Infrastructure and Poverty Reduction: Innovative Policies for Effective Access

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Acknowledgments

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Recommendations in this report are broad in nature, and application should be balanced within the context of each country. The specific country circumstances will affect how each recommendation is adapted and applied. Emerging and developing countries in particular may require specific considerations to be made in the application of these recommendations.

Executive Summary

A wealth of accumulated evidence shows that basic infrastructure services, including transport, energy, water and sanitation, and digital infrastructure, are key in the fight against poverty. These services directly enhance people's connections to jobs and economic opportunities, improve the affordability and access to goods and services, and ultimately support productivity and economic growth. They also generate important indirect benefits through agglomeration economies in cities, including access to ideas and innovation, education, health, gender equality, and resilience in the face of economic and environmental shocks. This is mirrored at the macroeconomic level by the evidence for a positive multiplier effect for infrastructure spending.

However, evidence also shows that the positive impact of infrastructure varies across locations, social groups, and skill groups, among others, and that at the microeconomic and macroeconomic levels it is conditional on the design and implementation details of infrastructure investment and management. This suggests that reaching out to the billions of people still lacking access to basic infrastructure services is a priority in the fight against poverty, but also that it must be done in a way that maximizes the development dividends. This report proposes a framework to guide this process and illustrates it with numerous examples from the existing literature and case studies provided by the G20 member countries.

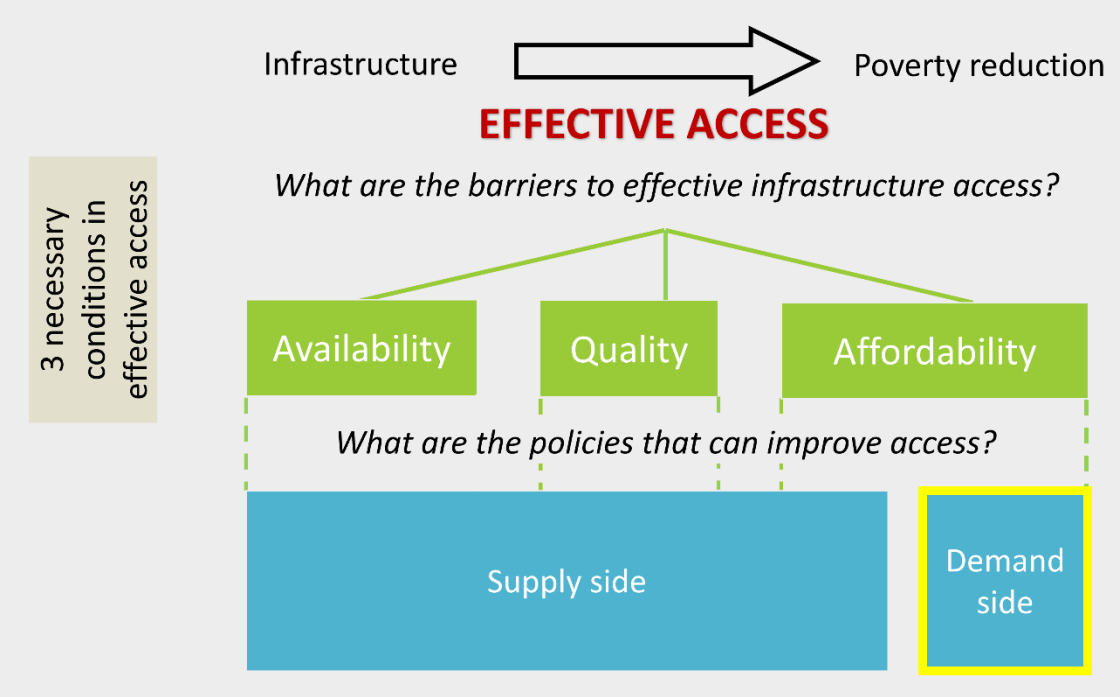
It starts by arguing, based on the empirical evidence to date, that "effective infrastructure access" hinges on these services meeting three crucial conditions: availability, quality, and affordability (Figure ES1).

- Availability requires that essential infrastructure services are easily reachable by all households, regardless of their location or income level. However, the presence of infrastructure services only indicates potential rather than actual usage and does not guarantee developmental impact.
- Quality of infrastructure services is multifaceted, it matters at the implementation and provision stages, and includes reliability, safety, and convenience. Higher quality leads to greater usability and positive outcomes, increasing households' willingness to pay for and use the services.
- Affordability means that paying for the costs of the services should not hinder individuals from meeting all their other basic needs. These expenses encompass all connections and utilization costs associated with accessing and using these essential services, including the equipment and appliances needed to enjoy them.

Assessing effective access properly requires defining clearly in countries' development strategies a minimal basket and quality of services that households should receive, and ensuring it is available and affordable.

The report goes on to detail a range of well-designed supply-side (for availability, quality, and affordability) and demand-side (for affordability) policies that are key in addressing bottlenecks across these three dimensions.

Figure ES1. Attributes of effective infrastructure access



Source: Authors' own work.

On the supply-side, the first important priority is to attract greater and more effective investment, leveraging both public, commercial, and private resources and developing innovative funding and financing mechanisms. Supply-side policies can also enhance the quality and the affordability of the services for the users through efficient implementation and service delivery, lowering lifecycle costs through better maintenance and the adoption of alternative cost-effective technologies tailored to local needs, from e-procurement to innovative designs.

On the demand-side, tariff structures should provide financial stability to providers, while also being simple, easy to implement, consistent, and transparent. In addition, subsidies may be needed, catering to two main objectives. First, they should address affordability issues, enhancing access for the segments of the population that are unable to pay for the basic bundles of services. In doing so, they can also help address externalities, incentivizing the consumption of services with socially beneficial effects on health and education, for example. Second, they should help manage demand and support the move to higher efficiency technologies.

However, the design, targeting, implementation, and funding of subsidies is complex. They may bring large benefits but can backfire if poorly managed, so the report highlights the key requirements for sound subsidy policies. Technology can be useful on the demand-side by making sure subsidies benefit only the needy and are delivered effectively. It can also support demand management through innovative technologies such as smart meters for energy and water delivery, and smart cards in urban transportation systems.

Finally, to be pro-poor, infrastructure services also need to include inclusiveness and resilience from the planning and implementation stages. Exclusion can be geographical, economic, or related to gender, ethnicity, physical disabilities, or age. In addition, investments in making infrastructure resilient to external shocks, implementing information mechanisms to support adaptative behavior, and establishing safety nets to help households and firms withstand shocks can all offer significant long-term economic benefits in the fight against poverty.

Overall, the report delivers five key messages for policymakers and governments aiming to improve infrastructure access and reduce poverty:

1. Countries should make a concerted effort to increase effective access to infrastructure by setting targets that consider availability, quality, and affordability.
2. Infrastructure policies should address both supply and demand aspects.
3. On the supply-side, the key policy objectives are to increase investments and reduce lifecycle costs through more efficient provision and maintenance.
4. On the demand-side, subsidy design should be considered carefully, balancing affordability with fiscal sustainability and sector efficiency.
5. Technology can be useful both on the supply side by reducing the cost of provision and on the demand-side by helping manage demand and ensuring that lower pricing appropriately targets those in need.

Chapter 1: Introduction

Key messages

- Evidence shows that access to basic infrastructure services like electricity, roads, digital connectivity, and WASH (water, sanitation, and hygiene) is crucial for development and growth and has a substantial impact on household welfare and poverty alleviation.
- It also shows that this is conditional on infrastructure design and implementation details.
- Effective infrastructure access depends on three key factors: availability (presence of a basic infrastructure service in an area), quality (performance standards), and affordability (costs for connection and use).
- Addressing bottlenecks across these three factors calls for a range of well-designed supply-side (availability, quality, and affordability) and demand-side (affordability) policies.

1.1 Infrastructure and development

There is a wealth of accumulated evidence showing that access to basic infrastructure services like electricity, roads, and digital connectivity, as well as WASH (water, sanitation, and hygiene), is crucial for development and has a substantial impact on household welfare and poverty alleviation.

Numerous studies have established that these services provide households with crucial opportunities to learn, receive good quality health care, access jobs, and enable businesses to operate efficiently, trade, and access markets. In addition, infrastructure also generates important indirect effects through agglomeration economies in cities, including access to ideas and innovation, education, health, gender equality, and resilience in the face of economic and environmental shocks. A recent qualitative review conducted by the World Bank, which examined over 300 studies conducted between 1983 and 2022, investigated the impact that digital, power, and transport infrastructure have on economic growth and social development (see Foster et al., 2023a and 2023b). According to the authors, most evidence suggests that improvements in infrastructure play a crucial role in supporting the development process. In addition, the impact of growth, which remains a main driver of poverty reduction (Dollar and Kraay, 2016; Crespo Cuaresma et al., 2022), appears to be robust across sectors as shown in a recent meta-analysis (Foster et al., 2023b). Finally, the simple fact to be curtailed from basic infrastructure services has direct implications for poverty (see Box 1.1 for a discussion of one way to assess this direct effect through the concept of multidimensional poverty).

This evidence must be considered in a context in which, despite impressive progress in the last decades, steered by initiatives such as the Millenium Development Goals and then the Sustainable Development Goals, there are still billions of people that lack of access to essential infrastructure services:

- 2.2 billion people still lacked safely managed drinking water services in 2022 (GWSP, 2023).

- 3.5 billion people lacked safely managed sanitation services in 2022 (GWSP, 2023).
- 2 billion lacked basic hygiene services in 2022 (GWSP, 2023).
- 2.1 billion people lacked access to clean cooking fuels and technologies in 2021 (IEA et al., 2024).
- 685 million people still lacked electricity access in 2021 (IEA et al., 2024).
- One billion people live more than two kilometers away from an all-season road (World Bank, 2024).
- Only 51.6 percent of the world's urban population had convenient access to public transport in 2022 (United Nations, 2023).
- 1.19 million people died in 2021 in road crashes because of lack of safe roads (WHO, 2023a).
- 2.6 billion people still do not use the internet in 2023 (ITU, 2023)

It therefore seems easy to jump to the conclusion that simply addressing these shortfalls, connecting as many people as possible to infrastructure networks and providing them with those services will deliver large development benefits and significantly reduce poverty. The reality is, however, more complex.

Understanding how to best address infrastructure shortages and maximize the impact of infrastructure services on social outcomes is challenging as the channels of influence are significantly affected by a wide variety of factors, including networks and service design, tariff regulation, the presence of other complementary infrastructure services, the extent of its user base, the characteristics of the local context, and the stage of development, among others. Focusing solely on specific aspects of infrastructure provision, such as electricity or water connectivity, without addressing issues like quality or affordability, offers limited insight into the efficacy of these services in mitigating poverty.

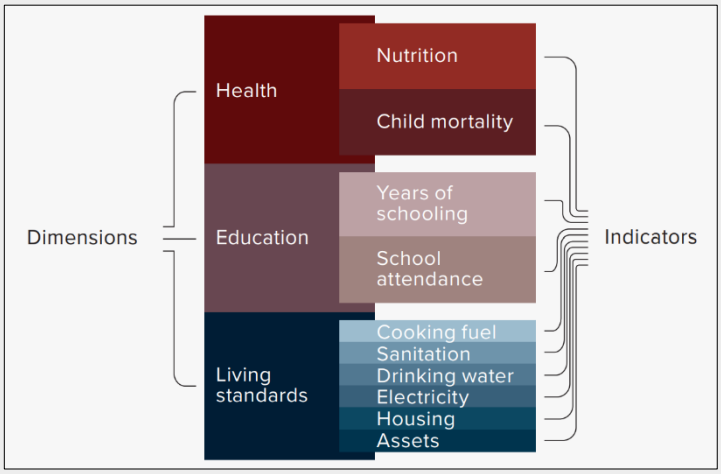
At the heart of these limitations is the fact that metrics of infrastructure access and investment often overlook many of these complexities. This is a key issue when it comes to designing specific policies, as ensuring their ultimate efficacy implies opting for the right design and regulatory arrangements and understanding precisely how other complementary factors affect their impact.

Box 1.1. The role of infrastructure access in multidimensional poverty

The traditional definition of poverty, often referred to as monetary or income poverty, focuses primarily on a person or household's income level relative to a certain threshold. Individuals or households falling below this threshold are classified as impoverished. However, this approach has shown to have some limitations. For example, the World Bank's Poverty and Shared Prosperity 2022 Report (World Bank, 2022a) shows that almost 4 out of 10 multidimensionally poor individuals are not captured by monetary poverty, as they are deprived in nonmonetary dimensions alone. To account for this, the concept of multidimensional poverty has gained more attention as it recognizes poverty as a complex phenomenon that is not solely determined by income. It looks at poverty from a broader perspective, considering various aspects of well-being and deprivation, many of which are fundamentally influenced by infrastructure access. The Global Multidimensional Poverty Index (MPI), one of the most widely known measures in this context, uses a set of weighted indicators to assess poverty across three dimensions: health, education, and living standards (Figure B1.1). All three dimensions are given equal

weight, with one-third of the overall MPI attributed to each. Within each dimension, specific indicators (10 in total) are selected to represent deprivations in that domain. For example, indicators such as nutrition and child mortality are considered in the health dimension, while variables like access to sanitation or drinking water are assessed in the living standards dimension. If an individual is deprived of one-third or more of the weighted indicators, he or she is considered to be multidimensionally poor. While some indicators in the MPI directly relate to infrastructure access, such as access to drinking water, sanitation, and electricity, the influence of infrastructure extends to other dimensions as well. For example, improved transport infrastructure can directly impact access to education and healthcare. Similarly, the implementation of clean water and sanitation systems is closely linked to public health. In essence, infrastructure access is intertwined with various dimensions of poverty, and its role in determining multidimensional poverty is fundamental. By addressing infrastructure gaps and ensuring access to essential services, governments and organizations can make significant strides in reducing multidimensional poverty and improving overall household well-being.

Figure B1.1. The Global Multidimensional Poverty Index (MPI)



Source: UNDP (2023).

Recent advancements in research methods and increased data availability have allowed researchers to start circumventing some of these challenges and have led to more nuanced insights on how infrastructure services affect development outcomes, including poverty:[1]

- The literature on the development impact of digital technologies shows significant effects on welfare in developing countries. Mobile phone adoption and mobile connectivity have been reported to positively influence educational outcomes in Niger (Aker et al., 2012), food security in Niger and West Africa (Aker, 2010; Aker et al., 2015), and reduced inequality and poverty in a cross-section of African countries (Calderon et al., 2021). Similarly, Internet coverage, for example, has been associated with positive effects for

[1] See Foster et al. (2023a) for a detailed coverage of the digital, energy, and transport sectors.

households, including increased employment in selected African countries (Hjort & Poulsen, 2019), increased consumption, and reduced poverty rates in Senegal and Nigeria (Masaki et al., 2020; Bahia et al., 2020). However, a recent review of the literature by Hjort and Tian (forthcoming) also suggests that the impacts are quite heterogenous and context-specific (e.g., when considering the effect of Internet connectivity on worker and firm productivity improvements).

- Energy infrastructure has been found to have positive effects on household welfare. For instance, electrification has been linked to higher household income, increased household expenditure, and greater school attendance among children in rural Vietnam (Khandker et al., 2013), and to large and positive impact on human development and housing values in Brazil (Lipscomb et al., 2013). It has also been associated with increased employment and earnings for women in South Africa, Nicaragua, and Peru (Dinkelman, 2011; Grogan et al., 2013; Dasso et al., 2015) and better health outcomes, such as reduced respiratory infections among children (Barron et al., 2017). Access to electricity has also been shown to have significant implications for improving food security, as it has immediate impacts on both the availability and utilization of food (Candelise et al., 2021). However, evidence for a lack of impact of electrification has been found, for example, in Rwanda with the roll-out of PV-solar technology (Lenz et al., 2017). Moreover, in Kenya, a highly influential paper reported that the cost of connection for rural grid extension exceeded households' willingness to pay, concluding to a negative social welfare impact (Lee, Miguel, and Wolfram, 2020). In India, positive impacts appear to materialize only in communities of sufficient size (Burlig and Preonas, forthcoming).
- Transport infrastructure has also been associated with positive impacts on households. Rural road development, for instance, has been linked to increased household consumption and reduced likelihood of falling into poverty in Ethiopia (Nakamura et al., 2019). Additionally, it has been associated with higher secondary schooling enrollment for children in Bangladesh (Khandker et al., 2009). Similarly, better road access has been shown to increase the number of earning opportunities for isolated households in Cameroon (Castaing et al., 2015), and the density of roads per square kilometer has been found to significantly contribute to food security in Africa (Blimpo et al., 2013). Lack of access to and safety of transportation represents one of the greatest obstacles to women's participation in the labor market in developing countries, reducing their participation probability by 16.5 percentage points (ILO, 2017). However, a comprehensive more recent study from India finds muted effects on consumption and income, although there is evidence of structural transformation as individuals leave the agricultural sectors when new rural roads are constructed (Asher and Novosad, 2020). In Tanzania, the rehabilitation of 2,500 km of major roads has a negative impact on households producing rice, as they reallocate labor away from agriculture but face scarce wage income opportunity (Dumas and Jativa, 2024). And in China, the construction of a large network of highways had positive impact on growth, although the effects were quite heterogeneous across locations (Roberts et al., 2012; Faber, 2014).
- Regarding access to safe drinking water, sanitation, and hygiene (WASH) on development outcomes, a World Bank meta-analysis on 136 impact evaluations conducted by Andres et al. (2018) found that WASH interventions helped reduce child mortality, diarrheal and

non-diarrheal diseases, school absenteeism and dropouts. Furthermore, WASH services have been associated with reduced dependency on health care services and increased productivity (Hutton, 2012). Even relatively small investments in WASH services have shown to have important impacts on reducing the spreading of waterborne diseases and associated hospitalizations in Brazil (Ferreira et al., 2021). Additionally, access to WASH services been highlighted as a crucial component in realizing gender equality and the empowerment of women and girls (GWSP, 2023). However, these positive average impacts appear to be conditional on design and institutional issues, as shown, for example, in the case of India (Deb et al, 2024).

- In addition, there is evidence that at the macroeconomic level, spending on infrastructure, as captured through public capital spending commands a positive multiplier. The evidence is much more extensive for developed countries, where recent analysis puts the multiplier in the 0.6 to 1 range (Ramey, 2019), than for developing one. A recent review (Vagliasindi and Gorgulu, 2021), shows that there is much less systematic evidence for developing countries, and that existing studies display significant heterogeneity, with some suggesting lower or even null multipliers, while others conclude to higher values due to the smaller stocks of existing capital. Among the reasons that may explain such variation, issues of design and implementation quality and delays, absorptive capacity, and lack of maintenance appear to be salient ones. In that sense, the variation found in macro-level studies appears consistent with the variation also observed in microeconomic analysis above.

This evidence thus indicates that access to basic infrastructure services, including electrification, rural road infrastructure, digital infrastructure, and access to safe drinking water, sanitation, and hygiene, plays a pivotal role in supporting economic and social development and the fight against poverty. Traditionally, infrastructure access has been assessed by determining whether a household can connect to or reach a specific service, leading to the number of connections being the main and often only objective. For instance, a simple lightbulb within the household would suffice as an indicator of electricity access. However, this approach has been found to be overly simplistic as it overlooks the diverse range of factors required to render a service truly useful and transformative. The positive effects of infrastructure access on developmental outcomes are contingent upon factors beyond the mere physical existence of basic services in each location. The examples above indicate that impact is often heterogeneous across locations, social groups, and skill groups, and it may vary depending on specific design and implementation details.

1.2 Conceptual framework

These findings provide the motivation for a conceptual framework that can support the design of better policies. Building on the evidence discussed above, this report argues that mediating issues can be grouped into a few key categories: availability, which refers to whether a service is accessible at all; quality, broadly defined, which determines whether services provide the expected type of access and benefits; and affordability, which is crucial to ensure that all households can effectively enjoy access.

Consider again the case of electricity access in Kenya, described in Lee, Miguel, and Wolfram (2020). In the experiment, households were offered a connection at prices varying from 0 to US$398 (with this highest price still being substantially lower than the actual cost to the utility). The results show that the demand curve is very steep. While take-up is almost universal at 95%, with the full subsidy, it drops sharply to 23 and 6 percentage points when the subsidy covers only 57% and 29% of the costs, respectively. This is indicative of important affordability constraints, which can reflect both the fact that households are unable or unwilling to spend such amounts, or that they are credit constrained. In a context where households' annual revenues are below $1,000, this is hardly surprising. In addition, the study shows that at any level of adoption, the consumer surplus created does not cover the costs of extending the service. The discussion points to several aspects of unsatisfactory quality, which reduce the households' willingness to pay. First, the bureaucratic process leading to the final activation of the line is extremely long, around six months. In addition, the service is characterized by frequent blackouts, making it highly unreliable. Unsurprisingly, given these quality and affordability issues, an ex-post analysis fails to find any meaningful positive impact on economic, health, or educational outcomes.

Similar combinations of lack of availability, quality, and affordability can be identified across other sectors. In transportation, the link between rural road improvements and travel costs is often conditional on the availability of suitable supply of public and private transport. In some cases, subsidies are needed to ensure that affordable options enter the market at all (Raballand et al., 2011). In water and sanitation, the quality of implementation looms large in some programs. For example, delays in releasing funds to extend monetary incentives to households due to political circumstances, and insufficient outreach of behavior change communication campaigns, led to the low impact of a large-scale intervention on sanitation and hygiene in rural Punjab, India (Deb et al, 2024).

In summary, infrastructure **effective access** that genuinely drives economic and social advancement, and contributes to poverty reduction by enabling households to derive wellbeing benefit from its utilization, depends on three key factors (see Figure 1):

- ***Availability:*** The material presence of a piece of infrastructure within a designated geographic area that could enable households to connect to it and benefit from its services.
- ***Quality:*** The performance standards of an infrastructure service. It encompasses factors such as reliability, convenience, durability, safety, sustainability, and resilience of that service.
- ***Affordability:*** The household's ability to pay for the utilization of a defined package of infrastructure service. It considers the expenses associated with connecting to the service, the recurring usage fees, and the costs incurred for acquiring essential equipment or appliances needed for the appropriate utilization of the service.

What we label as "effective access" to an infrastructure service hinges on its ability to meet these three conditions. It must not only be physically present and readily available at the necessary level but also exhibit a range of quality attributes that truly enhance its utility and transformative potential. Moreover, the cost of using the service is a critical factor: it should not only be affordable

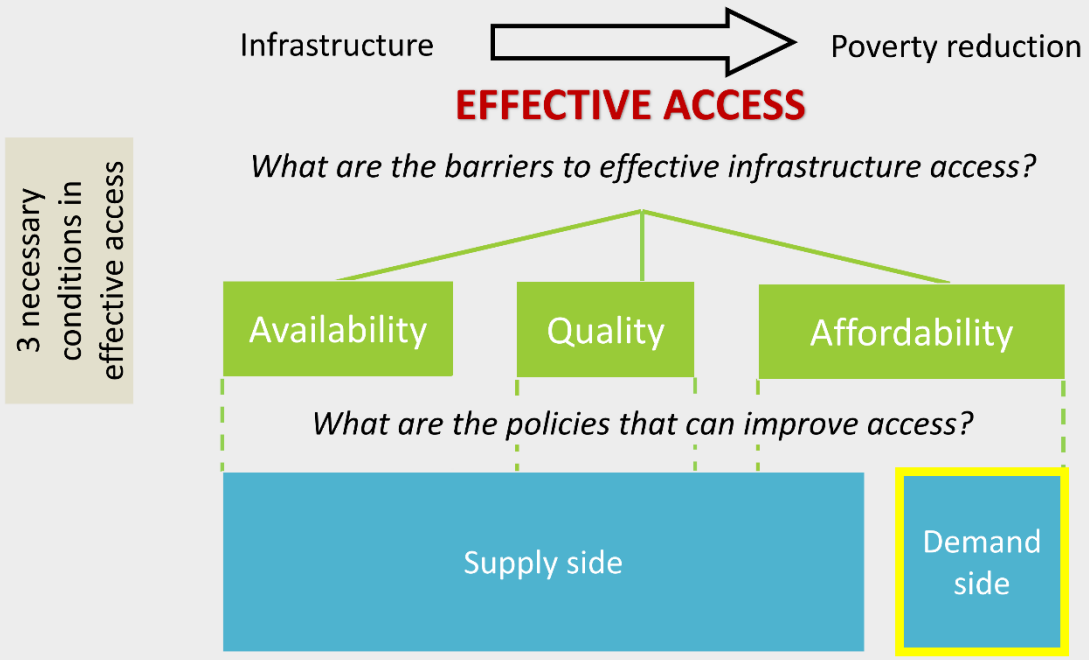
in terms of initial connection costs but also in terms of ongoing usage fees and the expenses incurred for essential equipment. Any constraints experienced by a household in relation to these three dimensions impedes universal access, thereby preventing the realization of the complete spectrum of developmental advantages associated with the utilization of an infrastructure service.

Ensuring availability, quality, and affordability requires appropriate policy design on both the supply- and demand-sides of infrastructure services. Supply-side policies refer to government initiatives and strategies aimed at expanding the availability and enhancing the quality of essential infrastructure services. These policies encompass a range of considerations, including the design and specifications of infrastructure enhancements, the choice of technology (and its associated cost) that is used to deliver the service, public incentives to bolster infrastructure investment and private sector participation, procurement mechanisms for infrastructure development to lower delivery costs, the regulatory framework governing market competition, and the standards for maintaining infrastructure assets. In addition, because they affect the cost of planning, building, maintaining, and operating infrastructure, supply-side policies also significantly impact the level of affordability of the services for households, as discussed later.

Demand-side policies encompass the strategies and mechanisms implemented by countries to ensure the affordability of essential services for users, particularly for poor and vulnerable households, and to increase their utilization to a degree that maximizes the benefits derived from them. Their first main component concerns the effective price faced by households when using infrastructure services. This starts with the design of an adequate tariff structure and its implementation, which can go through direct public policy decisions and different forms of regulation or competition policy. When needed, it can be complemented by measures aimed at facilitating actual consumption, with subsidies serving as the most prominent illustration. Finally, demand-side policies also include interventions focused on helping households reduce or manage their demand and expenditure on essential services. Examples include the provision of information, the use of monitoring devices, and incentives for the adoption of energy-efficient technologies.

Figure 1 summarizes these broad groups of policies and how they may impact the different attributes of availability, quality, and affordability. As can be seen, supply policies overlap with all three categories, while demand policies are mostly relevant for affordability. The next chapter analyzes in more detail the three attributes, and the following ones delve into the specific design and characteristics of supply- and demand-side policies aimed at addressing them respectively.

Figure 1. Attributes of effective infrastructure access[2]



Source: Authors' own work.

[2] The distinction between supply and demand policies is meant to be both broad and tailored to the specific context of traditional infrastructure delivery. However, as some technologies have fundamentally changed the way some households access infrastructure services, this differentiation between supply and demand may not fully encompass the unique dynamics present in alternative forms of infrastructure provision, such as distributed community-based services.

Chapter 2. The attributes of infrastructure access

Key messages

- Availability of infrastructure services refers to their presence near households. However, it only indicates potential rather than actual usage, and does not guarantee developmental impact.
- Quality of infrastructure services is a multifaceted concept, including reliability, safety, and convenience, and is crucial for developmental impact, with higher quality leading to greater usability and positive outcomes.
- Affordability of infrastructure services encompasses all connections and utilization costs and must be ensured for all households, especially the most vulnerable. Assessing it properly requires defining a minimal basket and quality of services that households should receive.
- Assessing these attributes allows for mapping affordable access, which precisely identifies the specific needs of different categories of households and provides information to tailor policies interventions accordingly.

As mentioned in the preceding section, a household is deemed to have effective access to an infrastructure service if this complies with three factors: it is available for use, the quality of provision is sufficient to render it functional, and the cost of its utilization is reasonable and does not hinder the household's capacity to meet other basic needs. To effectively address poverty and harness the advantages linked to infrastructure development, countries must be able to identify any impediments impacting households in any of these three dimensions. They should then design and implement the appropriate supply- and demand-side policies to ensure effective access. This section will expound upon these three factors, offering overarching considerations for policy implementation.

2.1. Availability

The first essential factor for an infrastructure service to be accessible is to be physically present near or within a household. This is what we call availability. Traditionally, availability has been assessed by proxy indicators that evaluate the physical manifestation of infrastructure in an area. For example, a 3G/4G antenna for broadband connectivity, a nearby all-weather road, or a transformer and electricity distribution line in proximity to a household's dwelling. However, despite its fundamental role in access, these factors provide very limited information regarding its effectiveness. In fact, the presence of an infrastructure service in a particular location does not inherently convey information about whether people are utilizing it.

A service could be available near or within a household, but if there are factors that disincentivize or prohibit users from consuming it (such as health or safety considerations, lack of adequate content, or prohibitive costs), the effects of its presence might be compromised. For example, current estimates indicate that 96 percent of individuals not using the Internet are within reach of the network, and 40 percent of unconnected households in Sub-Saharan Africa live under the

electric grid. Therefore, availability serves as an indicator of potential utilization but cannot be considered to appropriately capture actual usage.

2.2. Quality

The next relevant factor is the quality of the service. Quality depends on availability and reflects how well an infrastructure service operates in achieving its intended goal. It encompasses various factors, including reliability, capacity, durability, safety, sustainability, and resilience. Once a service has become available for a user, the quality of it plays a crucial role in determining its potential for economic and social development. A service of high quality holds the greatest potential for yielding positive developmental impacts. Conversely, a service of low quality may yield limited or even negligible developmental impacts relative to unserved households (see Samad & Zhang, 2017).

For an infrastructure service to be considered available and of good quality, it must satisfy the following criteria at a minimum:

- It must be available for use at the time of need.
- The quantity of the service provided must be sufficient to render it useful.
- The service must offer convenience, in terms of time and effort required for its utilization.
- The delivery of the service must be reliable, characterized by minimal or no unexpected interruptions, and consistent, with minimal or no fluctuations in the delivery rate.
- Using the service must not result in adverse health consequences for users or pose risks of injuries.
- The provision and utilization of the service must adhere to legal regulations and requirements.

These different factors underlying the availability and quality of infrastructure services underscore the presence of a spectrum of gradual enhancements in service provision. The more quality features an essential service includes, the greater its usability. In the energy sector, for example, this increased level of usability has been illustrated in the World Bank's Multitier Framework (see Box 2.1 for more details), which assesses access to modern energy sources, including household electricity and clean cooking. Within the domain of water, sanitation, and hygiene services (WASH), the service ladders underpinning the Sustainable Development Goal 6 on water and sanitation (Box 2.2) provide a similar illustration of the varying degrees of WASH provisions experienced by households worldwide.

Box 2.1. The World Bank's Multitier Framework for Energy Access (MTF)

The Multitier Framework (MTF) is a tool developed by the World Bank to assess the level of household access to electricity.[3] It assesses the dimensions of availability, quality, and affordability through a series of attributes of electricity supply that influence the household's experience. These are capacity, duration of supply, reliability, quality, affordability, legality, and health and safety of the electricity provision. Based on these characteristics, the MTF classifies

[3] For more information, visit https://mtfenergyaccess.esmap.org/methodology/electricity.

electricity supply into five tiers, spanning from Tier 0 (absence of supply) to Tier 5 (highest level of provision). A gradual enhancement in electricity supply indicates an increased potential for a wider range of electricity services (i.e., the variety of appliances or tools a household can utilize). As illustrated in Figure B2.1, a household in Tier 1, characterized by inadequate electricity supply, is restricted to basic tasks, such as rudimentary lighting and phone charging. Conversely, a household in Tier 5 benefiting from sufficient electricity supply, can operate a more diverse array of appliances, significantly influencing the usability and transformative impact of electricity.

Figure B2.1. Electricity access under the MTF

Source: Adapted from Bhatia, M., & Angelou, N. (2015), as cited in Rozenberg, J., & Fay, M. (2019).

Box 2.2. The WASH service ladders

These service ladders are a comprehensive set of global benchmarks used for the purpose of monitoring, classifying, and assessing progress in household accessibility to potable water, sanitation, and hygiene (WASH) services across countries. These service ladders serve as a structured framework for the identification of deficiencies in service delivery and play a pivotal role in directing policy and investment efforts aimed at enhancing the availability of these essential services and maximizing their impact on poverty reduction.[4]

The three ladders are:

1. The Drinking Water Service Ladder, which encompasses a classification system with five distinct tiers of access, spanning from 'Surface Water' (indicating the absence of service) to 'Safely Managed' service (the indicator for SDG target 6.1). For instance, at

[4] See World Bank Group (2017) for a detailed discussion of these linkages.

the lowest classification, 'Surface Water', a household obtains drinking water directly from an untreated natural reservoir such as a river, dam, lake, pond, stream, canal, or irrigation canal. Conversely, at the 'Safely Managed' level, the household's water source is situated on the premises, readily available as needed, and devoid of contamination.

2. The Sanitation Service Ladder, which employs a similar classification system encompassing five tiers of access to sanitation facilities, spanning from 'Open Defecation' (absence of facilities) to 'Safely Managed' sanitation service (the indicator on sanitation for SDG target 6.2). At the 'Safely Managed' level, households utilize improved facilities that are not shared with other households, and where excreta are safely disposed of on-site or removed and treated off-site.
3. The Hygiene Service Ladder, which establishes three distinct levels of access to essential hygiene facilities. These levels include 'No Facility' (indicating the absence of a handwashing facility at home), 'Limited' (denoting the presence of a handwashing facility lacking soap and/or water at home), and 'Basic' (indicating the availability of a handwashing facility equipped with soap and water at home).

Given the varying levels of infrastructure service provision and to support efforts to reduce poverty, countries should define and provide a basic set of services tailored to the local context, guaranteeing a baseline of quality that ensures usability for all households. The quality parameters of this basket could be based, for example, on the levels mandated by the SDGs or some predefined national standards. This pragmatic approach allows countries to define objectives for effective access based on their baseline situation and the resources available. They should then ensure that the foundational set of services they define can adapt in complexity as individuals progress socioeconomically and their needs evolve.

2.3. Affordability

When defining the level of provision of an essential infrastructure service, the third pivotal consideration lies in whether it is affordable for households. This represents the third factor needed to determine infrastructure access. Ensuring that households can afford the services provided is imperative for upholding their developmental impact over time.

The concept of affordability encompasses the entirety of costs associated with the utilization of an infrastructure service, including not only initial fixed costs and recurring expenses, but also additional inputs required to render the service usable. These additional inputs may include, for instance, appliances for electricity services or sanitation supplies for WASH services. It is imperative for countries to ensure that basic infrastructure services, provided at a level deemed desirable within the local context, are financially accessible to all households, with particular attention to those most vulnerable. This is because many essential services, such as access to potable water and sanitation, are recognized as basic human rights (see, for example, United Nations, 2010).

Despite its crucial importance, a consensus has yet to be reached on the optimal method for evaluating affordability. The complexity of needs across diverse local contexts, the wide spectrum

of service qualities outlined in the preceding section, and the dearth of essential information pertaining to households' incomes and expenditures are among the contributing factors to this challenge.

Among the prevalent methodologies for assessing affordability of basic infrastructure services, a commonly employed approach involves comparing a household's documented expenditure on an essential service, relative to its total household expenditure, against a predetermined threshold. Nevertheless, this approach has encountered a range of constraints that limit the depth of its findings. These limitations include the limited capacity to factor in the type and quality of the service received by the household, as well as the absence of consensus regarding appropriate affordability thresholds. For example, in the context of WASH services, there is notable variation in affordability thresholds among different countries and international organizations. For instance, Lithuania applies an affordability threshold equivalent to 2 percent of household income, whereas Mongolia's threshold stands at 6 percent (Smets, 2017). Furthermore, the UNDP adopts an affordability threshold of 3 percent, whereas the Asian Development Bank sets its threshold at 5 percent (United Nations, 2020).

To overcome these constraints, assessing affordability begins with the need for countries to define a minimum basket and quality of services of infrastructure services that are considered desirable within the local context and which all households should have access to. The costs of service utilization should consider the whole set of expenses a household must cover to access that basket, such as upfront costs and the recurring costs of consumption, (see, for example, Andres et al., 2020). This information then allows for the determination of a minimum level of household income required to afford the defined basket and other essential needs, enabling meaningful comparisons to a given income threshold.

2.4. Mapping affordable access

Once countries have defined this quality level and conducted the related affordability analyses, four potential scenarios with important policy implications could emerge. Each scenario corresponds to a distinct quadrant in Table 2.1, which classifies households based on whether they have access to the service and whether that service is affordable (Andres et al., 2020).

Table 2.1. Affordability quadrants

	Unaffordable Service	**Affordable Service**
With access to service	**Quadrant 1** Households that currently use the minimum basket of services but are paying more than the recommended affordability threshold for the recurring costs of use.	**Quadrant 4** Households that currently use the minimum basket of services can afford to pay the recurring costs of use.
	Quadrant 2	**Quadrant 3**

Without access to service	Households without access to the minimum basket of services and who cannot afford to pay the initial fixed costs of connecting to the services and/or the recurring costs of use.	Households without access to the minimum basket of services but who could pay the initial fixed costs of connecting to the services and the recurring costs of use.

Source: Andres et al. (2020).

This framework yields differentiated lessons in term of the policy needs for each category of households:

- Those situated in Quadrant 2 (i.e., those without access nor affordability) are of specific policy interest. Serving them might require extending supply to their area, as well as providing targeted subsidies to enable them a basic level of access when availability is already there.
- Quadrant 1 (i.e., those with access to the service but with affordability issues) represents another key cohort, as they may be compromising other fundamental needs to afford a defined service and would benefit from targeted subsidies aimed at reducing the cost of essential services.
- Quadrant 3 (i.e., households that have no access to the service, but which would have been affordable) warrants attention to determine the factors contributing to the lack of availability of the service. It is likely in this case that the main culprit is lack of available supply, although other aspects might be relevant as discussed below in the case of Internet access.
- Finally, although quadrant 4 (i.e., those with access and affordability) may not command immediate policy attention, households within this category can still provide valuable insights into their demand, the associated costs, and the effectiveness of any potential policies designed to facilitate access, such as subsidies.

It is also interesting to note that households positioned in the upper quadrants 1 and 4 (i.e., those with access to the services) have already overcome initial costs of connection or enrollment, facing solely recurring costs. Quadrants 2 and 3 may face challenges in accessing the service due to insufficient resources to cover the initial connection costs, recurring expenses, or both, underscoring the need for tailored policies to address these distinct scenarios. Box 2.3 presents an application of this methodology to assess the affordability of internet services in Latin America and the Caribbean.

Box 2.3. Affordability of internet services in Latin America and the Caribbean

The number of people connected to mobile internet in Latin America and the Caribbean has increased rapidly in the last five years going from 49 percent in 2017 to 62 percent in 2022 (Bahia et al., 2023). However, despite significant progress, important access disparities continue to affect the region. By 2022, a striking 32 percent of the population did not use mobile internet services, even though they lived within the coverage area of a mobile broadband network (Bahia et al., 2023). A recent telephone survey across 24 Latin American and Caribbean countries conducted by the World Bank Group and UNDP assessing different

dimensions of household welfare reported that half of all unconnected households cited the high cost of data services as the main barrier to internet access (Srinivasan et al., 2022).

To further explore the affordability challenge in the region, Andres et al. (forthcoming) evaluated the capacity of different households across eight countries to afford three comparable baskets of basic digital services between 2008 and 2018.[5] These three baskets are:

1. **Fixed-broadband basket:** Consisting of the least expensive plan that provided at least 1GB (raised to 5GB for the year 2018) of monthly high-speed data (at speeds of 256kB/s or higher) from the operator with the largest market share in each economy.
2. **Mobile data and voice low-consumption basket:** Consisting of a monthly usage of a minimum of 70 voice minutes, 20 Short Messaging Service (SMS), and 500 MB of data using at least 3G technology.
3. **Mobile data and voice high-consumption basket:** Consisting of a monthly usage of a minimum of 140 voice minutes, 70 SMSs, and 1.5 GB of data using at least 3G technology.

To assess the actual cost of a minimum basket of digital services and devices, the authors relied on price data obtained from providers and/or regulatory agencies. To determine household income and consumption, labor and expenditure surveys were used.

To evaluate affordability, the authors compared the prices of these three baskets of digital services against a threshold value of two percent of total household expenditure, in line with the targets set by advocacy groups like the Broadband Commission for Sustainable Development. A basket was considered affordable if the price of it was less than two percent of the total household expenditure.

The study's findings show that a significant number of households in the region are unable to afford digital services (as shown in Table 2.2). Specifically, 56 percent of households surveyed found fixed-broadband unaffordable, while 45 percent and 52 percent found the low-consumption and high-consumption baskets unaffordable, respectively. Additionally, many households are spending beyond the recommended affordability threshold for accessing these services, which might compromise their ability to cover other essential needs: 15 percent of households for fixed-broadband, 20 percent for the low-consumption digital basket, and 23 percent for the high-consumption digital basket. Moreover, the researchers discovered that even among households who could afford these services, a notable percentage remained unconnected: 19 percent for fixed-broadband, 17 percent for low-consumption mobile internet services, and 13 percent for high-consumption mobile internet services. The authors attribute this to various factors such as lack of digital skills, limited relevant content, and low perceived relevance. The study also revealed that internet services are particularly unaffordable for individuals without an elementary school education and those over 65.

Overall, these elements have significant implications for poverty and inequality in the region. To bridge this digital divide, the authors propose context-specific policies aimed at reducing

[5] The countries evaluated were Argentina, Bolivia, Brazil, Chile, Colombia, Dominican Republic, Mexico, and Uruguay.

internet service costs, providing targeted financial assistance for unaffordable connections and devices, and offering subsidies to help marginalized population segments access the internet.

Table 2.2. Affordability of internet services by basket (mean)

	Fixed-broadband basket		Mobile data and voice low-consumption basket		Mobile data and voice high-consumption basket	
	Unaffordable	**Affordable**	**Unaffordable**	**Affordable**	**Unaffordable**	**Affordable**
Households using the service	15.13%	24.51%	20.44%	37.6%	22.92%	35.11%
Households not using the service	41.31%	19.05%	24.65%	17.32%	28.95%	13.01%

Source: Andres et al. (forthcoming).

Summing up, ensuring effective access to infrastructure services requires considering the three key aspects of availability, quality, and affordability. The discussion shows that these dimensions are structurally related and may involve trade-offs that should be carefully navigated. For example, the relationship between key aspects of affordability, such as prices, quality, and households' willingness to pay, is not straightforward. Empirical evidence indicates that certain households may be inclined to allocate a greater portion of their budget to an essential service if its perceived quality and usability are superior (Abdullah et al., 2005). Relatedly, their willingness to pay high electricity connection costs may depend on the perceived reliability of the service (Lee, Miguel, and Wolfram, 2019).[6] Of course, increasing quality beyond a certain point may not necessarily improve welfare, given households' preferences and budget constraints. This underscores the need to define a basic suitable basket in each situation.

Given the multidimensional aspects involved in availability, quality and affordability, there is not a single standard of provision nor a single path to reach universal access. Whatever the objective chosen in the local context, infrastructure needs to consider all three. The role of policies in this balance is fundamental and will be discussed in the next chapters, which consider supply-side and demand-side policies in turn.

[6] Paying a higher price for an essential service does not always mean the user is receiving a higher quality, for example in the case of operators enjoying significant market power and facing inadequate regulation.

Chapter 3: Supply-side policies

Key messages

- Supply-side policies are key to enhancing access to infrastructure by improving availability, quality, and affordability.
- The first important priority is to attract greater and more effective investment in infrastructure services, leveraging public, commercial, and private resources through innovative funding and financing mechanisms.
- Supply-side policies also play a major role in ensuring the quality of infrastructure services through effective implementation and maintenance.
- Finally, supply-side policies can enhance the affordability of the services for the users through efficient service delivery, lowering lifecycle costs through better maintenance and the adoption of alternative cost-effective technologies tailored to local needs.

Delivering good quality, efficient, reliable, and affordable infrastructure requires innovative and adequate policy design. Optimal design will depend on the context, the sector, and the bottlenecks to effective access identified in terms of availability, quality, and affordability. In this section, we discuss various supply-side policy considerations aimed at ensuring access to infrastructure through the lens of these three dimensions.

As noted above, these three facets of infrastructure access are interconnected and may at times conflict with one another. For example, providing services in remote areas can be very expensive. The unit costs of road construction are in the tens or hundreds of thousands of dollars (Collier et al., 2015) and the cost of a transmission grid line extension is in the hundreds of thousand dollars. In Kenya, for example, the cost of a local electric connection was over US$1,200, exceeding the country's per capita GDP (Lee, Miguel, and Wolfram, 2019). Full cost recovery in many cases conflicts with the affordability of services, implying the need for complementary supply- and demand-side policies. Similarly, a focus on improving the quality of infrastructure services may lead to higher costs, making them less affordable. Therefore, in practice, we need to consider all these goals together and understand the trade-offs between the various objectives. This is crucial for designing the most effective set of policy actions to improve access.

This chapter starts with a review of the need for more and better infrastructure investment. It will then present supply-side policies aimed at improving the availability and quality of infrastructure services. The next section, and the core of this chapter, will present policies designed to improve affordability of infrastructure services. It highlights that these policies should start with sound supply-side strategies to lower lifetime costs as much as possible and provide alternative technological options. Throughout the chapter, case studies will be relied upon to illustrate important concepts. While these case studies do not always provide a comprehensive evaluation of the impacts or cost-effectiveness of the supporting policies, they are still useful to guide the reader through important aspects to consider when designing policies.

3.1 Availability: The need for more and better investment

The access rates to basic infrastructure services observed throughout the developing world underscore the insufficiency of current investment levels to achieve universal access. For instance, recent estimates suggest that annual infrastructure spending in Sub-Saharan Africa ranges between 1.9 and 3.5 percent of GDP, significantly lower than the estimated regional need (Fay et al., 2019; Rozenberg & Fay, 2019). In developing Asia, excluding China, the investment gap is estimated to be 5 percent of the GDP (ADB, 2017). Latin America and the Caribbean should invest at least 3.12 percent of its GDP annually starting in 2019 in energy, water and sanitation, transportation, and telecommunications to meet the Sustainable Development Goals by 2030 (Brichetti et al., 2021). This investment is especially needed in regions and countries with low connectivity to infrastructure networks. For example, Box 3.1 provides an example of a program to expand the electricity grid in Papua New Guinea, where only 12 percent of households are connected to the system.

Box 3.1. Expanding the connection to the electricity grid in Papua New Guinea: Powering homes and businesses in Morobe and East New Britain provinces (Case study contributed by the government of Australia)

Papua New Guinea has the lowest electricity access rate in the Pacific and one of the lowest in the world, with only 12 percent of households connected to the grid. To help address this challenge, the Australian government, through the Australian Infrastructure Financing Facility for the Pacific (AIFFP), and the Asian Development Bank have collaborated to implement a project aimed at providing electricity to the provinces of Morobe and East New Britain.

The project's goal is to connect between 30,000 to 40,000 households (150,000-200,000 people), as well as schools and clinics, to the electricity grid for the first time. This initiative will increase the number of Papua New Guineans connected to the national electricity grid by approximately 25 percent. It involves the construction of around 670 kilometers of new medium and low-voltage distribution lines and the installation of over 1,000 transformers. The project reached a financial close in 2023, and construction contracts are set to be awarded in 2024.

Furthermore, population growth poses a significant challenge. Despite overall improvements in access to infrastructure services over time, the absolute number of people lacking access could escalate if investment fails to keep pace with demographic shifts. In Africa, despite ongoing electrification, resulting in 53 million new connections being added between 2021 and 2022, many countries have struggled to compensate for the growth of population, which increased by 63 million over the same period. This led the number of people lacking a connection to grow from 675 to 685 million between 2023 and 2024 (IEA et al. 2024).

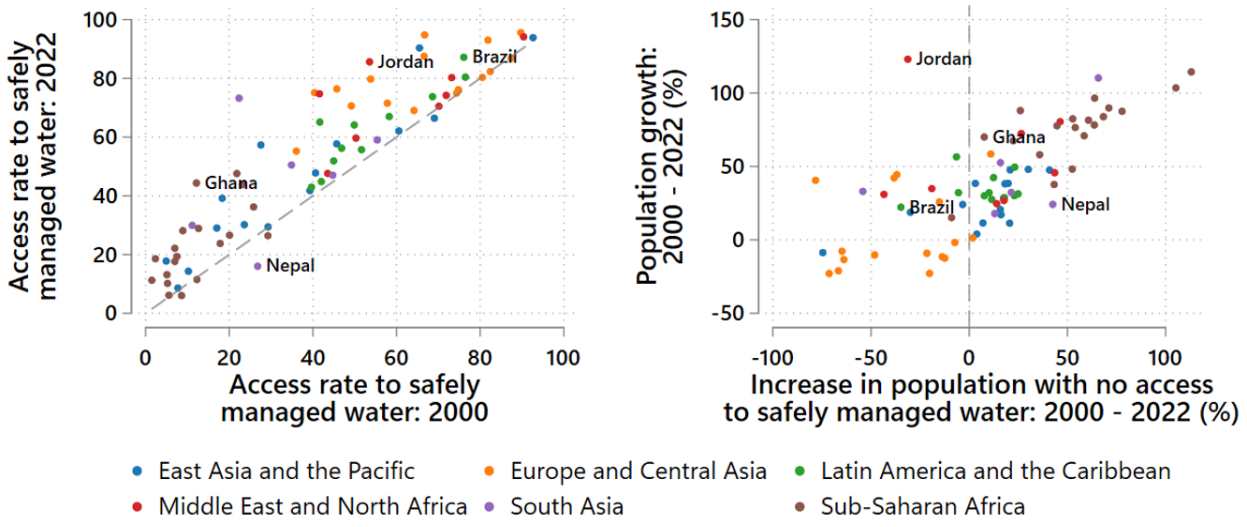
This challenge is also illustrated in Figure 3.1 in the context of the evolution of access to safely managed drinking water between 2000 and 2022 (Bagnoli et al., 2021). Figure 3.1a shows that most countries have improved their access rates between 2000 and 2022, as indicated by their position above the diagonal line. However, failing to account for population growth could lead to

an incomplete assessment of the situation, as seen in Figure 3.1b. The vertical axis measures population growth (between 2000 and 2022), and the horizontal axis shows the change in the absolute number of people without access to safely managed drinking water. For instance, in the case of Ghana, the country has achieved remarkable progress in access, more than tripling the rate in just over two decades, going from 12 percent of the population in 2000 to 44 percent in 2022 (see Figure 3.1a). However, due to a population growth of 70 percent, there were 1.3 million more people without access in 2022 compared to 2000, representing an 8 percent increase (Figure 3.1b). This is the case for all the countries on the right side of the vertical axis in Figure 3.1b. Conversely, countries on the left side of the axis have reduced the number of individuals without access to safely managed water between 2000 and 2022. For instance, Brazil achieved a 35 percent decrease in the population without access to safely managed drinking water.

Figure 3.1. Access rates to safely managed drinking water and population growth: 2000-2022

3.1a. Evolution of access rates

3.1 b. Population without access and population growth



Source: Authors' analysis, based on the World Development Indicators for available countries.
Note: High-income countries are excluded from the figure.

Finally, the challenge is compounded by the competing demands on resources stemming from the intertwined issues of climate change, conflict, and pandemics. According to the recent World Bank evolution roadmap paper, these demands amount to approximately US$2.4 trillion per year for all IDA and IBRD countries between 2023 and 2030 (IMF-World Bank Development Committee, 2023). Given constrained public and concessional resources, it is necessary to attract more private and commercial financing to infrastructure sectors. The difficulty in attracting private investors can explain part of the investment gap. Currently, only 9 to 13 percent of the global infrastructure investment in developing countries comes from private sources (Fay et al., 2019). Moreover, some sectors, such as water, have a negligible share of private involvement, accounting for only about 1.7 percent of total infrastructure investments (Joseph et al., 2024). This

difficulty is even more pronounced in the poorest countries. Innovative funding and financing mechanisms, such as value capture, risk mitigation instruments, impact bonds, and other financing instruments, are essential to attract private financing. Multilateral development banks (MDBs) can play an essential role in effectively mobilizing private investors and making use of mechanisms that reduce investment risks, such as blended finance or other de-risking mechanisms.

However, it should be noted that private participation can succeed only if there are sound public financial management and policy frameworks in place (Joseph et al., 2024; Herrera Dappe et al., 2023; Wahba et al., 2022). This includes improvements in procurement practices and regulation. For example, the G20/OECD Report for the G20 Infrastructure Working Group under the Indian Presidency in 2023 presented detailed recommendations for financing infrastructure investment in cities, which are summarized in Box 3.2.

Box 3.2. Financing Cities of Tomorrow – G20/OECD report for the G20 Infrastructure Working Group under the Indian Presidency: Main results and recommendations

1. **City governments have significant potential to meet current and future urban infrastructure challenges and promote investment.** They are directly involved in providing local urban services, making them well suited to identify investment needs. They can also leverage their role over urban planning and development strategies to effectively plan the use of resources and minimize investment costs.
2. **Effective urban planning improves the chances of attracting private capital for inclusive, resilient, and sustainable urban investments.** Better urban planning includes the following actions:
   - Including 21st-century challenges in strategic plans, such as the plans and policies that accelerate the net-zero transition in cities.
   - Creating regulatory environments with transparent and predictable processes.
   - Strengthening stakeholder collaboration and engagement.
3. **The financing of urban infrastructure is unattainable without cities leveraging private investment.** The following approaches are proposed to further support the leveraging of private investment.
   - Strengthen cities' competences, including legal and institutional frameworks or partnerships.
   - Use new instruments to finance emerging infrastructure needs, including biodiversity offsetting or land use capture.
   - Design built-in mechanisms to protect people in vulnerable situation from potential adverse consequences of land value increases.
4. **Enhancing access of cities to sustainable finance for quality infrastructure can contribute to the development of more inclusive, resilient, and sustainable cities.** Actions to harness to potential of sustainable finance include:
   - Create enabling environments, for instance through effective fiscal and regulatory frameworks.
   - Guarantee that cities have sufficient and reliable funding sources to meet operational, capital, and maintenance costs, and to repay financing.

- Promote the adoption of sustainable financing instruments through targeted support measures.

Source: OECD (2023).

Overall, this shortfall in investments not only calls for higher financing levels, but also better resource allocation to be able to do better with less. This includes the need to prioritize the right projects, improve the planning, implementation, and maintenance of infrastructure, and provide a choice of technological options that match the demand and the population's capacity to pay. These different aspects are developed in the following sections.

3.2 Quality: improving design, implementation, and maintenance

As mentioned earlier, quality is an important aspect of access to infrastructure services, and it manifests itself in various forms depending on the context and sector. For instance, in transport, quality may encompass aspects such as the quality and comfort of the transportation vehicle, commuting time, and the trip's safety. As mentioned above, quality is multidimensional and may include aspects such as reliability, capacity, durability, safety, sustainability, and resilience. This is aligned with the G20 principle for quality infrastructure investments (OECD, 2022), which is a set of voluntary and non-binding principles.[7] Quality is influenced, among others by adequate design, implementation, and maintenance during the project's life. Box 3.3 presents two examples of policies aimed at improving road safety in Bangladesh and India.

Box 3.3. Road safety in Bangladesh and India

Road safety is an important aspect of transport quality. In Bangladesh, road crashes claim the lives of more than 4,000 people per year, with countless others sustaining serious injuries. The rapid increase in the number of vehicles, coupled with inadequate institutional mechanisms and investment to address road safety, has led to a worsening situation over the past decades. The Bangladesh Road Safety Project, approved by the World Bank in 2022, is the first stand-alone multi-sectoral road safety project for the institution in South Asia. The initiative aims to support the country in developing a long-term national plan to improve road safety and related outcomes, aligning with the targets set out in the Sustainable Development Goals, which call for halving global road deaths and universal access to safe transport in cities by 2030.

Road safety management depends on various institutions and ministries, which can experience lack of coordination and might not always recognize it as a priority. To address this, the Bangladesh Road Safety Project will pilot comprehensive road safety measures, including improved engineering designs, signage and marking, pedestrian facilities, speed enforcement, and emergency care. More specifically, this project will help modernize the capacity of the

[7] See https://www.worldbank.org/en/programs/quality-infrastructure-investment-partnership/overview, accessed on Oct. 10, 2024.

patrols to manage speeding, improve post-crash care, and undertake campaigns to create awareness and behavioral change.

Besides investment projects, complementary policies, such as changes in legislation, can also play a significant role in enhancing road safety. For example, in 2019, India introduced a new motor vehicles bill that amended the original motor vehicle act of 1988, incorporating crucial safety provisions. These encompass heightened safety standards for children during commutes, such as the mandatory use of safety belts or helmets, penalties for contractors responsible for flawed road design and engineering, and increased sanctions for drunk-driving and speeding.

Implementation

The implementation of infrastructure projects is a key aspect in ensuring the long-term viability, efficiency, and sustainability of infrastructure assets and the services they provide. Implementation encompasses the project's planning, execution, and all stages leading to its completion.[8] Timely implementation is especially crucial, particularly in the context of climate change and energy transition, which require increased urgency of action. For an illustration of these aspects, Box 3.4 presents an example of sustainability constraints that were considered in the construction of a power plant in Cambodia.

Box 3.4. The importance of assessing the sustainability of a project in its design stage: The case of a hydropower plant in Cambodia (Case study contributed by the government of China)

The Lower Sesan 2 Hydropower Project is located in the Sesan River in Stung Treng Province, northeast Cambodia. Its goal is to establish a high-quality power station and provide clean, sustainable, and affordable power energy to the country. It was developed as a public-private partnership between the Cambodian government and co-invested by China Huaneng (with 51 percent of shares). The project commenced commercial operation in December 2018.

It is currently the largest hydropower station in Cambodia, accounting for nearly 20 percent of the country's total installed power generation capacity. The dam, stretching over 6,500 meters, is also known as "the longest hydropower dam in Asia", with an annual generating capacity of 1.97 billion KWH.

In addition to successfully reducing electricity costs and addressing power shortages, this project serves as a model for the importance of considering sustainability during the design phase. To minimize the project's impact on the river's ecological environment and aquatic organisms, China Huaneng invested approximately US$1.5 million to design and construct a natural-like migratory fish pass. A monitoring program was also implemented, confirming the

[8] For a guide on best practices, strategies, and policies to incorporate sustainability standards in PPP infrastructure projects in Latin America and the Caribbean see Inter-American Development Bank (2024).

fish pass's effectiveness in maintaining the diversity of fish and the river's connectivity and ecological environment.

Maintenance

Integrating maintenance practices throughout the lifespan of new infrastructure is essential to ensure that these investments effectively contribute to countries' sustainable development goals. Proper maintenance reduces operational costs, extends the lifespan of assets, and can make infrastructure more resilient to climate variability. Engel, Fischer, and Galetovic (2020) mention that intermittent maintenance costs between 1.5 (for developed countries) and 3 times (for developing countries) more than continuous maintenance. In fact, continuous maintenance can lead to up to 16 percent savings over the lifecycle of a typical 30-year project. Additionally, the costs of proper maintenance can be significantly lower than those required to repair and recover assets after an extreme event. Box 3.5 presents challenges and lessons learned for the maintenance of roads in South Africa, Argentina, and Brazil.

Box 3.5. On the importance of maintenance in low-volume roads

A. South Africa

South Africa has an extensive network of rural roads, with 94 percent of its population living within 2 km of them. If all these rural roads were upgraded to all-season roads, South Africa would rank among the top countries for rural access, as measured by the Rural Access Index (RAI).[9] However, the RAI's 2020 data reveals that only 57.5 percent of the rural South African population lives within 2 kilometers of an all-weather road. This low level of accessibility can be attributed to the poor condition of the rural road network. Overall, only 24 percent of rural roads in the country qualify as all-season roads. Moreover, about 81 percent of the rural road network remains unpaved, and only 9.7 percent of that network is in good or very good condition (DBSA and World Bank 2023).

The challenges faced by South Africa's infrastructure are not unique. Many developing countries follow a costly cycle of building, neglecting, and then rebuilding infrastructure, which ends up being significantly more expensive than the approach of building and maintaining infrastructure. For example, the South African National Roads Agency SOC Ltd (SANRAL) estimated that the cost of repairing roads in the country is six times higher than the cost of preventative maintenance after three years of neglect, and 18 times higher after five years of neglect (SANRAL, 2004).

To enhance rural access, the rehabilitation of the rural road network might be an alternative for many developing countries. However, this requires a comprehensive evaluation of the life-cycle

[9] The Rural Access Index measures the share of the rural population living within 2 km of an all-season road. This index serves as indicator 9.1.1 for SDG target 9.1, which aims to develop quality, reliable, sustainable, and resilient infrastructure to support economic development and human well-being, with a focus on affordable and equitable access for all.

costs of different scenarios. In South Africa, for example, rehabilitating all rural roads without changing the type of surface and undertaking adequate maintenance would cost 11 percent more over a 30-year horizon than paving all roads with a low-volume seal and following a proper maintenance schedule (DBSA and World Bank 2023).

B. Performance-based Road Rehabilitation and Maintenance Contracts (CREMA) in Argentina

For decades, persistent fiscal crisis and deficient management policies led to underfunding and deterioration of road assets in the country to the point that, in 1990, Argentina ended up with the lowest share of paved roads in good condition among upper-middle income countries.

In 1991, the government concessioned nearly 9,000 kilometers of the paved network with the highest volumes of traffic (above 2,500 vehicles/day). Overall, 18 concession contracts were awarded to the private sector for 12 years, and their upkeep was financed by road user tolls. For the rest of the paved network, the average density of traffic (a little less than 1,000 vehicles per day on average) was too low to enable tolls to finance the expenditures needed by the restoration works.

Between 1996 and 1997, building on the experience of the concession program, and with the World Bank's assistance, the National Directorate of Roads of Argentina (DNV) initiated the CREMA (Contrato de Recuperacion y Mantenimiento) contracts. The CREMA is a combined rehabilitation and maintenance contract that requires the Contractor to rehabilitate and maintain a sub-network of roads under a lump-sum contract for five years. The system applies to a paved sub-network that needs to be rehabilitated over a portion (or the totality) of its length and subsequently maintained. Rehabilitation work is done during the first 12 to 18 months of the contract, while maintenance is done throughout a five-year contract period.

Payments are made upon achieving a specified level of service, rather than being based on a pre-determined Bill of Quantities and unit rates, as in ad-hoc measurement-type contracts. Performance indicators are kept to the minimum and are easy to monitor and measure.

Between 1997 and 2009, about 24,000 kilometers of the non-concessioned paved network were maintained through 148 individual CREMA contracts. The total amount of financing assigned to the CREMA programs between 1997 and 2009 represents nearly US$2.5 billion, corresponding to about 20 percent of the total investments allocated by DNV to the maintenance, rehabilitation, and improvement of the non-concessioned national network. The World Bank contributed nearly 42 percent of that total amount through four successive highway rehabilitation loans.

The successful implementation of the CREMA system has dramatically impacted the condition and riding quality of the national network, as evidenced by the International Roughness Index (IRI). The IRI measures the roughness of road surfaces, with lower values indicating smoother roads and higher values indicating rougher roads. As a result of the CREMA system, the maintenance backlog, which represents the proportion of the 22,000 kilometers long non-concessioned network with an International Roughness Index (IRI) greater than 4, have been

reduced from approximately 35 percent to 10 percent. The proportion of roads in poor to bad condition, that is, with an IRI greater than 5, has been reduced from 11 percent to a current value of about 2 percent, while the proportion in good condition has increased from 65 percent to 90 percent. In terms of road users' costs, the savings that have accrued from the realization of the CREMA contracts on the non-concessioned network are substantial and estimated to be at least in the order of US$275 million annually (case study based on Silva and Liautaud, 2011).

C. The Brazilian experience with performance-based contracts

Brazil's transport infrastructure networks have suffered from years of under-investment, hindering both their expansion and consistent management. The deficit of transport infrastructure impairs competitiveness and inclusion and limits the potential for direct employment generation created through infrastructure investment.

Over the past 25 years, Brazil has gained unique experience in using Performance Based Contracts for the management of road infrastructures. These contracts, known as 'Contrato de Reabilitação e Manutenção' (CREMA), have improved expenditure efficiency in the sector, resulting in an average 20 percent reduction in financing needs over five years and leading to better outcomes for road users. Longer-term contracts are projected to achieve even greater cost savings, with initial estimates suggesting potential decreases of 40 to 50 percent over the full 15 to 20-year life cycle of the infrastructure. This approach also improves consistent road asset management, ultimately reducing travel costs and bolstering the country's competitiveness (for a detailed assessment on CREMA, refer to Lancelot, 2010).

3.3 Affordability: Lowering the cost

Beyond availability and quality of services, achieving universal access requires steps to ensure that services are affordable for the population. This section explores two key areas of focus for supply-side policies aimed at enhancing the affordability of infrastructure by lowering the costs of provision. One approach to making basic infrastructure services more affordable is to ensure that construction and operational costs are as low as possible while maintaining specific quality standards. In that way, supply-side policies can affect the affordability of infrastructure services through two main mechanisms. First, for a specific technology and a given quality standard, there might be a set of actions to increase the efficiency of the projects (by decreasing inefficiencies) to decrease their lifetime costs. Second, supply-side policies can also affect costs by offering a menu of technological alternatives capable of delivering infrastructure services at lower costs. The next sections delve into each of these options and provide concrete examples.

Efficient provision

The efficient provision and maintenance of any project can help lower fixed and variable delivery costs, potentially relaxing affordability constraints. For example, Box 3.6 presents a case study of the construction of the largest sewage treatment plant in South Asia, which resulted in high efficiency and reduced operational costs for downstream water supply plants.

Box 3.6. Lowering costs in the Dasherkandi Sewage Treatment Plant Project, Bangladesh (Case study contributed by the government of China)

The Dasherkandi Sewage Treatment Plant in Bangladesh, funded by the Chinese government with concessional loans, was completed in 2022 and stands as South Asia's largest sewage treatment facility. It can handle sewage from five million residents in Dhaka, equal to 20 percent of the volume. Over nearly two years, the plant treated nearly 250 million tons of water, significantly decreasing local water pollution and enhancing residents' quality of life.

During the construction phase, local procurement reached $45 million, creating over 1,000 local jobs with technical training and above-average wages, thereby also promoting local development.

Throughout the project's execution phase, great importance was given to innovation and application of key technologies, including digital solutions to optimize construction processes, achieve energy conservation goals, and improve efficiency. For instance, effective management of the project schedule and resource allocation enabled the project team to identify and address risks and deviations promptly. These examples highlight the role of technology in improving efficiency. Moreover, the impact of this sewage treatment plant extends beyond its immediate scope, as it has helped reduce the operational costs and increase the efficiency of downstream water supply plants, leading to additional long-term economic benefits.

Other ways to decrease costs and increase project efficiency include prioritizing the right projects, optimizing delivery mechanisms through transparent procurement and/or well-designed bidding procedures, and leveraging digital technologies, particularly in sectors such as water, transport, and energy. To illustrate the latter, Box 3.7 presents evidence on the effects of implementing e-procurement in Nepal, India, and Indonesia. Box 3.8 presents the case of a digital platform to help improving the quality of life in Russian cities.

Furthermore, fostering competition in the market, establishing effective price and quality regulations, and offering appropriate incentives for maintenance from the planning stage play a significant role in lowering lifetime costs of infrastructure provision, reducing affordability constraints, and enhancing households' resilience in the event of economic shocks. As discussed in the previous section, adequate and regular maintenance can generate significant savings over the lifetime of a project. Public-Private Partnerships (PPPs) are one way to generate incentives for such appropriate maintenance (Engel, Fischer, and Galetovic, 2020; Fabre and Straub, 2023).

Box 3.7. Lowering costs and improving quality of public works through e-procurement: Evidence from Nepal, India, and Indonesia

The procurement of road construction and maintenance projects in Nepal has been hindered by a lack of competition. Most road construction and maintenance projects in the country are awarded through procurement auctions. Interested firms submit bids and the lowest qualified bidder is awarded the contract and paid the bid amount. Unfortunately, these procurement auctions have been vulnerable to documented instances of cartelization, bidder obstruction, and intimidation (Government of Nepal, 2009). Cartel members have been reported to coordinate bids, inflating the government's expenses, while non-cartel bidders have faced physical obstruction from goons hired by dominant incumbent bidders.

In response to these issues, the Nepalese government introduced electronic bidding (e-bidding) as an option in auctions starting in 2008. E-bidding allows participants to submit their offers online, eliminating the need for physical presence at the procurement entity offices.

The introduction of e-bidding had a significant impact on auction outcomes. Auctions with the e-bidding option resulted in approximately 15 percent lower procurement costs. This decrease appears to be driven by a substantial increase (around 47 percent) in the number of submitted bids. Interestingly, e-bidding does not seem to have increased the number of interested contractors who buy bidding documents. This finding suggests that e-bidding might have undermined cartel activity, prompting non-cartel participants to engage (Herrera Dappe and Saini 2024).

India and Indonesia use e-procurement in public works. Unlike in Nepal, e-procurement in these two countries did not affect the prices paid by the government. However, it improved the project performance of winning bidders. In India, the average road quality increased after the implementation of e-procurement, possibly due to the selection of higher quality winners from outside the project's location. In Indonesia, the delay in project completion decreased with e-bidding (Lewis-Faupel et. al 2016).

Box 3.8. 'Goroda.RF': A digital platform for improving quality of life in Russian cities (Case study contributed by the government of the Russian Federation)

In 2023, Russia launched Goroda.RF (Cities.RF), a digital platform designed to enhance the quality of life in Russian cities. This platform serves as a two-way communication channel between city authorities, citizens, and businesses, enabling them to assess urban infrastructure, identify shortcomings, and propose solutions.

Goroda.RF is structured around four key modules:

1. City Profiles: These provide a comprehensive overview of each city, including key facts, economic indicators, points of interest, tourist attractions, and a platform for citizen engagement. Citizens can submit ideas, participate in surveys on city development, and contribute to crowdfunding projects.

2. Analytics: This module houses a database of 218 Russian cities, encompassing 350 indicators related to the quality of life. These indicators cover areas such as housing, income, health, education, mobility, and the environment. This section also includes an algorithm for assessing the impact of investment projects on a city's quality of life.
3. Special Projects and Support Measures: This module provides information on financial instruments offered by the State Development Corporation 'VEB.RF' to municipalities and regions for spatial and infrastructural development. It also features special projects like a competition for research papers on quality of life and an award recognizing entrepreneurs who improve city life.
4. Educational Projects and Programs: This module offers information on advanced urban development solutions, training materials, and webinars. It aims to foster a culture of urban development through educational initiatives.

Goroda.RF has already made a significant impact on improving the quality of life in participating cities. It has been used to analyze investment projects, identify cities needing support, and create a library of best practices. The platform has also helped businesses mobilize private capital and find new opportunities and has contributed to reduce the time it takes a citizen, a city manager or a businessman to obtain the information they need.

The long-term goal is to expand the platform to 300 cities and integrate it into business planning processes. Ultimately, Goroda.RF aims to create a "digital twin" for each participating city, providing a comprehensive platform for information and services. The platform also plans to include cities from the Eurasian Economic Union, aligning with VEB.RF's international agenda for BRICS and the Shanghai Cooperation Organization.

Alternative technological choices

Enhancing the affordability of basic infrastructure services can also be achieved by expanding and diversifying the range of technological options available for their delivery. This is particularly relevant in the efforts of many developing countries to reach remote and rural areas, where 'last mile solutions' are often challenging and costly. For example, improving electricity access in remote and rural areas has traditionally involved installing power lines over long distances and through challenging terrains, leading to significantly increased installation and operational costs. These high costs can create trade-offs between providing cost-effective service and ensuring equitable access (Cavallo et al., 2020). In the context of transport, Box 3.9 provides an example of an innovative solution to expand public transport in La Paz, Bolivia.

Box 3.9. Expanding the public transport network with innovative solutions: The case of Mi Teleférico in La Paz, Bolivia

Creating a good transportation network between La Paz and El Alto in Bolivia posed important urban planning challenges. Although the two cities are contiguous and mostly economically integrated, geographical barriers made commuting difficult. High slopes, poor pavement, and

poor drainage created severe congestion issues, and traditional solutions like BRT or subways were either unfeasible or prohibitively expensive (Cavallo et al., 2020).

In 2011, the Bolivian government adopted an innovative approach inspired by a pioneering project in Medellin, Colombia, and developed an extensive urban cable car network known as “Mi Teleférico.” As one of the largest in the world, Mi Teleférico has transported over 200 million passengers within five years, with 70 percent of them being low-income individuals (Mi Teleférico, 2019). The primary beneficiaries of this transportation system are residents of El Alto, who are mainly from low-income and indigenous households. This project has resulted in a 22 percent reduction in travel time, which translates to an average net benefit of US$0.54 per trip for users, assuming that the time saved is spent on working (Suárez-Alemán & Serebrisky, 2017).

Similarly, in many developing countries, the lack of connections to municipal piped water systems creates an affordability barrier for water access for low-income households. They sometimes need to resort to purchasing water from vendors at inflated prices to cover their water needs, with unit prices that can go as high as five times the cost of water through the network connection (Wahba et al., 2022).

In recent decades, technological solutions have begun to play a crucial role in improving access to basic infrastructure services at an affordable price. Examples of these solutions include decentralized electricity systems or off-grid solutions, as illustrated in Boxes 3.10 and 3.11, and rainwater capture systems, as illustrated in Box 3.12. These experiences from Brazil and Peru demonstrate that developing alternative technological choices is essential to ensure a balance between the infrastructure services, their costs, and the population's willingness or capacity to pay.

Box 3.10. Light for All in rural Brazil (Case study contributed by the government of Brazil)

The "Light for All" ("Luz para Todos" in Portuguese) program was established in November 2003 and stands as the main public initiative to enhance rural electrification in Brazil. The program addresses electricity needs and utilizes decentralized generation and renewable energy sources for remote areas.

The program’s primary objective is to provide electricity access to the population historically excluded from this essential public service, particularly in rural areas. A key focus of the program lies in the electrification of rural schools, with special attention to those located in indigenous and other traditional communities.

The "Light for All" program has had a substantial impact since 2004, benefiting over 16.4 million people in rural areas. Additionally, it has significantly contributed to poverty reduction, increased household income, and improved access to water supply, sanitation, health, and education services. A recent study further confirms the positive externalities of this program on education, demonstrating a reduction in dropout rates in rural schools (Mejdalani et al., 2018).

Box 3.11. Photovoltaic Policies in Peru

Peru has made significant strides in expanding access to electricity services. Between 2000 and 2018, access rates increased from 64 percent to 97 percent. This success stems from several factors, including the government's leading role in investing in extending energy access to the most isolated and lowest-income populations, as well as involving beneficiaries in installing and operating off-grid solutions. These off-grid solutions include specific programs aimed at increasing the use of decentralized renewable energy in rural areas.

These efforts encompass various photovoltaic policies, including the Social Inclusion Energy Fund (FISE), a program started in 2012 for implementing photovoltaic systems in areas not connected to the power grid. This initiative played a crucial role in providing electricity to 106,000 rural residents over a five-year period (Sanin, 2019; Cavallo et al., 2020).

Box 3.12. Cisterns Program: Enhancing water access for rural families in Brazil (Case study contributed by the government of Brazil)

Established in 2003, Brazil's National Support Program for Rainwater Capture and other Social Technologies ('Programa Cisternas' in Portuguese) aims to promote access to water for human consumption and food production through the implementation of simple and low-cost social technologies. The initiative targets low-income rural families affected by drought or regular lack of water, with priority given to the Brazilian semi-arid region and its traditional peoples and communities. The program is financed by the Ministry of Social Development and Assistance, Family, and Fight against Hunger and seeks to promote coexistence with the lack of rain, primarily through plate cistern technology. These reservoirs store rainwater for use during the region's most critical eight-month drought period. The program was later expanded to other areas in the Northeast and is now active across several biomes, including the Amazon.

According to the Ministry, over 1.14 million cisterns have been built in 20 years, with over one million units delivered by 2016. With agreements in place and calls for proposals launched, investment in 2023 is expected to surpass BRL 562 million (i.e. over approximately USD 110 million) and benefit 60 thousand families.

Chapter 4: Demand-side policies

Key messages

- Efficient provision should be complemented by tariff structures that provide financial stability to providers, while also being simple, easy to implement, consistent, and transparent.
- Tariff design should be adapted to consumers' heterogeneity and can be complemented by innovative technologies such as pre-paid meters.
- To address affordability issues and externalities, specific subsidies may be needed. They can help manage demand and enhance access for some segments of the population.
- The design, targeting, implementation, and funding of subsidies is complex. They may bring large benefits but can backfire if poorly managed.

Moving to demand-side policies, this section explores two key areas of focus for policies aimed at enhancing the affordability of infrastructure: designing effective tariff structures and implementing subsidies.

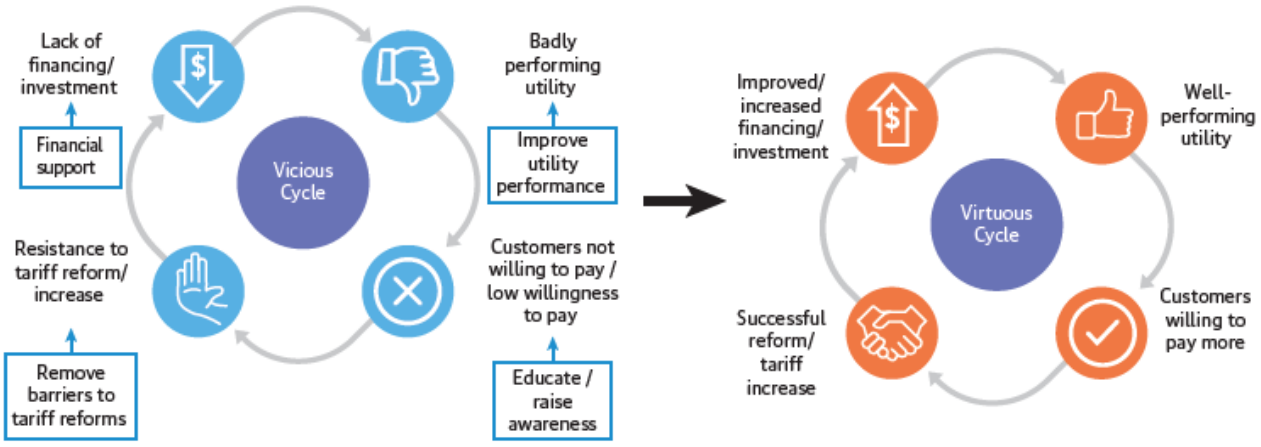
4.1 Designing and implementing adequate tariff structures

Effective design of tariff structure should then help maximize revenue collection and the financial sustainability of the providers. Conditional to good supply-side policies and effective tariff design, infrastructure services might still be unaffordable to some, making the case for well-designed and targeted subsidy schemes.

Ensuring the efficient provision of infrastructure services at lower costs while considering various quality and service technical options is crucial for expanding access to basic infrastructure services as it can improve the affordability of these services. However, another important aspect in service delivery is the existence of policies that ensure that the service provider is recovering costs through adequate tariff structures. It's important to recognize that tariff design is complex. It covers a range of policy objectives that include cost recovery and economic efficiency, as well as affordability, equity, environmental sustainability, and quality, all of which can sometimes be perceived as competing elements. Regardless of the specific combination of factors needed in the local context, countries should ideally aim for the implementation of tariffs that provide financial stability to providers, while also being simple, easy to implement, consistent, and transparent.

Designing tariffs starts with a detailed understanding of costs, which can be categorized as efficient and inefficient. Cost inefficiencies not only undermine cost recovery but also reduce the willingness of customers to pay for subpar services, resulting in low bill collection. This further hinders the service provider's ability to raise tariffs in the future, creating a negative feedback loop as illustrated in Figure 4.1.

Figure 4.1. Vicious and Virtuous Tariff Cycles



Source: Andres et al. (2021).

Optimal tariff structures vary depending on the country and sector. In the case of transport, the interplay of high fixed costs and a very diverse demand often results in complex pricing structures with various forms of price differentiation, including off-peak fare discounts or spatially varied fares (Gwilliam, 2017). However, tariff structures can inadvertently disadvantage the most vulnerable. For example, in New York City, the existing tariff structure has been found to disproportionally impact commuters in low-income neighborhoods. Due to financial constraints, many of them end up repeatedly buying weekly (7-day) unlimited ride passes for extended periods of time (at least 11 months) instead of monthly passes, resulting in these commuters paying 15 percent more for transit fares. In such a case, a tariff that puts a cap on the total fare paid each month that allows commuters to travel for free once the cost of the monthly pass has been reached could be highly beneficial for low-income passengers, without requiring an upfront lump-sum expense (Sun and Mikhed, 2023).

In the case of water services, most utilities in developing economies use increasing block tariffs (IBTs), where the cost increases as consumption rises. This approach assumes that poorer customers consume less water, making services more affordable for them. However, there is limited empirical evidence to support this assumption. On the contrary, poor households often have many members or share their water supply with neighbors, leading to higher consumption. As a result, many non-poor households benefit from IBTs, while many other poor and unconnected households remain unserved.

IBTs are also used to promote environmental sustainability by reducing consumption, yet their effectiveness on this is not-well supported by empirical evidence. A more efficient approach could be a two-part tariff, combining a fixed charge ensuring economic cost recovery with a volumetric rate sending a signal about service's scarcity and marginal cost.

Overall, tariffs and the associated regulations play an essential role in ensuring efficiency and good governance in the provision of basic infrastructure services. Strong political leadership,

improved service quality, and stakeholder engagement are also all essential elements for implementing successful tariff reforms.

Demand-side tariff design and enforcement can also benefit from innovative technologies. The use of pre-paid meters is a potential promising solution in water (Ogata et al., 2023) and electricity (Jack & Smith, 2020) to ensure bill collection, potentially helping with demand management and reducing waste while reducing negative externalities on all consumers from payment default. Improvement in the situation of the utilities in turn generates positive spillovers on their investment and maintenance capacity.

However, relying solely on tariff design to achieve multiple policy goals, particularly in the realm of alleviating poverty, might be challenging. Complementary measures, such as well-targeted subsidies, represent another path to address affordability for the most vulnerable populations.

4.2 Subsidies

Even after achieving low and efficient costs and implementing effective tariff structures, basic infrastructure services might still be unaffordable for some segments of the population. To address this, countries might consider subsidies as an additional policy tool to increase affordability and expand infrastructure access (see Box 4.1 for a discussion on the definition of subsidies). However, policymakers considering this alternative need to carefully ponder a range of factors to ensure that subsidies are effective in alleviating poverty while also being financially and economically sustainable in the long run. This section will explore the various aspects that countries should consider when designing and implementing subsidy schemes.

Box 4.1. What are subsidies?

Subsidies do not have a single, universal definition. Intuitively, subsidies are intended to enable a user/customer to pay less for a product or service than the service provider's price, with a third party responsible for covering the difference. However, this is just a partial aspect of a more complex series of dimensions, which can vary across different sectors. For example, in the energy sector, the Energy Sector Management Assistance Program (ESMAP) administered by the World Bank defines an energy subsidy as "a deliberate policy action by a government that specifically targets electricity, fossil fuels or district heating and that has one or more of the following effects: (i) reducing the net cost of energy purchased, (ii) reducing the cost of energy production or delivery, and (iii) increasing revenues retained by energy producers and suppliers" (Kojima, 2017).

It is important to keep in mind that subsidies can be delivered through different channels and may come in different forms, including indirect or implicit ones, which can make them challenging to account for. This wide range of forms include budgetary transfers of government funds, government-induced transfers between producers and consumers, foregone taxes and other government revenues, underpricing of goods and services, non-payment tolerance, and the implementation of price caps or quotas.

Subsidies can be designed on the supply-side, where funds are channeled through the service provider, who, in theory, passes on the funds to the consumer in the form of lower prices. Alternatively, they can be on the demand-side, involving a direct transfer between the government and the user. Demand-side subsidies are often preferred as they can specifically target their beneficiaries (Serebrisky et al., 2009).

What are the objectives of subsidies?

There are several policy objectives that may prompt governments to consider introducing subsidies. The two most common reasons are (i) to ensure affordability of the service for the most vulnerable and foster equitable access, and (ii) to tackle externalities associated with the use of the services.

Regarding the first policy objective, governments might want to subsidize the consumption of basic infrastructure services for those who are unable to afford them due to high connection or recurring costs. When this happens, it is important to consider that affordability issues can take various forms and vary across sectors. For example, a recent survey suggests that a large share of the population in Latin America and the Caribbean suffers from the heat or the cold, indicating either a lack of access to equipment (e.g., air conditioning) and/or a lower consumption of the service than what would be required to be comfortable (e.g., electricity in the case of air conditioning) (Cavallo et al., 2020). Several studies link insufficiently heated dwellings to higher wintertime morbidity and mortality (Alberini and Umapathi, 2019). A similar illustration can be seen in the transport sector, where a significant percentage of commuters are compelled to walk to work due to their inability to afford other means of transportation. For instance, in Nairobi, Kenya, 42 percent of residents commute to work by walking, while in Kampala, Uganda, this number rises to 70 percent (Wahba et al., 2022). When the policy objective is to increase affordability, policymakers face the challenges of identifying the ideal beneficiary group and implementing a targeting mechanism that effectively reaches the intended vulnerable population without subsidizing others.

Regarding the second policy objective, the use of infrastructure service might create externalities, which can be positive or negative. Positive externalities occur when the overall societal gains from increased consumption (or production) exceed the individual benefits. For instance, access to WASH services creates positive health and economic externalities by reducing the overall incidence of water-related diseases and the associated health costs in the communities where it is available.

In contrast, negative externalities occur when the consumption (or production) associated with the implementation of an infrastructure service directly imposes costs on third parties. In response, governments may introduce subsidies to manage consumer demand for services causing these externalities. For instance, to reduce electricity consumption, governments might subsidize the adoption of smart meters or the transition to cleaner technologies, such as solar panels for energy generation and energy-efficient household appliances. In the transport sector,

governments might promote the adoption of lower-emission vehicles or the use of alternative modes of transportation.

While subsidies can theoretically achieve various objectives, it is unlikely that a single instrument can meet all policy goals simultaneously. In fact, governments might face important trade-offs with their implementation. If a country decides to establish a subsidy scheme, it is crucial to thoroughly consider all the intended (and potentially unintended) outcomes and ensure that the subsidies are accurately targeted and effectively aligned with the desired policy objectives.

Subsidies are prevalent across infrastructure sectors and countries, regardless of region or income level.[10] Box 4.2 discusses some of the main challenges that should be considered when designing any subsidy reform to ensure its effectiveness in expanding access to basic infrastructure services.

Box 4.2. Challenges associated with existing subsidies

While subsidies might be an important tool for ensuring access to basic infrastructure services, the design of subsidy schemes face significant challenges that affect their effective implementation. **First, subsidies tend to be expensive**. For instance, fossil fuel consumption subsidies alone were estimated at US$1 trillion globally in 2022 (IEA, 2023). Indeed, energy subsidies often surpass allocations for social assistance in many developing countries (Mukherjee al., 2023). Similarly, water and sanitation subsidies cost governments worldwide around US$350 billion annually, which accounts for 0.55 percent of their GDP (Andres et al. 2019).[11] This percentage increases to between 1.59 and 1.95 percent of GDP when focusing solely on low- and middle-income economies. Adding explicit and implicit subsidies for fossil fuels, agriculture, and fisheries leads to a staggering amount exceeding $7 trillion or 8 percent of global GDP (Damania et al., 2023).[12]

Second, subsidies often do not effectively reach those who need them the most. There is important evidence indicating that subsidies, both across countries and sectors, tend to be regressive, disproportionately benefiting higher-income households (Coady et al., 2015). For instance, a study of 10 countries revealed that 56 percent of water subsidies went to the wealthiest quintile of the population, while only 6 percent reached the poorest quintile (Andres et al., 2019).

While subsidies might sometimes be regressive, they can still play a crucial role for low-income households, especially when considering them as a proportion of income. A good example of this is the case of propane subsidies in the Dominican Republic in 2004. Even though the poorest and wealthiest quintiles of the income distribution received 9 percent and 35 percent of the total subsidies, respectively, relative to their total income, these subsidies were more

[10] For example, for a detailed discussion about lessons and implications of energy subsidies at a global level, see Clements et al. (2013).

[11] These estimates exclude China and India.

[12] To put these figures in perspective, Rozenberg et al, (2019) estimate that low- and middle-income countries require an annual investment of 4.5 percent of GDP to achieve all the infrastructure-related Sustainable Development Goals and stay on track to limit climate change to 2°C.

significant for the former, representing 3.5 percent of income for the poorest quintile but less than one percent for the richest (Goldstein & Estache, 2009). While this does not imply that the subsidy was well-targeted, it does highlight the challenges associated with balancing the potential for regressive distribution.

One major reason for the ineffective targeting of subsidies is that many are structured as supply-side subsidies, distributed through the service provider. This results in those who use more services, typically not the most vulnerable, benefiting the most from these resources. Additionally, this structure means that subsidies can only reach individuals who are already connected to the services, thereby excluding by default the most vulnerable of all.

Third, subsidies can often be non-transparent. Due to their diverse forms and the challenges in accurately estimating their full costs, the magnitude of subsidies in each sector is rarely known to governments, regulators, and citizens. This lack of transparency can complicate efforts to ensure the accountability of the service provider.

Finally, poorly designed subsidies can be distortionary, sending incorrect signals to economic actors regarding the allocation of production factors. This can lead to inefficiencies and put the sustainability of services and investments at risk. For instance, if larger subsidies are provided to providers in areas with unreliable service, there might be less incentive to modernize their infrastructure. For example, McRae (2015), shows that electricity subsidies in Colombia discourage modernization investments by utilities. Distortions can also lead to the overexploitation of natural resources when price signals do not reflect the true cost of the service, leading to potential adverse environmental and health consequences (see, for example, Enriquez et al., 2018). Overall, these distortions can have adverse environmental and financial sustainability impacts, with supply-side subsidies often exacerbating these issues more than those on the demand-side. Given the dearth of global resources, the amounts allocated to distortive subsidies could better be repurposed to fund socially and environmentally useful policies (Damania et al., 2023).

Targeting of subsidies – What and who to target?

Upon selecting a policy objective, policymakers are faced with the challenge of determining which service(s) and/or population to target. For instance, addressing access to clean water in rural areas requires different strategies and resources compared to improving urban transportation networks. There is no one-size-fits-all solution to the problems of inadequate availability, quality, and affordability of infrastructure services. It requires a good understanding of who needs support, and the type of infrastructure service needed. The most suitable policy will depend on the country's context, the sector, the specific policy objectives, and the resource constraints of the government and stakeholders.

Below is a general outline of the type of questions involved in the targeting of a subsidy scheme. While they are clearly categorized here to aid the analysis process, there are considerable

overlaps between them in practice, and their relevance will depend on the specificities of the local context.

What to target? Policymakers are faced with the task of determining which specific service to target. For example, in transportation, countries might choose to subsidize a specific mode of public transport, such as trains instead of buses. Similarly, in the energy sector, the focus could be on subsidizing electrification or promoting clean cooking technologies. In the case of electricity services, policymakers might opt to subsidize grid extensions to benefit from economies of scale, or they could focus, for example, on decentralized or off-grid solutions to reach specific vulnerable populations.

When deciding what service to target, policymakers also need to consider whether to subsidize connection costs or the consumption of the service. While subsidizing connection costs tend to benefit households that currently do not use the service due to a lack of connection (typically the poorest households), subsidies on consumption are much more difficult to target effectively. However, solely subsidizing the connection might not fully address affordability issues for the most vulnerable. This underscores the importance of identifying the main access bottlenecks, as described in section 2.4.

Who to target? A subsidy policy also needs to clearly identify the intended beneficiaries. Various criteria, such as income, geographical location, gender, ethnic characteristics, etc., can be used to reach the most vulnerable populations.

A common goal for targeting is to focus on population groups based on their wealth and specifically reach lower-income households. However, identifying these households can be challenging, especially in contexts of high rates of informal employment and/or widespread underreporting of income. In practice, policies often rely on means-tested options to proxy income and target these subsidies. However, this approach can lead to significant errors of exclusion (failing to target households that need it) and inclusion (targeting households that do not need it). An example of successful targeting of a pro-poor subsidy in the context of public transport in Bogotá, Colombia, is presented in Box 4.3.

Box 4.3. Empowering low-income commuters: Bogotá's SISBEN Transport Subsidy

Implemented in 2014, the SISBEN subsidy for public transport in Bogotá, Colombia, is a program designed to provide financial assistance to low-income individuals to help them access public transportation services. SISBEN, an acronym for System for Identifying Potential Beneficiaries of Social Programs, generates a poverty score by considering various socio-economic characteristics of individuals and households. Individuals identified as in the lower socioeconomic strata are eligible to receive financial support for their public transportation expenses through a special card, which they can use to access subsidized transportation fares.

This targeting mechanism achieved its objective by being progressive. Maps of the city show that there is a high (negative) correlation between average household income in neighborhoods and the number of subsidized trips per inhabitant. This subsidy has had a positive impact on equity and beneficiaries' access to employment. The policy also contributed to a 56 percent

increase in the monthly trips of subsidy recipients (Rodríguez Hernández & Peralta-Quiros, 2016; Guzmán & Oviedo, 2018; Cavallo et al., 2020).

Geographical location can serve as another criterion for targeting beneficiaries. For example, countries might be interested in targeting urban areas with higher population density, as a subsidy scheme in this setting may yield greater returns by leveraging larger positive externalities. Conversely, policymakers might be interested in targeting rural areas as this may facilitate reaching lower-income households.

Gender represents another important variable when evaluating target populations. This is because men and women can have very different consumption patterns of basic infrastructure services due to factors like wage gaps and caregiving behaviors. As such, any policy that affects the affordability of an infrastructure service has the potential to affect men and women differently.[13] For instance, in the case of transport and mobility choices, women tend to make shorter, multipurpose trips during off-peak hours, while men tend to make longer, single-purpose trips during peak hours (Alam et al., 2022). This can affect the design and implementation of a mobility subsidy intended to increase women participation.

How to fund subsidies?

Once the policy objective and the specific service and population to be targeted have been defined, countries face the task of identifying funding sources to ensure the fiscal sustainability of a subsidy scheme. Subsidies can be funded through various means, including government resources, taxation, and cross-subsidies, which happen when some users pay more than the cost of service to compensate for other users who pay less than the cost. Importantly, this does not only concern current taxpayers or users. If services are underpriced today, future generations of taxpayers or users will have to pay more than their share.

Cross subsidies can be implemented within sectors or across services and sectors. For instance, a company might use revenues from its high-speed internet business to subsidize its landline services. On a larger scale, a country might implement a policy to ensure that the profits from one sector, such as electricity, are used to subsidize other sectors, like water and sanitation services. This financing can occur directly or indirectly (e.g., through an obligation to provide energy free of charge to water and sanitation providers). Box 4.4 presents an example of how well-targeted cross-subsidies can have remarkable impacts on economic redistribution.

Box 4.4. Social water pricing and cross-subsidies in Indonesia

In Indonesia, the water operator uses a cross-subsidy system among different groups of consumers. Residential consumers are divided into three income classes or social groups. The

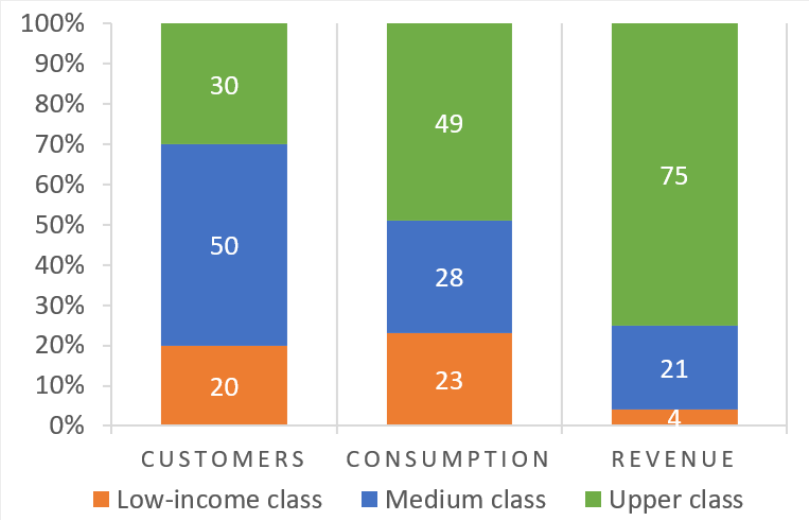
[13] The G20 Infrastructure Working Group under the Indonesia presidency produced a report addressing gender inclusive approaches in private participation in infrastructure. It highlights, among other topics, the need for including robust gender action plans during project preparation and the positive externalities of addressing the gender gap, particularly in the areas of clean cooking and public transport (World Bank, 2022b).

tariff structure follows an increasing block tariff (IBT), with each income class being charged a different rate. The highest tariff is about 14 times greater than the lowest rate, aiming at subsidizing low-income groups.

Figure B4.4.1 presents the effects of this cross-subsidy scheme. It shows that while 20 percent of all customers are classified as low-income, they account for 23 percent of total consumption but only 4 percent of the collected revenues.

Conversely, most of the revenue (75 percent) is collected from upper-class groups, even though they only represent 30 percent of the population, substantially impacting economic redistribution (Andres et al., 2021).

Figure B4.4.1. Effects of Cross-subsidies in the water sector in Indonesia



Source: Andres et al. (2021).

Each type of funding source, whether from the government, users, or third parties, comes with its own set of risks. For example, governments may fail to deliver promised resources, which could impact customers (in the case of demand-side subsidies) or service providers (supply-side subsidies). There might also be political risks if subsidies are part of the national budget and need annual approval, leading to potential continuity risks.

In the case of cross-subsidies, the risks stem from the difficulty of accurately estimating user charges across the customer base to ensure a proper balance between subsidy recipients and those who cross-subsidize. This difficulty might result in the subsidy amount exceeding the revenue collected from the cross-subsidizers, leading to a deficit (Andres et al., 2019). Regardless of the funding source, it is crucial to ensure that subsidies are fiscally sound, fully budgeted, and funded.

How to design and implement subsidies?

Even after considering all the factors mentioned earlier, countries may still need to assess additional factors to ensure that subsidies are designed and implemented effectively. While these factors include a wide range of considerations and recommendations (for instance, refer to Kojima, 2021, for various examples of subsidy delivery approaches in the liquefied petroleum gas sector), we focus here on two main elements: (i) decoupling subsidies from service charges, and (ii) evaluating the potential role of technology in improving service delivery. In both cases, the design of subsidies should be considered from the project preparation phase.

Regarding the first point, as previously discussed, subsidies can have important distorting effects. Therefore, countries might want to decouple subsidies from service charges as much as possible. By avoiding the service provider as an intermediary, it reduces the distortionary impact of subsidies. In practice, this could involve prioritizing cash transfers to beneficiaries rather than providing in-kind subsidies, such as reductions in electricity bills. In fact, cash transfers have emerged as one of the main instruments for alleviating the negative welfare effects of energy subsidy reforms (Mukherjee et al., 2023).

While cash transfers can theoretically reduce distortions, they might be more complex and costly to implement than in-kind transfers. Moreover, the success of in-kind transfers depends on both the context and the type of implementation. For example, Box 4.5 illustrates how consumer preferences for in-kind versus cash transfers can significantly differ between two different contexts.

Box 4.5. In-kind versus cash transfers: when the consumer's preferences depend on the context

The effectiveness of cash versus in-kind transfers strongly depends on implementation and local financial infrastructure. While cash transfers are theoretically beneficial in maximizing utility, in-kind transfers may sometimes be preferred in cases where they reduce transaction costs. A recent study by Berkouwer et al. (2021) explores the preference of individuals living in urban Kenya and urban Ghana regarding receiving a transfer in the form of mobile money (a cash transfer) or a pre-paid electricity credit.

Despite comparable levels of education, cell phone ownership, and electricity connectivity, the preferences for cash versus in-kind transfer vary significantly between urban Kenya and Ghana. In Kenya, 95 percent of respondents prefer mobile money over electricity transfers of similar value, reflecting the country's high adoption of mobile money. Conversely, in Ghana, where mobile money is less widespread and entails higher transaction costs, half of the recipients prefer electricity transfers, and many are willing to forgo significant value to receive electricity credit instead of mobile money.

This research underscores that there is no one-size-fits-all solution for implementing subsidies and transfers. Policymakers need to consider a diverse set of elements, such as the local financial infrastructure, when designing transfer programs. This example also emphasizes the

importance and potential of technology adoption in facilitating the delivery of subsidies and reducing constraints on financial infrastructure.

Technology can play a critical role in improving the delivery of subsidies. Examples of this include digital public registries, smart meters for electricity provision, and smart cards in the context of transportation. These latter, for instance, have been shown to enhance public transport systems by improving operational efficiency (e.g., using collected information to improve service design), increasing pricing flexibility (e.g., enabling multi-modal or multi-operator fare integration), and helping target subsidies more effectively (Gwilliam, 2017). Box 4.6 discusses the use of smart cards for public transportation in Argentina to target beneficiaries and transition from supply-side subsidies to demand-side subsidies directly aimed at the most vulnerable.

Box 4.6. Smart cards for public transportation in Argentina (Case study contributed by the government of Argentina)

Before the introduction of smart cards, the Argentinian government subsidized the public transportation system by covering the monthly difference between operating costs and user fares. However, this subsidy scheme was highly distortionary, impacted fiscal accounts, hindered private investments, and was not targeted towards the most vulnerable.

In 2009, the government introduced the SUBE (Single Electronic Ticket System in Spanish), a contactless smart card system for all public transportation in the Metropolitan Area of Buenos Aires and other cities in the country. This new technology allowed the government to shift from supply-side subsidies to demand-side subsidies, directly targeting the most vulnerable users based on their socioeconomic characteristics.

To access a reduced fare through the SUBE card, users need to register to the SUBE system. The applicants' socioeconomic data is then audited to verify their eligibility for reduced fares (i.e., their eligibility to receive a subsidy).

Target beneficiaries of the subsidy are retirees and pensioners, domestic workers, veterans, and those who have been granted access to assistance programs such as unemployment insurance or any other social assistance. If a user is eligible, their SUBE car will be charged either one third of the cost of the fare if they are considered the most vulnerable, or two thirds of the fare for the middle sector.

The SUBE system facilitates fund transfers from the National State to the transportation companies based on a user's number of tickets and type of fare, leading to greater traceability and efficiency in public resource allocation. It also provides a series of other advantages, such as allowing transport companies and the government to collect detailed information on the number of passengers, their modes of transportation, their demand for transport, as well as allowing for more reliable surveys on operating costs. Moreover, the use of SUBE allows

granting fare advantages to those who make transfers and can help reduce the time of boarding onto public transportation.

Complementary measures

Successful subsidy reforms are always accompanied by complementary policy mechanisms. First, effective communication about any subsidy reform or the introduction of new subsidies is crucial for proper implementation. Communication ensures that the public is well-informed and supportive of the reform and understands the reasons behind the policy change (Mukherjee et al., 2023; Vieites et al., 2023). For instance, in 2011, the government of El Salvador implemented a policy reform to the liquefied gas (LPG) subsidy, which increased the welfare of all but the two top deciles of the income distribution. However, the reform became highly unpopular, even among those who would benefit from it. Evidence pointed to misinformation, mistrust of the government's ability, and political biases as some of the reasons for dissatisfaction before implementation (Calvo Gonzales et al., 2015). Strategies to foster supportive political coalitions are also key for implementing a subsidy reform.

Similarly, designing and planning an exit strategy is a critical component of a reform package when a subsidy is intended to be short-term. Unless there is a clear policy objective stating that some degree of support should continue, subsidies should, when feasible, be temporary. In such cases, preparing the exit strategy upfront is crucial.

Finally, improving the affordability of basic infrastructure services might require a series of other interventions for proper implementation, including the use of social safety nets for vulnerable populations and removing legal and/or administrative barriers affecting their access. To illustrate these aspects, Box 4.7 discusses various ways in which policies related to housing can complement infrastructure policies.

Box 4.7. Housing as an important complement to infrastructure

Housing plays a crucial role in the broader context of infrastructure and poverty reduction. Its connections with basic infrastructure services significantly affect poverty alleviation and the promotion of sustainable development. At a household level, this can be seen, for example, in the improvement of residents' quality of life and the efficiency and affordability of basic infrastructure services. At a broader level, the effects of housing on poverty can be seen through integrated urban planning and land use regulations.

Enhancing the quality of life

One of the main objectives of improving infrastructure access is to enhance the quality of life for people within their homes, and housing plays a crucial role in achieving this goal. Housing serves as the central point where various basic infrastructure services converge. Stable and well-designed housing also provides a safe and healthy environment for individuals, which is

fundamental for their well-being. Therefore, several policies aimed at improving housing conditions are linked to reducing poverty in general.

An example of a policy aimed at improving housing for vulnerable populations is the "Minha Casa, Minha Vida" program ("My House, My Life" in English), which was launched by the Brazilian government in 2009 to address housing shortages and promote social inclusion. The program's objectives include building and financing the purchase of affordable homes for low- and middle-income families across the country. Operated by the federal government and the public bank Caixa Econômica Federal, in collaboration with municipalities, states, and private enterprises, the program operates through a partnership model that involves the construction of new housing units or the improvement of existing dwellings. The collaboration with private developers and financial institutions fosters a public-private partnership model, which facilitates the construction of housing units and provides necessary loans with favorable terms.

Improving infrastructure service efficiency and affordability within households

The quality of housing directly impacts the infrastructure services received by households and their affordability. For instance, poorly insulated dwellings lead to greater challenges in temperature management. In colder climates, this can result in indoor temperatures being below recommended levels, posing health risks or increasing heating costs due to high energy bills. In contrast, well-constructed buildings with efficient insulation and heating/cooling systems can significantly reduce energy consumption and expenses. This not only makes infrastructure services more affordable for vulnerable populations, but also has broader environmental benefits by reducing energy demand and greenhouse gas emissions.

Urban planning and land use regulations

Urban planning and land regulations related to housing have significant implications for ensuring optimal access to basic infrastructure services. For instance, when residential areas are far from job opportunities, educational institutions, and healthcare facilities, the cost and time of commuting increase, adding to the challenges faced by vulnerable households. Instead of solely relying on the transportation sector to address the affordability of commuting, integrated land use and transport planning can help by ensuring that residential areas are well-connected to essential services and job opportunities. For instance, urban development projects that promote mixed-use development, can ensure that commercial zones, essential services, job opportunities, and recreational zones are located closer to each other, reducing the need for longer and more expensive commutes. These types of approaches not only improve transport affordability but also enhance access to opportunities in general, leading to improved social mobility and inclusion.

Chapter 5: Additional considerations: inclusiveness and resilience

Key messages

- Exclusion runs along many dimensions, including geographical and economic aspects, gender, ethnicity, physical disabilities, or age.
- Beyond the role of standard policies such as subsidies, the integration of technology in infrastructure planning and operations can lead to more inclusive, equitable, and sustainable, access for those who are most vulnerable.
- Infrastructure services also need to be resilient to external shocks to help alleviate poverty, and investing in resiliency can offer significant long-term economic benefits.

5.1 Ensuring inclusiveness

In addition to income, geographical location, and gender, countries aiming to improve the affordability of basic infrastructure services may also target other vulnerable populations based on various criteria, such as ethnicity, physical disabilities, or age. The case of transport is useful to illustrate other types of vulnerabilities. For instance, historical racial discrimination and spatial segregation can have a strong impact on the affordability of commuting for populations that are already vulnerable, as the affordability of commuting crucially also depends on the match between residential locations and job opportunities (Lau, 2010). Box 5.1 outlines eight types of exclusions that can affect the mobility of certain groups of individuals.

Box 5.1. Mobility and social exclusion

What are the links between transportation and poverty? Table B5.1.1 provides eight transport-related types of social exclusion to illustrate the central role that transport policies can play in poverty reduction.

Table B5.1.1. Transport-related social exclusion

Physical exclusion	Physical barriers at a micro-level can affect the mobility of some individuals, such as those with physical disabilities.
Geographical exclusion	Access to transportation services varies greatly depending on where a person lives.
Exclusion from facilities	The lack of access to key facilities such as hospitals, schools or markets is closely linked to poverty.
Economic exclusion	The affordability of transport may be the biggest barrier to access the transport system among low-income people.
Time-based exclusion	Lengthy journeys particularly affect those who are already time-poor.

Fear based exclusion	Due to poor safety in public transport and public spaces.
Space exclusion	Restriction on access for certain groups or people in certain areas, such as those under control of militias, for example.
Social position-based exclusion	Exclusion that prevents some individuals from moving in public spaces due to censure, social control, or any other restrictions.

Source: Adapted from Benevenuto and Caulfield (2019).

Infrastructure services are often not designed considering the preferences and needs of women, even though they represent half of the population. Shu and Guimaraes (2022), produced as an input to the G20-Infrastructure Working Group under the Indonesian Presidency, provides several case studies that show how integrating women in the planning and implementation of infrastructure PPPs is critical to promote the equity of access to key infrastructure services.

It is important to note that infrastructure services can also have a differentiated impact on women despite not being specifically aimed at them. For example, supporting the installation of public lighting in streets at night, can benefit women by addressing safety concerns, as shown in Box 5.2.

Box 5.2. Public-Private Partnership for public lighting in Nova Lima (Case study contributed by the government of Brazil)

In 2022, the city of Nova Lima, in the Metropolitan Region of Belo Horizonte, state of Minas Gerais, held an auction for a 13-year Public-Private Partnership (PPP) project aimed at the administrative concession of public lighting services. The PPP was financed by the Government of Japan and structured in collaboration with the Inter-American Development Bank (IDB), Caixa Econômica Federal, and the Ministry of Regional Development.

This initiative involves replacing outdated lighting with energy-efficient LED technology, contributing positively to the economy and sustainability. The PPP includes a projected investment of approximately US$11 million for service improvements, with nearly 20,000 light points undergoing operational and modernization improvements. With well-lit streets, the city is expected to enhance safety for its residents, particularly for women.

Finally, to further illustrate the role of technology in fostering inclusiveness along the geographical dimension, Box 5.3 presents a case study about the use of digital infrastructure to alleviate urban poverty in India.

Box 5.3. The potential of digital infrastructure to boost street vendors' income and alleviate urban poverty in India (Case study contributed by the government of India)

The Prime Minister Street Vendor's AtmaNirbhar Nidhi (PM SVANidhi) is a micro-credit scheme launched by the Indian government in 2020 as a Covid-19 pandemic relief measure. It aims to provide affordable working capital loans to street vendors and alleviate urban poverty. Initially, the scheme was designed to provide collateral-free working capital loans of up to Rs. 50,000 (approximatively US$675) to help vendors restart their businesses. Over time, it has evolved to empower street vendors to expand their enterprises and bolster their economic growth through various mechanisms. These include providing interest subsidies to encourage regular repayment, offering cashback rewards for digital transactions, making higher tranche loans available, and providing safety net welfare schemes to street vendors' families.

At the core of this scheme is its robust digital infrastructure, which minimizes human intervention and streamlines access to benefits. The various portals contribute to easy access, efficient processing, integration with the banking system, reduction in application time and documentation hassles for beneficiaries. The scheme puts significant emphasis on digital adoption by street vendors, involving comprehensive training sessions to enable them to receive digital payments seamlessly using QR codes.

The scheme's impact has been substantial, with over 8.1 million loans disbursed to 6.2 million beneficiaries. It also played a significant role in promoting formal financial institutions, as 95 percent of vendors who accessed loans through the scheme did so from the formal financial system for the very first time. Overall, the PM SVANidhi's digital-first approach is proving to be a significant step towards urban poverty alleviation, demonstrating the potential of technology to drive inclusive growth and sustainable development.

5.2 The importance of resilience

The effectiveness of basic infrastructure services heavily depends on their reliability. Any interruption in these services can have disproportionately severe repercussions on poor and vulnerable populations, as they have fewer resources to mitigate these effects. While service interruptions can be caused by various factors, including lack of maintenance or improper operation, one of the most pressing causes has become climate change. According to Hallegatte et al. (2019), climate events in low- and middle-income countries already cause direct damages to infrastructure assets, amounting to nearly $18 billion every year. Moreover, the authors note that the impacts of natural hazards extend beyond the direct consequences on physical assets and find that a large fraction of the financial burden of these events lies in the effects on firms and households.

For firms, disruptions in basic infrastructure services mean they cannot operate properly, leading to reduced productivity and incurring significant losses with important implications for areas such as employment and international competitiveness. While short-term disruptions are likely to be severe, firms undertake adaptative measures in the medium to long-term. For example, in Pakistan, firms react to floods by adjusting their location, supplier, and route choices, a behavior that could be sustained by providing them with updated information on ongoing flood risk (Balboni et al. 2024).

For people, particularly those in vulnerable situations, disruptions in basic services might impact various other development outcomes, including household income, expenditure, education, employment, and gender equality (see, for example, Samad and Zhang, 2017). Overall, infrastructure disruptions caused by natural hazards generate costs of between US$391 and US$647 billion a year for households and firms in low- and middle-income countries (Hallegatte et al, 2019).

Given this, countries need to ensure that their infrastructure incorporates resilience considerations at every step of the asset lifecycle to anticipate, withstand, and quickly recover from adverse events, such as disasters, climate change impacts, and other types of economic shocks. To address this, a series of supply- and demand-side policies are available.

On the supply-side, countries need to invest more in building assets that can withstand climate change. Hallegatte et al. (2019) estimate that the cost of building resilience in basic infrastructure systems is just around three percent of the overall investment need. Moreover, when the benefits of reduced service disruptions are considered, the authors state that these marginal investments in resilience could bring developing countries net benefits of nearly $4.2 trillion over the lifetime of this new infrastructure. In other words, countries could obtain a $4 benefit for each dollar invested in resilience. Investing in resilience includes better planning and maintenance. But it can also mean investing in new types of infrastructures to address the challenges posed by changing climatic conditions. For instance, Box 5.4 presents the case of the construction of a large dam in Jordan built in response to water stress in the region.

Information and incentives to foster adaptation are also important. For example, market prices of land, if left to evolve free of distortions, are likely to convey crucial signals about the evolution of productivity and desirability in the agriculture and housing sectors. These signals can highlight the costs of climate change and the potential benefits of adaptation (Anderson et al. 2019).

On the demand-side, countries can implement policies to ensure that individuals and businesses can effectively manage the impact of income shocks. Safety nets, such as cash transfer and voucher programs, play a vital role in providing immediate assistance to households during times of crisis.

Looking towards the long term, investing in education and skills development can create more opportunities for vulnerable populations to adapt during challenging periods. Expanding financial protection through insurance or risk-sharing mechanisms can also aid businesses in their recovery efforts. Moreover, implementing incentives to reduce the demand, such as promoting improved household consumption efficiency, can alleviate pressure on systems following a natural disaster (Hallegatte et al, 2019).

Box 5.4. Building infrastructure as an instrument for climate resilience: The case of the Jordan Kufranja Dam (Case study contributed by the government of the United Arab Emirates)

Jordan, located at the crossroads of Asia, Africa, and Europe, is nearly landlocked and borders the Gulf of Aqaba. With a lakeshore at the Dead Sea and a population of around 9.9 million, the

country faces water stress, a common issue among developing arid and semi-arid countries. As of 2015, Jordan was the fourth country suffering the most from freshwater storage, with issues of decreased rainfall and increased consumption. The country's water demand was 900 million cubic meters per year, with 75 percent arising from the Jordan river basin. The total dam capacity in Jordan was estimated at 350 million cubic meters, including those in the desert. For the population, this means there is less than 150 cubic meters per capita per year. This is starkly below the world water poverty line (at 1000 cubic meters per capita per year) and has classified Jordan in “absolute scarcity” (for countries with less than 500 cubic meters of water per capita, according to the UN).

To mitigate these struggles, Jordan adopted a National Water Strategy focusing on improved water resource management and sustainability for future use. Water scarcity is Jordan's most critical environmental concern, with potential economic and social implications such as reduced competitiveness of industries, increased cost of basic food items, and social unrest. The Abu Dhabi Fund for Development (ADFD) provided Jordan with a grant worth AED 103 million (approximatively USD 28 million) for the construction of the Kufranja Dam, a project that has played a pivotal role in supporting economic and social development. The dam has a capacity of 6 million cubic meters and tripled the daily water supply to the estimated 40,000 residents of Kufranja City from 22 to 63 liters per day.

The construction of the dam led to UNICEF collaborating with the Jordanian Ministry of Water and Irrigation. Together they established a water supply system connected to the dam comprising a desalination plant, a 10-kilometer pipeline, and three pumping stations. In the Ajloun Governorate, support was provided for drilling two boreholes, benefiting 96,000 people and in the South of Amman, the water network was expanded to connect five schools, providing 6,600 children with daily water. Emergency relief efforts provided 12.4 liters per person per day to Rukban and 30 liters per person per day to Hadalat, benefiting an estimated 46,528 people living in the two settlements. Agriculturally, several farms benefitted from irrigation pipes that supply a total of 26.3 hectares of land with water.

Recognized as one of the government's most ambitious initiatives to ease stress on their water supply, the Kufranja Dam constituted one of the country's most ambitious initiatives to ease the stress on their water supply, in line with their National Water Strategy. The dam in Wadi Kfarnja is of paramount importance, enhancing water resources for irrigation, drinking, and environmental development while also protecting against flooding.

Source: Abu Dhabi Fund for Development. “Success Stories”, accessible at https://www.adfd.ae/en/success-stories/kufranja-dam-jordan (Last accessed on September 9, 2024).

Chapter 6: Conclusion

This report has argued that delivering efficient infrastructure services to the billions of people that still lack access to them is key in the fight against global poverty. Essential infrastructure, including transport, energy, water and sanitation, and digital infrastructure, generates direct private benefits and many indirect positive social effects. It has looked at policies through the lens of three major requirements: availability, quality, and affordability.

The report delves into supply- and demand-side policy solutions to achieve these goals, stressing opportunities and risks. It puts forward a few key principles that can guide public policies. First, policies need to be comprehensive, addressing both the supply and demand aspects. On the supply-side, increased levels of investment are needed to reach the SDGs and bridge the last mile in the provision of essential services. However, to also release as much as possible the affordability constraint, it is crucial to put the emphasis on investment efficiency to lower the life-time costs of provision.

On the demand-side, ensuring access to good quality, affordable infrastructure requires choices from governments. First, they should decide which level of services they want to provide, and this is likely to evolve with stages of socio-economic development. Second, they may need to rely on demand-side subsidies to make infrastructure services affordable for the poorest and the most vulnerable. The report delves into the design of subsidies, the cases in which they are justified, and the associated risks. Targeting these subsidies adequately is important, and the report analyzes the situation of different groups of consumers and their respective constraints. It also insists on maintaining fiscal sustainability and sector efficiency, and avoiding perverse incentives for providers, high opportunity costs for governments, and economywide distortions.

Finally, the report stresses that the technological infrastructure landscape has been evolving rapidly, through the integration of enabling digital technologies among others. It reviews, through several case studies, how these technologies can help reduce the cost of production and provision of services, as well as making consumption more efficient and helping with the targeting and delivery of subsidies. Successful infrastructure policies aimed at reducing poverty require careful planning and sophisticated implementation, but they hold the promise of large development benefits. For that promise to be realized, working out the practical steps to implement the approach developed in this report is the next challenge on the agenda.

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