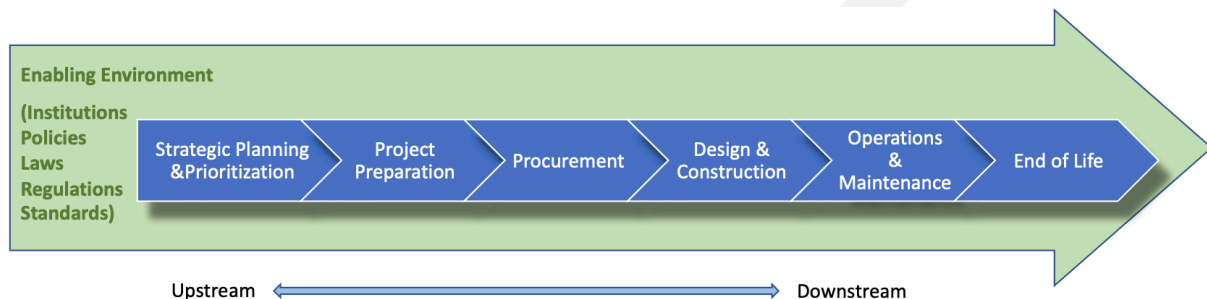


Figure 1: the infrastructure lifecycle and enabling environment

In "business-as-usual" approaches, the environmental and social impacts of infrastructure are often considered only at the project level, and the interconnections between different infrastructure systems and sectors are not fully accounted for. However, infrastructure systems are interdependent, and landscapes, ecosystems, and societies are subject to the cumulative impacts of multiple infrastructure systems. When infrastructure is viewed as a "system of systems", trade-offs and synergies from different projects and sectors can be balanced against one another to achieve more efficient allocation of infrastructure investments for delivering services and meeting national sustainable development objectives.¹⁰ Potential risks can be identified and addressed earlier in the planning process, resulting in more sustainable projects that are better aligned with users' needs and expectations.

Although there are many existing guidelines, standards, and tools for integrating sustainability into infrastructure and spatial planning, they are usually only applied at the single-project level and often too late in the process to have an impact, after key decisions about what to build and where to build it have been made.

This guidance, therefore, summarizes best practice for integrated, upstream, systems-level approaches to sustainable infrastructure planning, preparation, and delivery that aim to create the enabling environment for sustainable infrastructure that supports the achievement of the SDGs.

The guidance is focused on actions that can be taken by governments. The public sector plays the main role in creating the enabling environment for sustainable infrastructure, and without the right institutions and policies in place, infrastructure investments will continue on an unsustainable "business-as-usual" pathway. This applies to all infrastructure development, regardless of the respective roles that the public and private sectors may play as sponsors or investors of any given project.

In addition to creating the enabling environment, governments are also the major drivers of infrastructure development. While private investment is needed to help close the infrastructure gap and is expected to play an increasingly important role in infrastructure development, it is government that civil society ultimately holds accountable for providing most infrastructure services. This is reflected in the fact that the public sector accounts for the majority of global infrastructure investment.¹¹ In 2017, for example, the public sector accounted for 83% of infrastructure investment in developing countries, and when the private sector does invest in infrastructure it is often in publicly sponsored infrastructure

⁹ For a more detailed description of integrated approaches, see: United Nations Environment Programme (UNEP). *Integrated Approaches to Sustainable Infrastructure*. (Geneva, UNEP, 2019).

¹⁰ Hall J.W., Tran M., Hickford A.J., Nicholls R.J., eds., *The Future of National Infrastructure: A System of Systems Approach*. (Cambridge, UK, Cambridge University Press, 2016).

¹¹ The Global Commission on Economy and Climate. *The Sustainable Infrastructure Imperative; Financing for Better Growth and Development*. (Washington, DC, World Resources Institute, 2016).

projects and involves financing from public institutions.¹² Public policy and procurement of infrastructure, therefore, is a powerful force for channelling investment into sustainable infrastructure projects and creating positive on-the-ground impacts.

Guiding principles

1. *Infrastructure policies and decisions should be based on strategic planning that is aligned with global sustainable development agendas¹³ and supported by enabling policies, regulations and institutions that facilitate coordination across departments and levels (national and sub-national) of public administration.*

Short, medium and long-term decision-making on infrastructure investment should be informed by a long-term, needs-based strategic vision for sustainable development and just transition that transcends national and sub-national political cycles. This vision needs to be supported by appropriate planning, including via national and sub-national development and investment plans aligned with sequential planning cycles. It is crucial that environmental, social, and economic sustainability is fully integrated in those plans, and that there is conceptual coherence between them. Infrastructure projects should then be aligned with these plans and delivered in the context of multi-year public sector budgets.¹⁴ Planning should include clear environmental, social and economic goals and targets, which can help guide decisionmakers towards the selection of more sustainable infrastructure projects.¹⁵

In addition to new sustainable infrastructure systems, these plans should include sustainability strategies for existing infrastructure, including in sectors that are not sustainable (e.g., oil and gas or mineral resource extraction). This can help to minimize environmental and social impacts from these sectors, avoid stranded assets where possible, and mitigate the economic impacts where stranded assets are unavoidable.

To enable integrated sustainable infrastructure planning, delivery, and management, institutional coordination is required, both vertically (national to sub-national) and horizontally (e.g., between different ministries and administrative jurisdictions) at all levels of government. Across its lifecycle, infrastructure—and sustainable infrastructure in particular—touches upon the mandates of many different parts of government, and infrastructure systems and their impacts often cross geographical and administrative boundaries, including transnational boundaries. By planning and managing infrastructure development at the level of its wider geographic impact, planners are better able to optimise the management of physical and natural capital and use limited resources more efficiently.¹⁶

To enable this type of coordination, traditional silos need to be broken down—both between and within institutions—to facilitate more interdisciplinary collaboration. Data collection, generation and analysis needs to be coordinated; data needs to be shared; vision, planning, and policies need to be jointly conceived; and processes need to be in place to ensure that policies and regulations at various levels do not contradict each or set opposing incentives or market signals. Interdisciplinary and intersectoral coordination among and within institutions is also of major importance to ensure that all relevant aspects—including environmental and social sustainability—are duly considered from the earliest stages of infrastructure planning.

Better coordination and collaboration may require organizational change and capacity building.¹⁷ Initiatives to improve institutional and organizational capacity should include peer learning, joint problem solving, and co-creation, in addition to targeted training programs. Besides government officials at the ministerial level and local officials, training should also be offered for stakeholders from the private sector, including financial institutions, contractors and sub-contractors. The complexity of

¹² World Bank. Who Sponsors Infrastructure Projects? Disentangling public and private contributions, 2017. (Washington, DC, World Bank, 2019).

¹³ The 2030 Agenda for Sustainable Development is considered to be the current overarching global sustainable development agenda.

¹⁴ IDB. What is Sustainable Infrastructure? A Framework to Guide Sustainability Across the Project Cycle.

¹⁵ The 2030 Agenda and related material—which includes, inter alia, the SDGs, the Addis Ababa Action Agenda, the Paris Climate Agreement, the Sendai Framework, and the New Urban Agenda—provides a comprehensive and broadly accepted framework on which to base national strategic visions and plans. Governments should select appropriate targets and indicators based on local objectives and conditions.

¹⁶ Battacharya, A., Nofal, B., Krueger, L., Jeong, M., Gallagher, K. “Policy and Institutional Framework for Delivering on Sustainable Infrastructure”, T20 Policy Brief, (Japan, T20 Task Force 4: Economic Effects of Infrastructure Investment and its Financing, 2019).

¹⁷ IDB. What is Sustainable Infrastructure? A Framework to Guide Sustainability Across the Project Cycle.

interdependent infrastructure systems heightens the need to strengthen institutional and organizational capacities.

Implementation of the plans and strategies must be supported by a stable and predictable enabling regulatory and policy environment that mandates and incentivizes sustainability consistently over time and across domains. Governance structures, legal frameworks, and economic, social, and environmental policies that are aligned with long-term, needs-based visions and plans help to provide certainty and reduce risks for planners, businesses, investors, and other key drivers of infrastructure development. This includes not only policy shifts directly related to infrastructure, but also to any other elements of the integrated governance framework (notably laws and regulations) that have an effect on it, such as contract enforcement and transborder issues such as capital account convertibility and the ability to repatriate profits. The enabling framework for financing also includes regulatory certainty, appropriate economic incentives, fiscal policies, credit enhancement and risk mitigation mechanisms (including for social and environmental risks) as well as improving local capital market conditions for sustainable infrastructure (through green bonds, for example).¹⁸ Sanctions and penalties for non-compliance with laws and regulations need to be sufficiently high and well-enforced to avoid being considered part of “the cost of doing business”.

These measures are particularly important for attracting private sector investment, which will play an increasingly important role in infrastructure development as limited public budgets mean that governments are looking to the private sector to fill infrastructure investment gaps. A stable policy and regulatory environment must be accompanied by appropriate institutions capable of designing, implementing and enforcing reforms to enable private investment.

- 2. *Infrastructure planning and development should be based on a good understanding of infrastructure service needs and informed by the diverse solutions available to meet the needs. This includes understanding and managing the changing demand for infrastructure and meeting needs through renovating or rehabilitating existing infrastructure before investing in new infrastructure. Systems-level planning of Infrastructure projects should promote synergies for improved connectivity, which can lead to improved productivity, efficiency, sustainability, and spillover benefits of investment. Flexibility and resilience should be built into infrastructure plans to account for changes and uncertainties over time.***

Infrastructure planning should be based on clearly identified service needs and be adaptable to a variety of future conditions. Planning sustainable infrastructure from a service-based understanding of needs allows for more efficient allocation of resources and can result in lower-cost infrastructure that is better aligned with user needs and sustainable development objectives.¹⁹

Central to service-needs-based approaches is a solid understanding of the changing drivers of demand for infrastructure—including demographics and population growth, urbanization and migration, climate change, lifestyles, health, climate change, and economics, among others—as well as the performance (including the sustainability) of existing systems in meeting current and projected demand.

It is also important to consider potential risks to the viability of infrastructure, such as the estimated impacts of climate change and land degradation, disasters, pandemics, economic crises, and other shocks. In addition, infrastructure should be planned and designed to accommodate technological changes and avoid locking in technology that may become obsolete or prohibitively expensive. This can include carbon intensive and polluting technology that may increase future operating costs as environmental externalities are increasingly factored into pricing. Conversely, technology that increases future flexibility (e.g. digital solutions) can help to reduce the risks of uncertainty and increase resilience to shocks.

Accounting for the interactions between different infrastructure systems and sectors is critical to understanding all of these factors, as changes made to one can affect the risks to, demand for, and performance of others. For example, any infrastructure system is only as reliable, resilient, or sustainable as its energy source. Failure to understand these interlinkages at the planning phase threatens the viability of infrastructure systems and can have broader social and environmental ramifications. Integrated, systems-level approaches to infrastructure planning not only ensure

¹⁸ Inter-American Development Bank (IDB). What is Sustainable Infrastructure? A Framework to Guide Sustainability Across the Project Cycle. (Washington, DC, IDB, 2018)

¹⁹ Rozenberg, J., Fay, M. Beyond the Gap: How Countries Can Afford the Infrastructure They Need while Protecting the Planet. (Washington, DC, World Bank, 2019)

enhanced connectivity and synergies between services but also enables better integration of sustainability over the entire lifecycle.

Following an assessment of current and anticipated service needs—and the performance and sustainability of existing infrastructure assets—planners should explore a range of solutions. In meeting infrastructure service needs, planners should follow the mitigation hierarchy, where negative environmental and social impacts (e.g. resulting from project siting, resource use, emissions, population displacement, etc.) are first avoided, then minimized, and if unavoidable are compensated for.²⁰

In some instances, new infrastructure assets will be the right choice. However, despite their political appeal, new assets are usually natural resource-, carbon-, and capital-intensive and often take time to become operational. The tendency of planners to focus on new assets can often mean that other more sustainable, less costly, and lower-risk solutions for infrastructure service provision are overlooked. This can result in infrastructure that is unsustainable, inefficient, and ultimately not fit for purpose. So-called “white elephant” infrastructure projects offer extreme examples of misalignment with demand, but even more moderate cases represent missed opportunities and inefficient allocation of scarce resources.

While trade-offs between environmental, social, and economic costs and benefits are inevitable, there are many options for meeting infrastructure service needs in a way that balances outcomes vis-à-vis the three dimensions of sustainability. The choice for solutions should be informed by the best available evidence on a range of options that can most sustainably and effectively meet needs, including reducing demand for services where usage is inefficient or unsustainable (e.g. through financial incentives and taxation); retrofitting or upgrading existing infrastructure assets; selecting the best available technologies; improving efficiencies of distribution including reducing losses and policing illegal connections and usage; and substituting grey infrastructure with NbS where possible (see guiding principle four). Co-location and multi-purpose infrastructure should also be considered as a means of improving resource efficiency, reducing the costs of construction and operations, minimizing adverse environmental and social impacts, maximizing synergies in service delivery, and capturing the benefits of economies of scale.

Planners can use tools such as modelling, scenario analysis, and strategic foresight, to understand the interactions between different infrastructure systems, the trade-offs between different costs and benefits, potential risks and future uncertainties, and the viability and sustainability of different infrastructure solutions and incorporate them into infrastructure planning. When used as part of systems-level approaches, these tools can help create flexible, “no-regret” approaches that allow for adaptation to changes and ensure continued and sustainable delivery of infrastructure services.²¹

3. *Infrastructure’s environmental, social, and economic sustainability should be assessed as early in the planning and preparation cycle as possible, covering both financial and non-financial factors across interdependent projects, systems, and sectors over their lifecycles. Assessments should consider the aggregate impacts on ecosystems and communities at the landscape scale, beyond a project’s immediate vicinity, and account for transnational impacts.*

Analysis of infrastructure options should include economic factors, as well as the cost of externalities and social and environmental costs and benefits with adjustments for risks and market imperfections. Where possible, all types of costs and benefits should be quantified in monetary terms so that objective trade-offs can be made based on a common frame of reference.

Environmental factors include the impacts of infrastructure on nature (including direct impacts like habitat degradation and pollution, as well as indirect impacts from climate change, resource use for construction, and illegal wildlife trade, among many others); the impacts of nature on infrastructure and people (especially in terms of climate and disaster resilience); and the value that biodiversity and ecosystem services provide.²² Social factors include human rights, inclusiveness, the creation of

²⁰ While the mitigation hierarchy was conceived with specific reference to biodiversity losses, the principle can also be applied to other negative environmental and social impacts.

²¹ United Nations Development Programme (UNDP) Global Centre for Public Service Excellence. *Foresight as a strategic long-term planning tool for developing countries*. (Singapore, UNDP, 2014).

²² There are several methodologies for quantifying the value of natural capital and ecosystem so that they can be incorporated into decision-making (e.g. TEEB, WAVES, SEEA, InVEST). They all recognize the social and economic importance of biodiversity and ecosystem services and quantify their values in economic terms that can inform cost-benefit analysis and decision-making. These tools can help to demonstrate the benefits of investing in natural infrastructure and facilitate accurate comparison of grey and green infrastructure as potential solutions for meeting infrastructure service needs.

employment and livelihoods, gender implications, and the ways in which infrastructure impacts the health and safety of users, workers, and communities, among others.

Social and environmental impacts can be both immediate as a result of construction (e.g. biodiversity loss from land clearing, displacement of people, etc.) and ongoing during operation (e.g. carbon emissions, disrupted ecosystem and habitat connectivity, changes in land use and economic activity, noise pollution, gender discrimination, etc.). Environmental, social, and economic costs and benefits should be considered across the entire infrastructure lifecycle (see figure 1). For example, the environmental and material footprint of each stage of the lifecycle must be assessed and cumulative impacts considered. This includes both inputs (e.g. energy, construction materials like sand, minerals, etc.) and outputs (e.g. solid waste, water, emissions, etc.).

Planners should also account for the cumulative costs and benefits of multiple interconnected infrastructure systems and projects, and evaluations should not be arbitrarily constrained by administrative boundaries. Environmental impacts should be considered at the landscape or ecosystem scale, across all relevant jurisdictions. This includes transnational impacts, which are particularly important for resources such as water, where upstream impacts in one country may have downstream effects in other countries, and for impacts to migratory species whose ranges and habitats extend beyond national borders. In the latter case, ensuring habitat connectivity across borders is an important way of managing impacts.

Rural-urban linkages are also important. Infrastructure built in rural areas to meet the service needs of urban populations may have negative local impacts that outweigh the benefits to the end-users. With large amounts of infrastructure expected to be built in—or to provide services to—increasingly crowded and expanding urban areas, planners must understand the spatial distribution of costs and benefits.

Understanding the costs and benefits at the aggregate level, and the synergies and trade-offs between environmental, social, and economic costs and benefits, can help determine if the overall mix of infrastructure systems provides the best solutions for meeting service needs (see guiding principle two) while achieving sustainability objectives.

To fully understand the environmental, social, and economic costs and benefits of different infrastructure systems, instruments such as sustainability assessments, strategic environmental assessments, and cumulative impact assessments should be systematically applied as early in the infrastructure lifecycle as possible—ideally during strategic planning—when alternatives and opportunities for risk avoidance and synergies are still politically, economically, and technically feasible.

4. Adverse environmental impacts from infrastructure should be minimized, and natural capital enhanced to the greatest degree possible. Construction should be avoided in areas important for the persistence of biodiversity or of high ecosystem service value. The development of physical infrastructure should seek to complement or strengthen rather than replace nature's ability to provide services such as water supply and purification, flood control, and carbon sequestration. Nature-based solutions should be prioritized.

Infrastructure inevitably becomes a component of its environment and interacts with existing ecosystems, many of which provide important ecosystem services (e.g. carbon sequestration, water quantity and quality management, flood protection, air purification, land stabilization, among others) that are easily disrupted.²³ Based on a good understanding of aggregate environmental impacts at the landscape and ecosystem scales (see guiding principle three), infrastructure planning and development should account for and maintain natural infrastructure systems so that they continue to flow, adapt, and produce – while delivering the services humans need to survive.

In order to minimize environmental impacts, brownfield development—i.e. choosing sites that have already been altered from their natural states—and co-location should be prioritized to the extent possible, which applies to both above- and below-ground sites. Where greenfield development—i.e. building in previously undisturbed sites—is necessary, planners should follow the mitigation hierarchy (see guiding principle two), with the additional consideration that impacts to areas important for the persistence of biodiversity or high of ecosystem service value should be avoided altogether if possible.

²³ Ecosystem services are the benefits that people obtain from ecosystems. For more information, see: Millennium Ecosystem Assessment. *Ecosystems and Human Well-being: Synthesis*. (Washington, DC, Island Press, 2005).

Such areas provide the most benefits at larger scales, making it extremely difficult or impossible to adequately compensate for impacts to them.²⁴

For some infrastructure assets (e.g. oil and gas infrastructure), even the *potential* environmental impacts of an accident or disaster may be so great that large buffers should be maintained between the assets and areas important for the persistence of biodiversity or high of ecosystem service value.

Where construction and operation of infrastructure near environmentally sensitive areas—or the use of potentially polluting or hazardous materials or technologies—is acceptable and necessary, best practice measures to manage waste and mitigate environmental and safety impacts throughout the lifecycle should be factored into the cost-benefit analyses of the various options being considered. Governments should develop plans at the transnational, national, and subnational levels for the management of pollution to soil, water, and air as well as the stewardship of biodiversity, and assess the impacts of infrastructure projects in relation to local and national sustainability targets.²⁵

Resilience is also a key consideration, as ecosystem degradation can become a threat to built infrastructure systems themselves if nature loses its capacity to protect them from floods, landslides, wildfires, and other disasters and accidents. Potential impacts from accidents and disasters, and the effects of climate change should also be taken into account when planning the location of infrastructure, both in terms of the resilience of the infrastructure itself—exposure to landslides or flooding in a certain location, for example—and in terms of impacts that infrastructure can have on the natural environment in the event of a disaster. Resilience and disaster and emergency response strategies should be prepared for all phases of the infrastructure lifecycle and should account for uncertainty as much as possible, as well as known or anticipated risks.

The use of NbS as a means of delivering infrastructure services can play a major role in achieving “triple wins” of increased environmental, social and economic sustainability. Nature-based infrastructure solutions involve using the services that landscapes and ecosystems provide naturally to replace or complement built infrastructure options. Examples of the former would include enhancing the water storage capacities of wetlands to provide flood protection and preserving existing forests to prevent landslides and soil-erosion. Examples of the later includes the incorporation of green spaces into urban environments, and the use of environmental design features such as green walls and roofs. NbS have the advantage of delivering infrastructure services while at the same time providing numerous co-benefits for nature, the society (including the built environment) and human health and well-being.²⁶

In many cases, NbS can be more cost-effective than built infrastructure solutions, particularly when the cross-sectoral co-benefits are considered. Investing in the protection of mangrove ecosystems as flood protection, for example, can save millions of dollars per year in the costs of dyke construction and maintenance while also enhancing the biological productivity of the marine ecosystem from which local people derive their livelihoods.²⁷ Similarly, investing in watershed protection and restoration can save hundreds of millions of dollars a year in the cost of water quality management.²⁸

Preserving natural ecosystems is much less costly than restoring or replacing them, so policymakers should prioritize their protection when planning infrastructure development and seek to maximize synergies between natural and grey infrastructure. Investment into preserving and enhancing natural capital and ecosystem services should also be considered even when there are no immediate and direct social or economic benefits. Well-functioning of natural systems and biodiversity have intrinsic value, as well as many indirect and long-term benefits for humans.

5. *Circularity and the use of sustainable technologies and construction materials should be planned and designed into infrastructure systems to minimize their natural resource footprints and reduce emissions, waste, and other pollutants.*

²⁴ Bartlett, R. *Visioning Futures: Improving infrastructure planning to harness nature’s benefits in a warming world.* (Washington, DC, WWF, 2019)

²⁵ IDB. *What is Sustainable Infrastructure? A Framework to Guide Sustainability Across the Project Cycle.*

²⁶ Cohen-Shacham, E. and others, *Nature-based Solutions to address global societal challenges.*

²⁷ International Federation of Red Cross and Red Crescent Societies (IFRC). *World Disasters Report; Focus on Reducing Risk.* (Geneva, IFRC, 2002). <https://www.ifrc.org/Global/Publications/disasters/WDR/32600-WDR2002.pdf>

²⁸ Gartner, T., J. Mulligan, R. Schmidt, and J. Gunn. *Natural Infrastructure Investing in Forested Landscapes for Source Water Protection in the United States.* (Washington, DC, World Resources Institute, 2013)

The construction of infrastructure uses vast amounts of natural resources, accounting for almost half of the global material footprint,²⁹ and is a major contributor of global greenhouse gas (GHG) emissions.³⁰ In addition, infrastructure assets contribute to other types of air, ground, and water pollution during construction, operation, and decommissioning, and are also responsible for a large volume of solid waste. The construction, maintenance, and demolition of buildings, for example, is responsible for 40% of solid waste produced in developed countries.³¹

Decoupling infrastructure from resource consumption, GHG emissions, pollution, and waste generation can be done most effectively using integrated, service-needs-based approaches (see guiding principle two) to minimize the amount of new infrastructure that is constructed. With such approaches, reducing demand and investing in natural infrastructure should be the first options considered, followed by upgrading or repurposing existing infrastructure.

Where new infrastructure assets—or repairs and upgrading of existing assets—are required, planners should understand the type and quantity of natural resources required for construction across the whole value chain and consider the use of alternative materials and technologies that can help to reduce the material requirements. For example, finding alternatives to concrete—and ways to use less of it—will have a major positive impact on the resource efficiency (as well as the carbon footprint) of infrastructure.^{32, 33} Similarly, the prohibition or avoidance—where possible—of materials that are polluting, hazardous, or difficult to dispose of safely can lead to significant savings on the costs of environmental mitigation and safety measures during construction and operations, and disposal costs during decommissioning.

Circularity and industrial symbiosis are also extremely important for improving resource efficiency and reducing pollution and waste. Reusing materials from existing infrastructure assets that are being replaced with new ones, for example, can reduce costs and increase the resource efficiency of the new assets. The potential savings are significant, since the cost of raw materials can account for 40-60% of the overall cost of construction of an infrastructure asset. Similarly, carefully designed interconnected and multifunctional infrastructure such as district heating systems enable greater energy efficiency and associated cost savings. District heating systems typically have efficiencies of 90%.³⁴

Principles of circularity—including resource recovery, reuse, remanufacturing, and recycling—should be designed into the entire lifecycle of infrastructure. Integrated planning across different sectors is essential to enabling this, as choices about the location of infrastructure and the technologies and materials used all impact the degree to which circularity can be incorporated.

New technologies may also be able to help decouple infrastructure development from resource use and pollution and waste by enabling “dematerialized” solutions, such as digital infrastructure that can reduce the need for built infrastructure. Digital infrastructure may also contribute to increased economic and social resilience to shocks, such as during the COVID-19 pandemic when access to internet and digital technology was a major factor in limiting the negative economic and social impacts of measures taken to stop the spread of the virus. In addition, technology like artificial intelligence and real-time data from remote sensors and smart meters can help to improve the efficiency of service delivery by better matching it to demand. In the case of energy infrastructure, for example, this can help lower peak demand and the associated costs, enable the use of clean energy, and provide electricity more reliably.³⁵ Technological solutions may themselves, however, have environmental impacts that must be accounted for as well (e.g. energy consumption and use of rare earth minerals).

Public policies play a critical role in enabling the use of new technologies and alternative construction materials in infrastructure projects. Standards and specifications for design, construction, and operation of infrastructure must be formulated to promote or enforce the use of sustainable and innovative materials, and laws and regulations should limit or prohibit the use of hazardous ones.

²⁹ Life Cycle Initiative. SCP Hotspot Analysis Tool, available at <http://scp-hat.lifecycleinitiative.org/> (accessed on 15 October 2019).

³⁰ Saha, D. “Low Carbon Infrastructure: an essential solution to climate change?”

³¹ Bringezu, S. and others. Assessing global resource use: A systems approach to resource efficiency and pollution reduction. (Nairobi, International Resource Panel and United Nations Environment Programme, 2017)

³² Peduzzi, P. “Sand, rarer than one thinks.” *Environmental Development* volume 11, p.208-218 (2014).

³³ Lehne, J. and Preston, F. *Making Concrete Change: Innovation in Low-carbon Cement and Concrete*. (London, Chatham House, 2018)

³⁴ UNEP. District Energy in Cities: Unlocking the Potential of Energy Efficiency and Renewable Energy. (Nairobi, UNEP, 2015).

³⁵ Atkinson, R. D., Castro, D., and Ezell, S. J. *The Digital Road to Recovery: A Stimulus Plan to Create Jobs, Boost Productivity and Revitalize America*. (Washington, DC, Information, Technology, and Innovation Foundation, 2009).

When issuing contracts for infrastructure projects, governments can incentivise bidders to incorporate sustainability by embedding those criteria—including requirements for compliance with integrated spatial plans, the use of sustainable construction materials, incorporation of NbS and hybrid solutions, and sustainability certifications—into procurement processes. Governments can also put more weight on sustainability factors and performance-based criteria when awarding contracts. Rather than basing procurement decisions on the lowest-cost bid, for example, governments should consider life-cycle costing—including the costs carbon emissions and other externalities over the entire infrastructure lifecycle—as a means of incentivizing more sustainable infrastructure projects.³⁶ Performance-based specifications (PBS) are another way for the procurement authority to incorporate sustainability into infrastructure procurement. PBS describe the desired performance level through output specifications with associated performance indicators, and they should include environmental and social performance criteria. By only specifying the desired outcomes and not the means of achieving them, well-formulated PBS can tap the power of the private sector to find innovative sustainable infrastructure solutions.³⁷

6. Infrastructure investment must be balanced between social and economic priorities. Infrastructure should provide accessible and affordable services equitably to all with a view to promoting social inclusion and fostering economic empowerment and social mobility and protecting human rights. It should avoid harm to communities and end-users—especially those who are vulnerable or marginalized—be safe and promote human health and well-being.

Infrastructure is the basis for the enhancement of human and social capital and plays a central role in the development of healthy, resilient, and inclusive communities. It delivers essential services and facilitates social integration and is therefore vital for enhancing the social inclusion of the world's poorest and most vulnerable. Underinvestment in—and a lack of access to—infrastructure is one of the main drivers of social exclusion. However, unlike economic infrastructure that can often recover and generate revenue from end users, many types of social infrastructure are reliant on public sector financing.³⁸ As a result, more than twice as much investment goes into economic infrastructure than to social infrastructure.³⁹

At the strategic level, infrastructure planning needs to allocate adequate resources to the development of social infrastructure, as well as economic infrastructure. Given the limited resources of many governments, innovative solutions are required in order to bring in other sources of financing and investment. In many cases user revenues alone may not be enough to offset the cost of building and operating an infrastructure system and other sources of revenue or cost reduction must be found. Projects that have primarily social or environmental benefits, for example, may never be “bankable” when considered as stand-alone projects. In such cases, other more bankable projects may be able to help cover the costs of providing important public goods. For example, taxes on cars or user fees from toll roads can be used to subsidize low-carbon public transportation. Such considerations require integrated planning.

All Infrastructure development—social and economic—should benefit communities, workers and employers, service users, taxpayers and the population at large in an equitable and transparent manner with an adequate level of social protection and equal access to the critical services and benefits provided by the infrastructure, regardless of ability to pay. Similarly, measures must be put in place to uphold human rights and counteract the tendency of adverse impacts from infrastructure development to fall disproportionately on poor, vulnerable, marginalized, and disadvantaged groups. Infrastructure development should not cause displacement, loss of housing, land, assets and livelihoods, and should avoid cultural heritage sites and other areas conserved by indigenous peoples and local communities.⁴⁰ This includes potential impacts from accidents and disasters.

Particular attention should be paid to the needs of women and girls. The gaps in access to infrastructure affect men and women in different ways. Infrastructure development should therefore be gender

³⁶ OECD/World Bank/UNEP. Financing Climate Futures: Rethinking Infrastructure. (Paris, OECD, 2018)

³⁷ Turley, L., Hug Silva, M., Benson, S., and Dominguez, C. *Performance-Based Specifications: Exploring when they work and why*. (Winnipeg, Manitoba, IISD, 2014).

³⁸ Fransen, L., del Bufalo, G., and Reviglio, E. “Boosting Investment in Social Infrastructure in Europe: Report of the High-Level Task Force on Investing in Social Infrastructure in Europe”, European Economy Discussion Paper 074. (Luxembourg, publications office of the European Union, 2018).

³⁹ Woetzel, J., Garemo, N., Mischke, J., Kamra, P., and Palter, R. *Bridging Infrastructure Gaps: Has the World made Progress?* (McKinsey Global Institute, 2017)

⁴⁰ International Union for the Conservation of Nature (IUCN). Document WCC-2016-Rec-102-EN Protected areas and other areas important for biodiversity in relation to environmentally damaging industrial activities and infrastructure development.

responsive and provide men and women with equal access to jobs and services, as well as an equal voice in setting priorities for infrastructure design and operation.⁴¹

Governments should ensure that measures are in place to protect workers on infrastructure projects, including legislation and standards on minimum wages, social security, leave, occupational safety and health, and public procurement processes. National legislation and standards should be in line with the International Labour Organization (ILO) Declaration on Fundamental Principles and Rights at Work.⁴²

7. Infrastructure should create employment, support local businesses, and build amenities that benefit communities, thereby maximizing and safeguarding its economic benefits.

In many cases, economic stimulus is a driving factor in the decision to build new infrastructure. The provision of certain services—from energy, water, or transportation infrastructure, for example—can have far reaching benefits for the economy, such as stimulating industrial development, trade, and workforce mobility, among others. However, these projected benefits can fail to materialize if infrastructure is planned based on an incomplete understanding of needs, in isolation of interconnected systems, and without the enabling policies in place to ensure the desired outcomes.

Infrastructure planners and developers should also systematically seek opportunities to create environmental and social co-benefits of infrastructure development, which requires integrated, systems-level planning that considers sustainability and interlinkages across sectors from the outset.

The construction and operation of infrastructure has strong potential for job creation and stimulation of local economies. Measures to optimize the employment impacts—including incentivizing the use of labor-based and local-resource-based solutions, technologies and practices and enabling the participation of micro small and medium enterprises (MSMEs)—should be included in the design and procurement strategies and processes for infrastructure. Such approaches are often well aligned or synergistic with the deployment of NbS. For example, the use of native vegetation instead of concrete to prevent soil erosion around structures and as flood protection in coastal areas provides installation and maintenance jobs for local communities reduces the amount of imported construction materials.

Involving MSMEs in infrastructure projects can have a multiplier effect on economic benefits in the local community. Linkages among large companies and MSMEs can be effective avenues for the transfer of technology, knowledge, and managerial and technical skills, but this depends on the enabling environment and absorptive capacity of domestic MSMEs. Contractual incentives, streamlined business regulations and bidding procedures, targeted vocational training, business development services, and access to financing dispute resolution mechanisms can help to increase MSME involvement in infrastructure development.

Development around growth poles—which involves concentrating multi-sectoral investment and development in areas where certain infrastructure already exists—is another strategy for increasing the economic benefits of infrastructure development by driving the agglomeration of economic activity and growth of industry. Beyond the simple economic benefits of co-location, growth pole development can stimulate growth by increasing competition, fostering innovations, and exploiting synergies and linkages between different sectors and industries.⁴³ Co-location around growth poles can also have environmental benefits by enabling circularity and multipurpose infrastructure and limiting the need for greenfield development.

8. Infrastructure development should ensure fiscal transparency, financial integrity, and debt sustainability.

The development, operation and maintenance of infrastructure requires large capital investments, with countries spending up to 8% of GDP on infrastructure.⁴⁴ With these investments expected to increase over the next 20 years to meet the estimated US\$15 trillion infrastructure investment gap,⁴⁵

⁴¹ Wellenstein, A. and Gill, M. “Making Infrastructure Work for Both Women and Men”, World Bank Blogs, August 28 2019.

⁴² International Labour Organization (ILO). Declaration on Fundamental Principles and Rights at Work.

⁴³ Speakman, J. and Koivisto, M. “Growth Poles: Raising Competitiveness and Deepening Integration”, in *The Africa Competitiveness Report 2013*. (Geneva, World Economic Forum, 2013).

⁴⁴ Fay, M., Lee, H.I., Mastruzzi, M., Han, S., and Cho, M. “Hitting the Trillion Mark; A Look at How Much Countries are Spending on Infrastructure”. Policy Research Working Paper 8730. (Washington, DC, World Bank Group, 2019).

⁴⁵ Global Infrastructure Hub. Global Infrastructure Outlook, available at https://outlook.gihub.org/?utm_source=GIHub+Homepage&utm_medium=Project+tile&utm_campaign=Outlook+GIHub+Tile (accessed on 3 November, 2019).

governments must be vigilant about ensuring financial and fiscal sustainability at the programme and project level as well as debt sustainability at the national level. This has become even more important as the economic impacts of the COVID-19 crisis stretch public budgets and threaten debt sustainability in developing countries, in particular.⁴⁶

Debt sustainability assessments should take into account the aggregate commitments to infrastructure projects, whether projects are financed publicly, privately, or both. The International Monetary Fund (IMF), for example, has developed debt sustainability assessment frameworks for countries of different income levels that can be used to identify vulnerabilities in national public debt structures and implement measures to address the issues. The results of debt sustainability assessments should help to inform the development of sustainable infrastructure investment plans.

Taking a long-term view of fiscal sustainability is particularly important for sustainable infrastructure projects where the more sustainable options may have higher up-front costs but deliver significant savings and benefits in the long run. Integrated, systems-level planning is essential for understanding fiscal sustainability across the lifespan of infrastructure, and how revenues from certain infrastructure projects may help to offset the costs of others, enabling economic trade-offs in the short term that can lead to “triple-wins” of enhanced environmental, social, and economic sustainability in the long term.

There are different ways to pay for and finance infrastructure development, each with varying degrees of public and private sector involvement. The type of infrastructure that is being built and the services it is intended to provide will often determine the different financing options available,⁴⁷ which in turn factor into decisions about what infrastructure solutions are ultimately selected to meet a given need. Selection of infrastructure projects and the choice between public and private provision (or a blend of both) should be guided by an impartial assessment of what best serves the public interest. This is best achieved through full cost-benefit analysis considering the entire infrastructure lifecycle (see guiding principle 3), all alternative modes of delivery, the full system of infrastructure provision, financing options, and value for money.

Public Private Partnerships (PPPs) have become an important means of mobilising private sector participation and long-term private finance for infrastructure projects, and they can improve the value for money of projects and create a contractual framework for financing sustainable infrastructure outcomes. However, in some cases, the line between economic and social infrastructure may not be clear, and it is important that PPPs—which often involve increased cost recovery from users—do not prioritize private sector profits over provision of essential services. Similarly, a PPP project with low or marginal risk transfer to the private sector will not reap the benefits of better risk management and therefore is probably best suited to conventional public procurement. Transferring too much risk to the private sector, on the other hand, increases project cost and may negatively impact the cost-benefit of private investment in the project.

Regardless of the source of investment in infrastructure, fiscal and financial transparency are an essential part of sustainability, and institutional coordination is required to ensure accurate collection, analysis, and sharing of financial information.⁴⁸ When the private sector is involved, guarantees and other financial incentives should be disclosed to the public.

9. Infrastructure development should be underpinned by transparent planning, information sharing and decision-making processes that facilitate meaningful, inclusive, and participatory stakeholder consultation, and in the case of indigenous peoples, their free, prior, and informed consent. National, sub-national, and project-level grievance mechanisms should be available for addressing stakeholder complaints and concerns.

Inclusive and meaningful stakeholder consultation is essential to the successful implementation of every aspect of sustainable infrastructure. It facilitates a good understanding of service needs and

⁴⁶ United Nations Conference on Trade and Development (UNCTAD). “The Covid-19 Shock to Developing Countries: towards a “whatever it takes” programme for two thirds of the world’s population being left behind”. Trade and Development Report Update, March 2020. (Geneva, UNCTAD, 2020).

⁴⁷ For example, the private sector is unlikely to invest alone in projects that cannot generate a financial return on investment (see guiding principle 6).

⁴⁸ Nolan, S., Hardy, D., and Anos Casero, P., eds. “G20 Note: Improving Public Debt Recording, Monitoring, and Reporting. In Low and Lower Middle-Income Countries”, G20 Notes on Strengthening Public Debt Transparency, June 14 2018. (Washington, DC, International Monetary Fund and World Bank, 2018).

preferences and helps ensure that infrastructure development is culturally appropriate⁴⁹ and well-aligned with demand (see guiding principle two). It is also an important tool for accurately assessing the environmental, social, and economic costs and benefits (see guiding principles three, four, six, seven, and eight) of different infrastructure solutions and balancing trade-offs between them. Increased transparency helps to reduce corruption, thereby lowering the cost of infrastructure development and contributing to fiscal sustainability (see guiding principle eight).⁵⁰

Stakeholder consultation is also an important way of building trust support for projects amongst local communities and can help to significantly reduce the likelihood of conflict related to infrastructure development, of which lack of transparency and consultation is a major driver.⁵¹ It is also a prerequisite for obtaining free, prior and informed consent, in line with the United Nations Declaration on the Rights of Indigenous Peoples.⁵²

To be effective, stakeholder consultation should be integrated throughout the infrastructure lifecycle and include all potential users, as well as non-user groups that are directly and indirectly affected. It is particularly important to include women; people with disabilities; older people; youth; indigenous peoples; minorities; and other vulnerable, marginalized or disadvantaged groups. It is also important to engage the private sector, including project developers, sustainability standards setters, private finance institutions, construction and operation firms, and others that play a role in infrastructure at various points in the infrastructure lifecycle.⁵³

The quality of stakeholder consultation depends on the availability of appropriate information and the design of the processes themselves. Effective consultations involve early and ongoing public participation and disclosure of relevant information, including development objectives, spatial planning data, environmental baseline data, options considered, results of assessments, justifications for decisions, procurement processes, and costs, among others. This information must be communicated in ways that various stakeholders can understand. Consultation processes must also be designed with enough time to allow for stakeholders to provide feedback, and they must begin early enough in decision-making processes to enable stakeholders to have input on key decisions about what to build and where to build it.

Judicial and non-judicial (operational) grievance mechanisms should be available to help respond to stakeholders' grievances. These mechanisms should use understandable and transparent processes that provide timely feedback to those concerned, without any retribution, and should not impede access to other judicial or administrative remedies that might be available under the law or through existing arbitration procedures. The existence of these mechanisms should be communicated to all stakeholders.⁵⁴

10. The planning and management of infrastructure throughout the lifecycle should be informed by key performance indicators, which should promote data collection, including data that is disaggregated by stakeholder groups. Regular monitoring of infrastructure performance and impacts is necessary to generate data, which should be made available to all stakeholders.

The measurement of key performance indicators is an essential tool for managing the service delivery, value for money, and environmental, social, and economic sustainability of infrastructure. Monitoring the performance and impacts – both positive and negative – of infrastructure systems enables the use of adaptive management approaches that respond to changing conditions over the lifespan of an infrastructure system. This can mean continuous improvement in the sustainability and service delivery of infrastructure systems across the different phases of the lifecycle.

Relevant ex-ante and ex-post data on all stages of the infrastructure lifecycle should be identified and defined, collected, managed, analyzed, and fed back to decision makers and stakeholders, so that fact-

⁴⁹ This refers to the fact that the suitability of services and means of delivery may be perceived differently by minority groups with different cultural backgrounds.

⁵⁰ G20. G20 Compendium of Good Practices for Promoting Integrity and Transparency in Infrastructure Development. (2019).

⁵¹ Watkins, G., Mueller, S., Meller, H., Ramirez, M.C., Serebrisky, T., and Georgoulas, A. *Lessons from Four Decades of Infrastructure Project-Related Conflicts in Latin America and the Caribbean*. (Washington, DC, IDB, 2017).

⁵² IUCN, Document WCC-2016-Rec-102-EN.

⁵³ IDB. What is Sustainable Infrastructure? A Framework to Guide Sustainability Across the Project Cycle.

⁵⁴ International Finance Corporation (IFC). *IFC Performance Standards on Environmental and Social Sustainability*. (Washington, DC, IFC, 2012).

based decisions can be taken. This includes data on the performance of the existing stock of built and natural infrastructure (see guiding principle two).

In addition to economic and financial data, adequate resources should be allocated to the collection data related to the environmental and social sustainability factors outlined in guiding principle three. The relevant environmental data must be collected and understood at the landscape scale so that the health and functioning of entire watersheds and ecosystems be considered when planning infrastructure. Social data should be disaggregated by the various population groups affected by infrastructure (e.g. gender-disaggregated data), particularly those that are vulnerable or marginalized.

Data should be collected at the national level when planning infrastructure, as well as at the local and project levels, and for the entire supply-chain. Blockchain and other emerging technological innovations may offer solutions to challenges in accessing data along the whole supply chain (e.g. from sub-contractors).

Effective monitoring requires data management and storage capacity that allows for continuity of data and information gathering, storage, and sharing across different project phases and regardless of personnel changes. The use of common indicators allows for benchmarking against existing standards, and also allows government to assess performance against pre-defined targets and objectives and ensure alignment with strategic plans and global policy frameworks like the SDGs.

Data is not only required by governments, but also by investors, who seek clear market signals, including on aspects of sustainability. To meet the needs of investors, it is important that sustainable infrastructure indicators are relevant, quantified and comprehensive (covering environmental, social, economic/financial governance), yet not overly complex or simply too numerous. The economic benefits of public sector data transparency have been estimated at US\$3 trillion to US\$5 trillion per year globally.⁵⁵

Governments can engage in partnerships with the private sector, academia, and civil society to ensure that most relevant data are defined, measured, collected, analyzed and synthesized in ways that are useful for decision makers and the public.

⁵⁵ United Nations Department of Economic and Social Affairs (UNDESA). *United Nations E-Government Survey 2016: E-Government in Support of Sustainable Development*. (New York, United Nations, 2016).

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