BEYOND THE GAP

How Countries Can Afford the Infrastructure They Need while Protecting the Planet

Policy Note 4/6

Transport: Choice of Mode and Complementary Policies Shape Costs

In low- and middle-income countries, infrastructure—defined here as water and sanitation, electricity, transport, irrigation, and flood protection—falls short of what is needed to address public health and individual welfare, environmental considerations, and climate change risks, let alone achieve economic prosperity or middle-class aspirations. How can this situation be reversed? This policy note is drawn from *Beyond the Gap: How Countries Can Afford the Infrastructure They Need while Protecting the Planet*, edited by Julie Rozenberg and Marianne Fay, Sustainable Infrastructure Series (Washington, DC: World Bank, 2019). *Beyond the Gap* contends that the focus should be on the service gap—not the investment gap as is typically the case—but also offers a careful and systematic approach to estimating the funding needs (capital and operations and maintenance) to close the service gap. The results presented here were developed specifically for this report, based on clearly specified access and climate goals and using numerous scenarios to explore both uncertainty and the consequences of policy choices.

Policy Note 4—one of six drawn from *Beyond the Gap*—explores the costs of needed infrastructure for the transport sector. Policy Note 1 provides an overview of the report; Policy Note 2 focuses on water, sanitation, hygiene, and irrigation; Policy Note 3 focuses on the power sector; Policy Note 5 focuses on coastal and river flood protection; and Policy Note 6 focuses on climate change.

Key messages

- **Transport investment needs in low- and middle-income countries (LMICs) for 2015–30 range between 0.5 percent and 3.3 percent of gross domestic product (GDP) per year, depending on the choice of mode and the success of policies to influence occupancy. Future demand for mobility can be satisfied at relatively low infrastructure investment costs (1.3 percent of GDP) and low carbon dioxide (CO_2) emissions via a shift toward more rail and urban public transport if policies are in place to ensure high rail occupancy and urban densification.**
- **The maintenance of existing and new transport infrastructure costs as much as new transport capital investment—and even more in regions that have already built the bulk of their infrastructure. Failure to perform routine maintenance would increase total capital and rehabilitation costs by 50 percent over the 2015–30 period.**
- **For many countries, universal access to paved roads by 2030 is not a realistic goal given costs. But indicators of access can help to prioritize investments, and other solutions exist to improve integration in low-density areas.**

Formal public transportation is simply not available in most cities in the world—75 percent of world cities have no subway, tramway, light rail system, or bus rapid transit—while access to all-weather roads in rural areas is below 60 percent in most LMICs. At the same time, the transport sector is the fastest-growing greenhouse gas–emitting sector, representing 20 percent of global emissions from fuel consumption in 2014.

Estimating investment needs for transport is complex. There is no clear development goal for transport access, unlike in the water and sanitation sector and the electricity sector. Transport investments need to respond to demand for mobility and to manage pollution, including emissions of greenhouse gases. But demand for mobility is endogenous and varies with socioeconomic changes. *Beyond the Gap* undertakes a comprehensive quantification of future investment needs for LMICs in the transport sector, with three separate assessments looking at rural accessibility, urban mobility, and the transport sector as a whole.

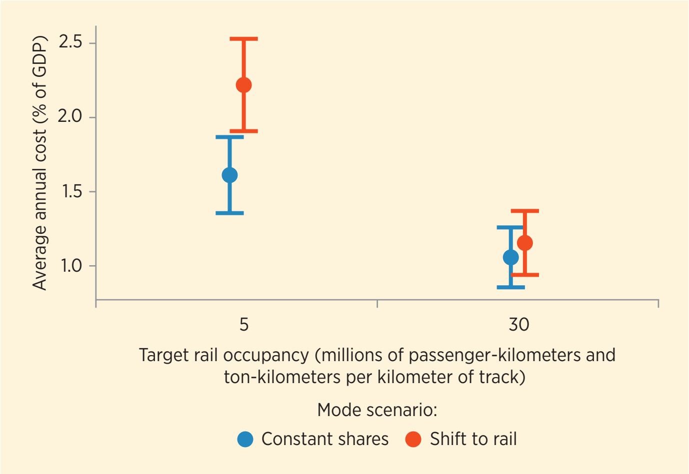
Future mobility can be supplied at relatively low cost and CO_2 emissions with smart planning and policies

We use one of the rare models that not only simulates decarbonization pathways but also captures a detailed evolution of the transport sector within the global economy. This model allows us to simulate future mobility scenarios for both freight and passenger transport across hundreds of scenarios that combine varying socioeconomic pathways, consumer preferences, spatial organization, climate policies and ambitions, and technical challenges to mitigation policies (such as availability and cost of low-carbon technologies).

Our results show that transport investment pathways could cost anywhere between 0.5 percent and 3.3 percent of LMICs' GDP per year, depending on the assumptions made and the

FIGURE 1 The choice of terrestrial mode and rail occupancy drive transport investment costs

Average annual cost of capital investment in transport in LMICs, by choice of terrestrial mode and rail occupancy, 2015–30



Source: See figure 4.12 in the full report.
Note: The bars represent the range of estimates, generated by hundreds of scenarios, while the central dots represent the median value across estimates. LMICs = low- and middle-income countries.

policy instruments rolled out. Among the dozens of parameters explored, the two main cost drivers are the choice of mode for terrestrial transport—constant shares or shift to more rail and bus rapid transit—combined with policies to increase rail transport occupancy (figure 1).

The message is similar for urban transport—which is the focus of a separate model that allows for a much more detailed analysis of urban transport. We compare three strategies: (a) "business as usual," (b) "robust governance," which relies on classic instruments to promote low carbon use (such as pricing and regulatory policies, including stringent fuel and vehicle efficiency standards, and investments in public transport), and (c) "integrated land-use and transport planning," which adds land-use policies to the previous toolbox. The third strategy is systematically cheaper than any of the others.

A clear result of these two studies is that future demand for mobility can be supplied at relatively low infrastructure investment costs and low CO_2 emissions with a shift toward more rail and urban public transport—if it is accompanied by policies to ensure high rail occupancy and land-use policies to densify cities (table 1). Our "preferred scenario" for the entire transport sector would cost 1.3 percent of LMICs' GDP per year on average between 2015 and 2030 and would stay on track to limit global temperature rise to

TABLE 1 The preferred scenario uses low-carbon modes and accompanying policies for rail and public transport

Average annual cost of investment in transport infrastructure, by scenario, 2015–30

% of GDP

	Entire transport sector		Urban transport sector only	
Mode	**Accompanying policy for high rail occupancy**	**No accompanying policy**	**Land-use planning**	**No land-use planning**
Low carbon (rail, bus rapid transit)	**1.3**	2.3	**0.37**	0.47
Business as usual (roads)	n.a.	1.7	n.a.	0.45

Note: The preferred scenario is in bold. n.a. = not applicable.

2°C. For urban areas, our preferred scenario is the "integrated land-use and transport planning" strategy, which would cost an average of 0.37 percent of GDP per year.

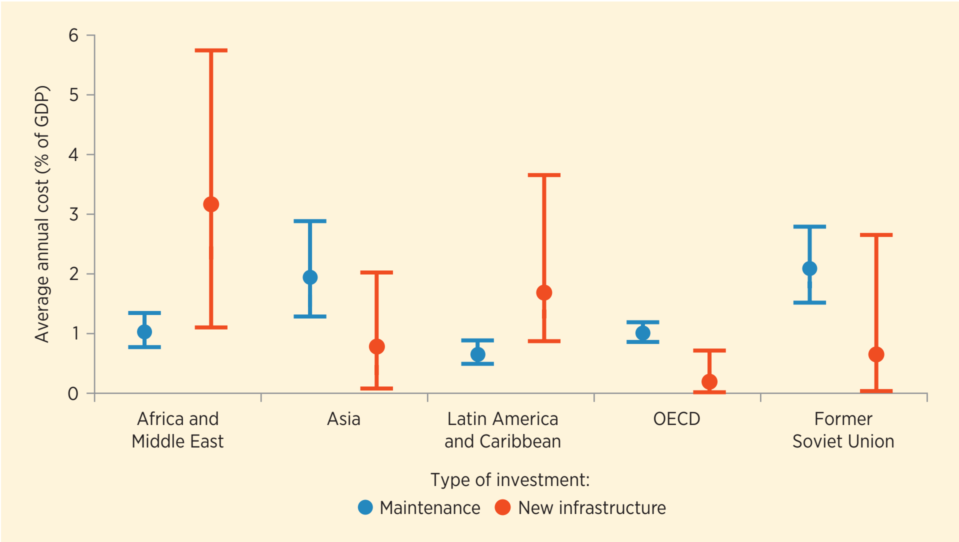
Overall maintenance costs as much as new investment

Maintenance costs for all existing and future transport infrastructure in LMICs could amount to between 1.1 percent and 2.1 percent of GDP per year, on average, between 2015 and 2030—which is almost as high as what is needed for new capital investment. The costs of maintenance are even higher than the costs of new investment in countries that already have large transport networks, such as Asia and the former Soviet Union (figure 2). Failure to perform routine maintenance work would increase overall capital and rehabilitation costs by 50 percent.

For urban areas, operating costs for public transport dwarf the costs of both maintenance and new investment. While total maintenance costs amount to between 0.19 percent and 0.21 percent of GDP per year, on average, over 2015–30, depending on the strategy, the operation of public transport infrastructure could represent between 1 percent and 1.3 percent of GDP per year, on average, in LMICs—or twice as much as new investment costs. While some of these operating costs would be recouped through passenger fares, cost recovery is typically low. In European countries, subsidies for public transport represent up to 60 percent of total operating costs. Cities should be prepared to spend at least as much on the operation of their public transport system as they spend on new infrastructure, on average, every year.

FIGURE 2 **Maintenance may cost as much as or more than new investments in transport**

Average annual cost of investment in maintenance and new transport infrastructure, by region, 2015–30



Source: See figure 4.13 in the full report.
Note: The bars represent the range of estimates, generated by hundreds of scenarios, while the central dots represent the median value across estimates. The regional breakdown is that of the IMACLIM-R model and is *more* aggregated than the usual World Bank regional breakdown. OECD = Organisation for Economic Co-operation and Development.

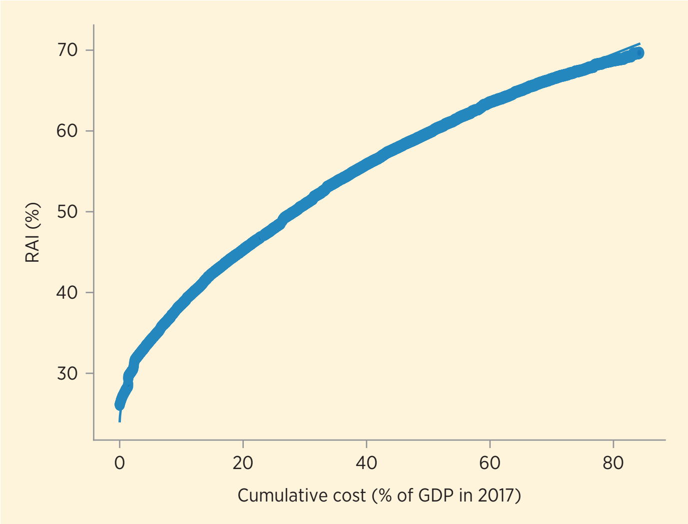
Universal access to paved roads by 2030 is not a realistic goal given costs, but models can help to prioritize rural investments

How about rural areas? We also look at the rural transport subsector, for which an indicator is mentioned in Sustainable Development Goal 9 ("proportion of the rural population who live within 2 kilometers of an all-season road"). However, no target is specified for this indicator—likely because a global target regarding rural accessibility is difficult to define. To gain more insight, we build a model to prioritize rural road investments based on two simple criteria: (a) maximizing the rural access index (RAI), which is defined as "the number of rural people who live within 2 kilometers of an all-season road as a proportion of the total rural population," and (b) providing connectivity with the primary and secondary network. We price the investment option of upgrading existing tertiary roads or tracks to an all-season (paved) road.

Our results show that setting a simple universal goal—for example, 80 percent accessibility—is neither realistic nor appropriate. The incremental cost of increasing rural accessibility increases rapidly with the ambition of the goal and, for many countries, rapidly becomes prohibitive. To illustrate: paving Sierra Leone's tertiary roads would increase its RAI from 28 percent to 70 percent but cost nearly as much as the country's GDP in 2017 (figure 3). Increasing the country's RAI by 1 percentage point would cost US$30 million when the RAI is 30 percent (about 1 percent of GDP), but US$200 million when it is 70 percent.

FIGURE 3 **Upgrading rural roads in Sierra Leone becomes costly—fast**

Cumulative cost of increasing access from 28% to 70%



Note: RAI = rural access index.

TABLE 2 Universal access to paved roads is not within countries' reach by 2030

Ability to achieve universal access to paved roads by 2030, by level of spending and region

% of rural population within 2 kilometers of a primary or secondary road

Region	2017	If all countries in the region spend 1% of their GDP per year by 2030
East Asia and Pacific	52	61
Europe and Central Asia	29	40
Latin America and Caribbean	34	45
Middle East and North Africa	39	51
South Asia	43	57
Sub-Saharan Africa	29	46

Note: GDP for each country grows following the shared socioeconomic pathway 5, which has the highest growth rate.

Given that it is impossible to cost rural access overall, because goals and costs are too country-dependent, we reverse the question and examine how much access countries could gain by 2030 by spending 1 percent of their GDP on new rural roads every year. Our results show that with optimistic assumptions regarding GDP growth, the increase in access could range from 9 percentage points, on average, in East Asia, to 18 percentage points, on average, in Sub-Saharan Africa (table 2). But across all LMICs, rural accessibility would increase only from 39 to 52 percent.

The implication, then, is that achieving universal access to paved roads may not be a realistic goal for many countries. Instead, rural roads should be prioritized carefully, and other solutions should be sought for increasing social integration in low-density areas.

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