BEYOND THE GAP

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

Policy Note 1/6

Overview of Infrastructure Investment Needs in Low- and Middle-Income Countries by 2030

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). The report not only 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 1—one of six drawn from *Beyond the Gap*—provides an overview of the report's key findings. Policy Note 2 focuses on water and irrigation, Policy Note 3 focuses on the power sector, Policy Note 4 focuses on transport, Policy Note 5 focuses on flood protection, and Policy Note 6 focuses on climate change.

Beyond the Gap aims to shift the debate regarding investment needs for infrastructure away from a simple focus on spending more and toward a focus on spending better on the right objectives using relevant metrics. It does so by offering a careful and systematic approach to estimating the funding needs (capital as well as operations and maintenance) to close the service gap for low- and middle-income countries (LMICs) in water and sanitation, transportation, electricity, irrigation, and flood protection.

The main innovations of our work relative to other estimates of investment needs are the following: (a) the results presented here were developed specifically for this report, following a consistent approach and timeline and based on clearly specified goals; (b) numerous scenarios were used to explore both uncertainty and the consequences of policy choices; (c) the estimates included not just new investments, but also the costs of replacement capital as well as the costs for maintaining new and existing infrastructure; and (d) estimates were made for both access and climate goals. This policy note highlights the key findings of the report.

How much countries need to spend on infrastructure depends on their goals, but also on the efficiency with which they pursue these goals

New infrastructure could cost LMICs anywhere between 2 and 8 percent of gross domestic product (GDP) per year to 2030, depending on the quality and quantity of service aimed for and the spending efficiency achieved to reach this goal (table 1).

TABLE 1 Infrastructure spending needs are shaped by goals and efficiency

Infrastructure spending needs on capital and maintenance in LMICs, by scenario and sector, 2015–30

Scenario and sector	% of GDP		2015 US$ (billions)	
	Capital	Maintenance	Capital	Maintenance
Low-spending scenario				
Electricity	0.9	0.3	300	110
Transport	0.53	1.1	160	550
Water and sanitation	0.32	0.48	120	30
Flood protection	0.06	0.014	20	10
Irrigation	0.12	—	40	—
Total	2.0	1.9	640	700
Preferred scenario				
Electricity	2.2	0.6	780	210
Transport	1.3	1.3	420	460
Water and sanitation	0.55	0.75	200	70
Flood protection	0.32	0.07	100	20
Irrigation	0.13	—	50	—
Total	4.5	2.7	1,550	760
High-spending scenario				
Electricity	3.0	0.8	1,020	280
Transport	3.3	2.1	1,060	700
Water and sanitation	0.65	0.75	230	70
Flood protection	1.0	0.14	340	40
Irrigation	0.2	—	100	—
Total	8.2	3.8	2,750	1,090

Note: Costs in U.S. dollars are discounted with a 6 percent discount rate. LMICs = low- and middle-income countries; — = maintenance costs for irrigation infrastructure are included in capital costs.

In the low-spending scenario, ambitions are modest, and efficiency is high. As a result, LMICs only need to spend 2 percent of GDP per year on new capital. In this scenario, countries would (a) focus on providing universal access to *basic* water and sanitation services by 2030; (b) focus on expanding access to electricity to satisfy basic needs (enough to power a few light bulbs in rural areas) and make energy efficiency a priority; and (c) concentrate investments on efficient public transportation and use high fuel taxes to make individual transport less attractive.

The high-spending scenario is characterized by high ambition and low efficiency. Countries need to spend 8 percent of GDP per year on new capital to provide universal access to *safe* water and sanitation (treated water and sewerage systems) and the highest tiers of electricity services (enough to power domestic appliances). This investment would also satisfy an ever-growing demand for transport, generated by urban sprawl and individual use of cars.

With the right policies, investments of 4.5 percent of GDP will enable LMICs to achieve the infrastructure-related Sustainable Development Goals and stay on track to limit climate change to 2°C

The report identifies policy mixes that could enable LMICs to achieve universal access to water, sanitation, and electricity; greater mobility; improved food security; better protection from floods; and eventual full decarbonization—while limiting spending on new infrastructure to 4.5 percent of GDP per year.

The ambitious goals and high efficiency of this "preferred scenario" require smart policies and good planning:

- Countries account for long-term climate goals to avoid expensive stranded assets later.
- They invest in renewable energy.
- They combine transport planning with land-use planning—resulting in denser cities and cheaper and more reliable public transport—and develop reliable railway systems that are attractive to freight.
- They deploy decentralized technologies in rural areas—such as minigrids for electricity and water purification systems that are powered by renewable energy.

Thus, the focus for the international community and climate finance should be on helping countries to achieve decarbonization objectives at the lowest possible cost by supporting better planning and policies.

Investing in infrastructure is not enough; maintaining it matters

Improving services requires much more than capital expenditure. Ensuring a steady flow of resources for operations and maintenance is a necessary condition for success. In the low-spending scenario, spending to maintain existing and new infrastructure doubles total spending needs, while in the high-spending scenario, spending on maintenance increases total needs by 50 percent. In our preferred scenario, LMICs would need to spend 2.7 percent of GDP per year to maintain their existing and new infrastructure, in addition to the 4.5 percent of GDP for new capital (table 1). But good maintenance generates substantial savings, reducing the total life-cycle cost of transport and water and sanitation infrastructure by more than 50 percent.

Global numbers hide disparities between regions

In dollar terms, in all three scenarios, about 50 percent of total capital investment needs happen in Asia, 20 percent in Africa and the Middle East, 20 percent in Latin America and the Caribbean, and the rest in Europe and Central Asia. However, in GDP terms, Africa and the Middle East have the highest needs—ranging from 2.9 percent of GDP in the low-spending scenario to 12.5 percent of GDP in the high-spending scenario, with the preferred scenario at 6.4 percent of GDP (table 2).

How do these needs compare with what countries actually spend?

It is remarkably difficult to figure out how much countries actually spend on infrastructure—especially given that fiscal accounts do not typically report consolidated information on infrastructure investments. However, a recent World Bank report (Fay and others 2019) provides the first consistently estimated data set on infrastructure investments in LMICs, building on proxies drawn from national accounts data, fiscal data, and the World Bank's Private Participation in Infrastructure (PPI) database.

It finds that LMICs spend between 3.38 percent of GDP (lower bound) and nearly 5 percent (upper bound), with a central estimate of around 4 percent for 2011 (table 3). But these averages mask considerable differences across regions, ranging from 2.5 percent of GDP in Sub-Saharan Africa to 5.7 percent in East Asia and Pacific, using the central estimate. Moreover, East Asia and Pacific spends the most across all estimates.

TABLE 2 Some regions will have to invest a lot more than others

Infrastructure spending needs on capital and maintenance in LMICs, by scenario and region, 2015–30

	% of GDP		2015 US$ (billions)	
Scenario and region	**Capital**	**Maintenance**	**Capital**	**Maintenance**
Low-spending scenario				
Africa and Middle East	2.9	1.1	150	50
Asia and Pacific	1.6	2.1	310	420
Eastern Europe and Central Asia	1.1	2.1	30	70
Latin America and Caribbean	1.9	0.7	140	50
Preferred scenario				
Africa and Middle East	6.4	1.8	320	90
Asia and Pacific	4.0	2.5	790	500
Eastern Europe and Central Asia	5.8	3.0	180	100
Latin America and Caribbean	3.3	1.0	250	80
High-spending scenario				
Africa and Middle East	12.5	2.0	620	100
Asia and Pacific	7.0	2.7	1,380	530
Eastern Europe and Central Asia	5.2	2.7	160	80
Latin America and Caribbean	7.6	1.2	580	90

Note: The Africa and Middle East region is the combination of the Sub-Saharan Africa and Middle East and North Africa regions. The Asia and Pacific region is the combination of the South Asia and East Asia and Pacific regions. LMICs = low- and middle-income countries.

TABLE 3 East Asia and Pacific tops the regional list for infrastructure investments

Summary estimates for infrastructure investment as % of GDP, by scenario and region, 2011

Region	Lower-bound estimate	Central estimate	Upper-bound estimate
East Asia and Pacific	5.36	5.72	6.71
Europe and Central Asia	1.51	2.73	4.36
Latin America and Caribbean	2.02	2.39	3.22
Middle East and North Africa	1.67	4.79	4.73
South Asia	3.59	4.42	4.25
Sub-Saharan Africa	1.87	2.54	3.47
LMIC average	3.38	4.11	4.99

Source: Fay and others 2019.
Note: Estimates were named lower-bound, central, and upper-bound based on the LMIC average. For some regions the central estimate is actually the highest. Averages are weighted by GDP shares. LMIC = low- and middle-income country.

The Middle East and North Africa region and South Asia also spend the most, while Latin America and the Caribbean and Sub-Saharan Africa spend the least. This is particularly worrisome for Sub-Saharan Africa, given its low GDP and low infrastructure endowment.

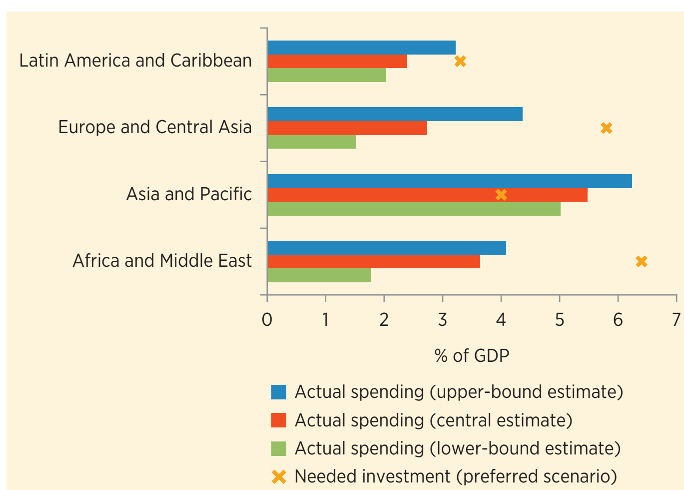
Not only does East Asia spend the most relative to its GDP, it also spends the most in absolute terms—accounting for more than half (55 percent) of infrastructure spending in LMICs. These high outlays are driven largely by China. At the other end of the spectrum is Sub-Saharan Africa, which accounts for a mere 4 percent of total LMIC spending on infrastructure.

Satisfying future infrastructure needs will require a big increase in spending in all regions but Asia

How do current outlays on infrastructure compare with the amounts that will be needed to satisfy future infrastructure needs? To answer this, we compare our historical (2011) estimate of actual spending with our estimate of spending needs under the preferred scenario for 2015–30 (figure 1). Our results show that all regions—except Asia—would need to increase significantly the share of GDP allocated to infrastructure. The gap is highest in Africa, with its urgent need to expand access to infrastructure, and in Europe and Central Asia, which faces high costs to replace aging infrastructure (especially in the power sector).

FIGURE 1 Meeting infrastructure needs in all regions, except Asia, will require much higher spending

Summary estimates for infrastructure investment as % of GDP in 2011, compared to investment needs in preferred scenario



Source: Fay and others 2019.
Note: Actual spending is estimated for 2011, while needed investment is estimated as an annual average over 2015–30. The Africa and Middle East region is the combination of the Sub-Saharan Africa and Middle East and North Africa regions. The Asia and Pacific region is the combination of the South Asia and East Asia and Pacific regions.

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Spending better is important

In all regions, the public sector dominates infrastructure spending, accounting for 87–91 percent of infrastructure investments—albeit with wide variation across regions, from a low of 53–62 percent in South Asia to a high of 98 percent in East Asia (table 4). Given tight fiscal space, closing the gap—or at least narrowing it—will require spending as efficiently as possible.

TABLE 4 The public sector accounts for the bulk of infrastructure investments in all regions

Public spending as a % of total infrastructure investments, by scenario and region, 2011

Region	Lower-bound estimate	Central estimate	Upper-bound estimate
East Asia and Pacific	98	98	98
Europe and Central Asia	70	83	89
Latin America and Caribbean	71	75	82
Middle East and North Africa	83	94	94
South Asia	53	62	60
Sub-Saharan Africa	66	75	82
LMIC average	87	89	91

Source: Fay and others 2019.
Note: LMIC = low- and middle-income country.

Reference

Fay, Marianne, Sungmin Han, Hyoung Il Lee, Massimo Mastruzzi, and Moonkyoung Cho. 2019. "Hitting the Trillion Mark: A Look at How Much Countries Are Spending on Infrastructure." Policy Research Working Paper 8730, World Bank, Washington, DC.

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BEYOND THE GAP

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

Policy Note 2/6

Water, Sanitation, and Irrigation: Target, Technology, and Public Support 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). The report not only 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 2—one of six drawn from *Beyond the Gap*—explores the costs of needed infrastructure for water, sanitation, hygiene, and irrigation. Policy Note 1 provides an overview of the report, Policy Note 3 focuses on the power sector, Policy Note 4 focuses on the transport sector, Policy Note 5 focuses on coastal and river flood protection, and Policy Note 6 focuses on climate change.

Key messages

- **Universal coverage of safe water, sanitation, and hygiene (WASH) in low- and middle-income countries (LMICs) could be achieved at the relatively modest capital cost of 0.3 percent to 0.6 percent of gross domestic product (GDP) per year, depending on the ambition of the target (basic or safe service) and the technology adopted (low cost or high cost).**
- **However, operations and maintenance (O&M) more than doubles the funding needed, to between 1.1 percent and 1.4 percent of GDP. Our "preferred" strategy—involving a gradual rollout of safely managed water and sanitation using high-cost technology where appropriate given population density—would cost LMICs a total of 1.3 percent of GDP per year.**
- **Extending irrigation to the full extent of available water (after satisfying human and industrial consumption) would cost between 0.15 percent and 0.25 percent of GDP per year, depending on policy choices pertaining to subsidies. Our "preferred" strategy—involving subsidies for irrigation equipment, but not for water consumption—would cost around 0.13 percent of GDP per year for capital and maintenance. In all scenarios, complementary policies are needed to limit the negative impacts on ecosystems.**

Water is a central concern for populations in LMICs. Yet only 43 percent of the population of LMICs has access to "safely managed" water and 30 percent has access to sanitation—far from the universal coverage for safe water and sanitation set by Sustainable Development Goal (SDG) 6. Even access to *basic* water and sanitation is not universal (81 percent for water, 61 percent for basic sanitation). Irrigation, another critical facet of the water infrastructure agenda, covers only 30 percent of global cropland—less than half of irrigation potential—despite the fact that irrigation can improve land productivity and climate resilience, thereby contributing to SDG 2 on food security.

What would it cost to achieve the water-related SDGs? *Beyond the Gap* undertakes a comprehensive quantification of future investment needs for LMICs in WASH and in irrigation by 2030. The two most important determinants of cost for WASH are the ambition of the goal for access and quality—underscoring the need for policy debates focusing on this issue—and for technology.

Water: Tailored strategies and attention to O&M can keep costs reasonable

SDG targets 6.1 and 6.2 set out the goal of universal access to *safely managed* water, sanitation, and hygiene services and an end to open defecation by 2030. This goal can be achieved using more or less expensive technologies (for example, relying on septic tanks rather than sewerage systems with treatment). We compare the cost of achieving the SDGs with the cost of achieving access to *basic* water and sanitation (two different levels of ambition), and we vary technologies, pathways toward the SDGs, and assumptions regarding population growth and urbanization as well as capital costs.

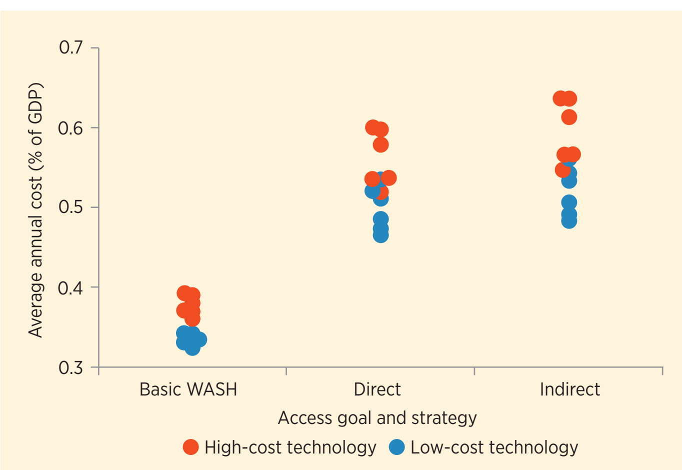
Lower-cost technologies can help to achieve the SDGs at a relatively modest 0.5 percent to 0.6 percent of GDP in capital costs

Our results show that, while the total capital cost to achieve universal access to *basic* water and sanitation ranges between US$116 billion and US$142 billion, the cost to achieve the SDG targets ranges between US$171 billion and US$229 billion (0.5 percent to 0.6 percent of GDP). This includes the costs of extending coverage to persons who are currently unserved, as well as around US$100 billion to replace *existing* assets that have reached the end of their useful life. The principal driver of capital cost beyond the ambition of the goal is the choice of technology (figure 1).

Thus, countries may want to limit the use of high-cost technology to higher-density cities and deploy low-cost technologies where the conditions (population density, urbanization) allow, with conventional sewerage and wastewater treatment phased in as population density increases. Such an approach (our "preferred scenario") would rely on high-cost technology in cities and low-cost technology in rural areas, bringing the total amount to US$198 billion, or an average of 0.55 percent of LMICs' GDP.

FIGURE 1 The goal and the choice of technology are the main drivers of investment costs

Average annual cost of capital investment in water and sanitation, by access goal, strategy, and choice of technology, 2015–30



Source: See figure 2.2 in the full report.

Note: Each dot corresponds to 1 of 36 scenarios based on variations across three goals (basic WASH, direct, indirect), two technologies (high cost, low cost), three possible rates of population growth and associated urbanization, and a high and a low estimate of capital cost. The graph (like others in this policy note) is a "beeswarm" plot, which plots data points relative to a fixed reference axis (the x-axis) in a way that no two data points overlap, showing not only the range of values but also their distribution. The "direct" pathway is one in which every new household served is provided with safely managed water and sanitation; the "indirect" pathway first rolls out universal access to basic services before upgrading to safely managed services. Estimates include capital costs both to expand access and to preserve it for those currently served. WASH = water, sanitation, and hygiene.

O&M accounts for more than half of financing needs

But capital investments are only part of the story. For water and sanitation, average annual O&M costs exceed capital costs in all of the scenarios considered, accounting for 54–58 percent of the total annual expenditure needed to deliver the service. When O&M costs are included, meeting SDG targets 6.1 and 6.2 would cost between 1.1 percent and 1.4 percent of LMICs' GDP (figure 2). Failure to perform routine maintenance would reduce the useful life of installed capital and increase overall capital replacement costs by at least 60 percent.

The fact that O&M constitutes the bulk of overall costs means that countries need to think about the affordability of expansion plans. It is not enough for donors to raise funds and for governments to make room for capital investments. Allowance for an equivalent amount, or more, must be made for O&M in order to ensure that safe water flows through the pipes.

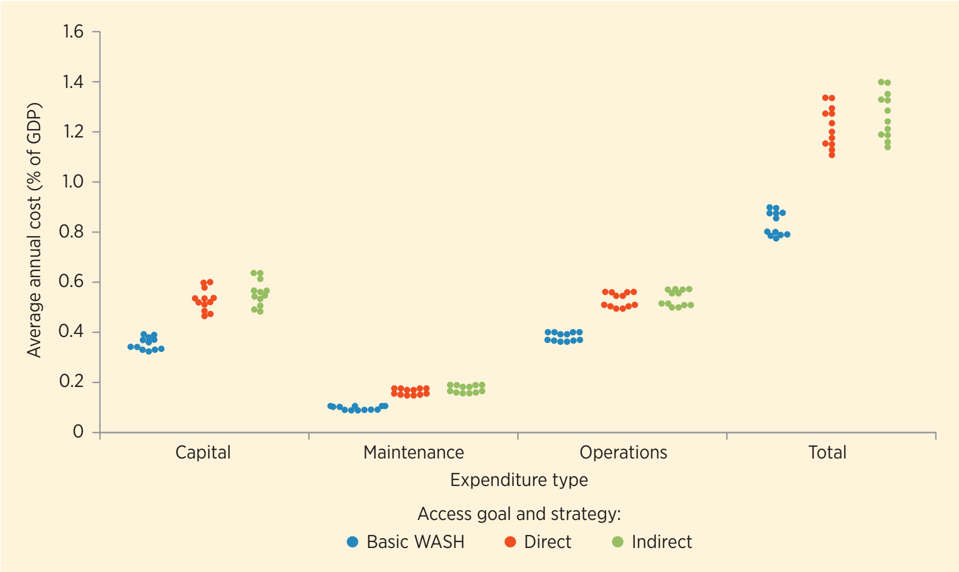
Irrigation: Public support boosts food security but can pose issues for other SDGs

How much would expanding irrigation in LMICs cost? Where irrigation is appropriate, public support for irrigation is necessary, as the needed investments go well beyond the economic means of farmers. We thus model two strategies for public support for irrigation, which differ in the degree to which they subsidize irrigation capital and water use. We assess the cost of these two strategies across multiple scenarios, varying assumptions regarding trade openness for food markets, climate change, and changes in diets.

The primary driver of future investment costs for irrigation is the extent of public support. Under high public support policies—which subsidize both capital and operating costs, resulting in irrigated land extending to its full potential—irrigation investments would be between 0.15 percent and 0.25 percent of GDP per year, on average, between 2015 and 2030 in LMICs. This is substantially more than under moderate public support policies that cover only capital expenditures (figure 3). As with water and sanitation infrastructure, a large share of total spending would be to replace existing capital (0.05 percent of GDP per year between 2015 and 2030).

FIGURE 2 Operations and maintenance spending matters as much as capital spending for water and sanitation

Average annual cost of capital and operations and maintenance in water and sanitation, by access goal and strategy, 2015–30

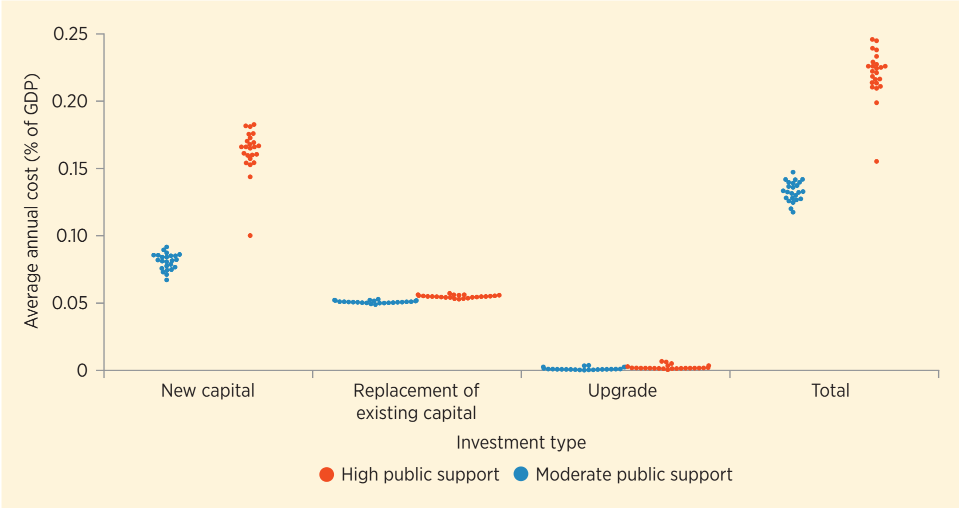


Source: See figure 2.4 in the full report.

Note: Capital, operations, and maintenance costs are for both new and existing users. They represent the amount needed both to expand service and to continue serving existing users. The "direct" pathway is one in which every new household served is provided with safely managed water and sanitation; the "indirect" pathway first rolls out universal access to basic services before upgrading to safely managed services. WASH = water, sanitation, and hygiene.

FIGURE 3 Public support policies drive investment costs in irrigation

Average annual cost of investment in irrigation, by investment type and level of public support, 2015–30



Source: See figure 2.6 in the full report.

Note: High public support policies fully subsidize irrigation capital expenditures and water for farmers. Moderate public support policies cover only capital expenditures.

Costs vary significantly across regions—from between 0.08 percent and 0.16 percent of GDP annually for the Middle East and North Africa to between 0.32 percent and 0.72 percent of GDP annually for Sub-Saharan Africa—as do impacts on food security: the impact on food security from increasing irrigation to its full potential varies from 10 kilocalories per capita per day in Europe and Central Asia to 51 kilocalories per capita per day in South Asia.

In addition, investments in irrigation can have negative impacts on environmental flows and on forests—because of the rebound effect created by higher yields, which increase the expansion of cultivated land—and thus on greenhouse gas emissions and biodiversity. Further, in dry areas, irrigation can lead to maladaptation, whereby farmers drain finite underground water resources or specialize in "thirsty" crops ill-suited for the local climate. Thus, complementary policies are needed to limit the negative impacts on ecosystems and provide farmers with climate-smart practices and technologies.

The most desirable strategy in our analysis is perhaps to provide moderate public support for irrigation, which subsidizes irrigation equipment but not water, so that farmers gain a sense of increased water scarcity when too much water is extracted. This strategy would cost LMICs around 0.13 percent of GDP per year.

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BEYOND THE GAP

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

Policy Note 3/6

Power: Level of Service and Choice of Technology Shape Costs to Pursue Universal Access to Clean Electricity

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* not only 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 the 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 3—one of six drawn from *Beyond the Gap*—explores the costs of needed infrastructure for the power sector. Policy Note 1 provides an overview of the report; Policy Note 2 focuses on water, sanitation, hygiene, and irrigation; Policy Note 4 focuses on the transport sector; Policy Note 5 focuses on coastal and river flood protection; and Policy Note 6 focuses on climate change.

Key messages

- **Over 2015–30, capital investment needs for the power sector in low- and middle-income countries (LMICs) could cost between 0.9 percent and 3 percent of gross domestic product (GDP) annually, depending on the desired level and quality of service and the technologies deployed—with the deployment of new technologies and business models for the delivery of electricity a critical variable in reducing costs.**
- **In countries that have not reached universal access to electricity, power sector investment costs are driven mostly by whether governments favor a strategy that can satisfy a high level of consumption or promote technologies that provide a more basic level of service (such as simple solar home systems). Two critical factors for uptake by yet unserved households are that the electricity is reliable and affordable—highlighting the need for budgets to account for operations and maintenance (O&M), which take up almost half of the sector's total costs.**
- **Taking climate change into account does not necessarily lead to higher investment costs. A low-emissions power sector can be achieved through three levers, each with very different impacts on cost: low-carbon technologies, demand management, and the early retirement of fossil fuel power plants. Our "preferred" scenario—investing now in renewable energy and energy efficiency and gradually ramping up access to electricity in the poorest areas—would cost about 2.2 percent of GDP annually and ensure that LMICs stay on track to achieve a decarbonized power sector by 2050.**

Today, nearly 1 billion people, half of them in Africa, still lack access to electricity. But estimating investment needs for electrification is difficult. Simply connecting households is not sufficient to realize the benefits of electricity: if service expansion comes at the expense of quality and affordability, it will compromise the benefits for existing users and depress demand from potential new users. Moreover, with power generation and heating contributing to 49 percent of carbon dioxide emissions from fuel combustion, the power sector is central to decarbonization efforts.

Against this backdrop, it is vital for any analysis of investment needs to address both effective access to electricity and climate goals. To shed light on these costs, *Beyond the Gap* undertakes a comprehensive quantification of future investment needs for LMICs in the power sector.

The level of service drives the cost of universal electrification

The Sustainable Development Goals set a goal for electricity: achieving universal access by 2030. To understand the cost drivers for universal electrification, we rely on a costing tool created to estimate country-level funding requirements for Sub-Saharan Africa and extend it to another six countries (Afghanistan, Bangladesh, India, Myanmar, the Philippines, and the Republic of Yemen) that, together with Africa, account for around 95 percent of the population without access to electricity.

The analysis explores several strategies pertaining to the tier of service or consumption level it allows—from enough power to charge a phone and power a few light bulbs for a few hours per

TABLE 1 Policy choices on tiers of service drive costs of electrification

Average annual cost of investment in electrification, by tier of service provided, 2015–30

Indicator	Basic	Middle range	High quality
Amount (US$, billions)	45–49	47–52	53–58
% of GDP	0.92–0.94	0.95–0.98	1.1–1.2

Note: Costs are for Sub-Saharan Africa, Afghanistan, Bangladesh, India, Myanmar, the Philippines, and the Republic of Yemen. "Basic" corresponds to tiers 1 and 2 of the multitier framework of the Sustainable Energy for All global tracking framework; "middle range" refers to tier 3; and "high quality" refers to tiers 4 and 5. Variations within tiers of service are driven by assumptions regarding population growth, urbanization rate, industrial demand growth, technology cost evolution, and fuel price.

day to enough power to run high-consumption appliances reliably. Each tier is assessed across multiple scenarios built with uncertain parameters (rate of population growth and urbanization, growth of industrial demand, evolution of technology cost, and fuel price).

The tier of service offered to newly connected households is the main driver of investment costs for universal electrification (table 1). Governments may choose first to offer basic service to newly connected households or instead to offer high-quality service immediately. Providing access via lower tiers of service may also help to tackle demand-side constraints such as consumers' low willingness or ability to pay. This pathway may also be the only affordable way forward for many countries.

Our results show that the economically optimal investment strategy to reach universal access by 2030 would cost Sub-Saharan Africa and the other six countries between US$45 billion and US$49 billion (0.9 percent of GDP) for the basic-service strategy to between US$53 billion and US$58 billion (1.1 percent of GDP) for the high-service strategy.

Effective access requires significant additional funding for O&M

However, capital costs are only one part of the access challenge: O&M also needs to be budgeted for to ensure the reliability and affordability of electricity. But once O&M costs are included, the amount of needed financing doubles to between US$88 billion and US$118 billion (2.1 percent to 2.8 percent of these countries' GDP) per year driven primarily by high fuel costs. Unfortunately, O&M—particularly maintenance—is an often-forgotten component of the power sector industry in LMICs. In some countries, up to half of the installed capacity is unable to operate because of a lack of maintenance.

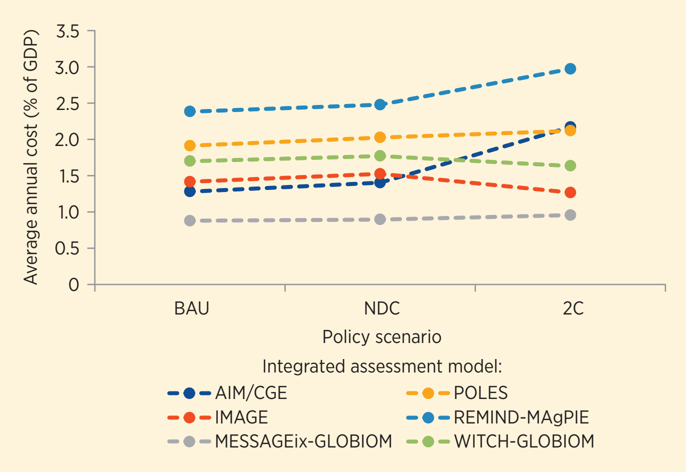
Decarbonizing electricity need not cost more than polluting alternatives

In addition to providing access to the millions without it, the goal is to provide reliable and affordable electricity while moving toward a decarbonized power system that is consistent with the 2°C target or the 1.5°C target of the Paris Agreement. Many economic engineering models have examined this challenge by relying on different assumptions and strategies. We examine six of these models to compare the costs of a business-as-usual strategy with those of a 2°C strategy.

Our results show that a 2°C pathway could be either more or less expensive than a business-as-usual one for the power sector, depending on the assumptions made regarding socioeconomic pathways, technological change, and policy choices. Two models anticipate high investment costs (up to 3 percent of LMICs' GDP), while the more optimistic one anticipates lower costs regardless of the pathway chosen (about 1 percent of LMICs' GDP) (figure 1). Our "preferred" pathway—which limits stranded assets, does not reduce consumption, and invests mostly in renewable energy and storage—results in average annual capital costs of 2.2 percent of LMICs' GDP per year.

FIGURE 1 A 2C world may cost less than the business-as-usual one—or a lot more

Average annual cost of investment in the power sector in LMICs, by policy scenario and integrated assessment model used, 2015–30



Source: See figure 3.9 in the full report.
Note: BAU = investment needed if countries follow a business-as-usual trajectory; LMICs = low- and middle-income countries; NDC = cost of implementing measures announced by countries in their nationally determined contribution to the Paris Agreement on Climate Change; 2C = measures needed for an emissions trajectory consistent with keeping climate warming below 2°C.

SKU 33268

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.

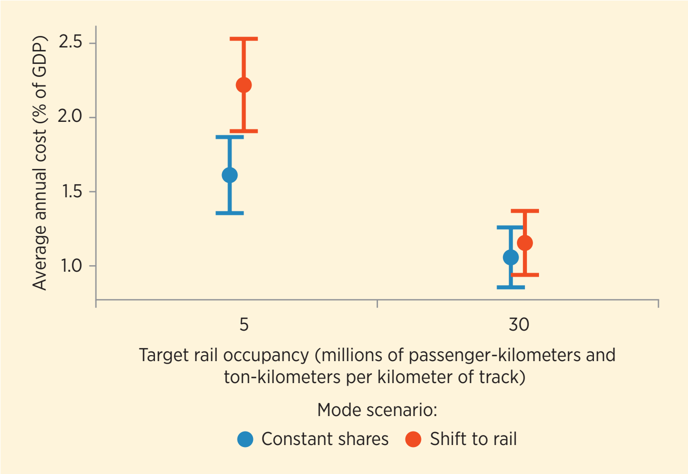
Future mobility can be supplied at relatively low cost and CO_2 emissions with smart planning and policies

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.

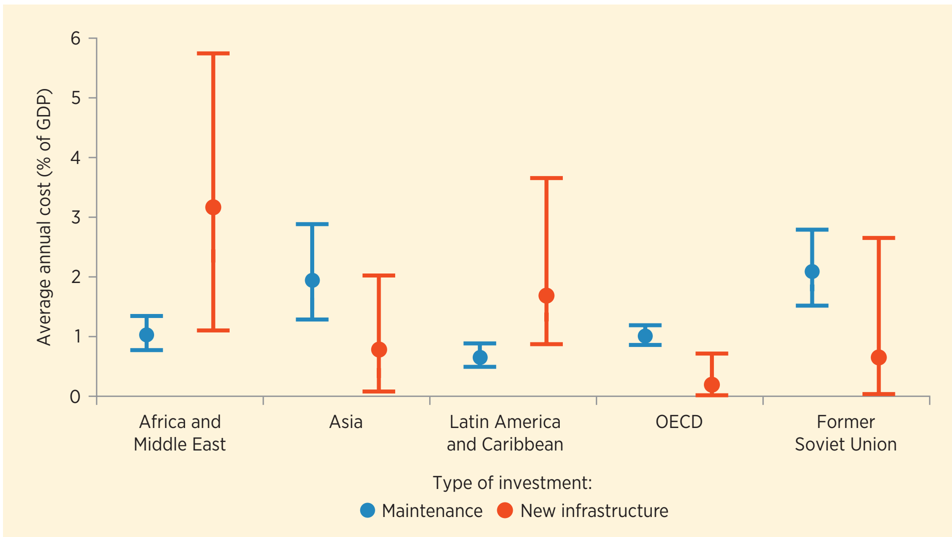
Overall maintenance costs as much as new investment

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.

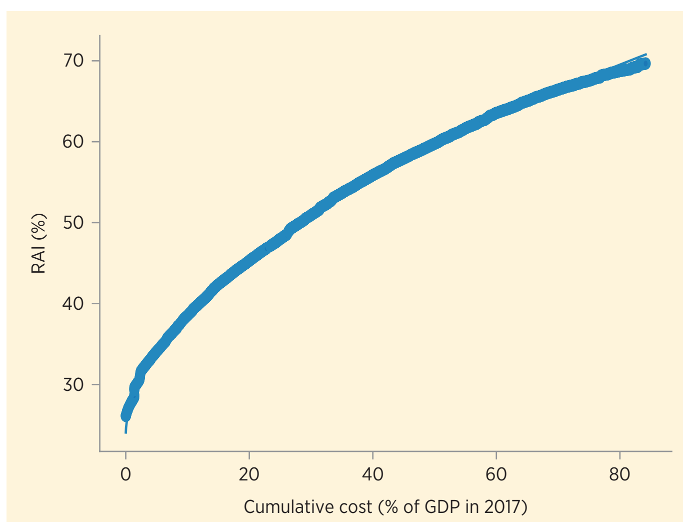
Universal access to paved roads by 2030 is not a realistic goal given costs, but models can help to prioritize rural investments

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.

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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.

SKU 33269

Coastal and River Flood Protection: Future Risk Tolerance and Construction Costs 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* not only 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 needed (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 5—one of six drawn from *Beyond the Gap*—explores the costs of coastal and river flood protection strategies. 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 4 focuses on the transport sector; and Policy Note 6 focuses on climate change.

Key messages

- **Over 2015–30, investments to protect against both coastal and river floods could cost low- and middle-income countries (LMICs) between 0.06 percent and 1 percent of gross domestic product (GDP), depending primarily on the level of risk that is acceptable to local populations and the uncertainty pertaining to construction costs.**
- **Our "preferred" strategy—involving the adoption of Dutch standards of coastal flood protection for cities and the acceptance of higher risks from river floods based on a cost-benefit analysis—would cost LMICs about 0.32 percent of GDP.**
- **Failure to secure the appropriate financial tools, institutions, and governance mechanisms to ensure maintenance—and thus continuous protection over time—would increase risk and could result in catastrophic failures. Absent a firm commitment to reliable maintenance, a combination of nature-based protection, land-use planning, and retreat should be favored.**

Flood damages are expected to increase significantly over the 21st century as sea-level rise, more intense precipitation, and extreme weather events combine with socioeconomic developments to put an ever-rising number of people and an ever-more-expensive value of assets at risk in coastal and riverine floodplains. While increased damages and corresponding adaptation costs might well be the most costly impacts of climate change, little attention has been paid so far to the investments needed in flood protection.

To shed light on these costs, *Beyond the Gap* undertakes a comprehensive quantification of future investment needs for LMICs in coastal and river protection infrastructure by 2030.

Key cost drivers are construction costs and risk tolerance

Our costing exercises rely on specialized models that consider (a) different *levels* of protection (reflecting different levels of risk aversion, as described in box 1); (b) different *means* of providing that protection (through different protection technologies, like surge barriers or river dikes); and (c) uncertainties surrounding the costs of protection, future socioeconomic changes, and climate change.

For both coastal and river floods, uncertainty regarding construction costs and the protection strategy (defined by risk tolerance) are the key drivers of costs—much more so than uncertainties about climate change or socioeconomic change (GDP, population), even though climate and socioeconomic changes are critical inputs for choosing areas to protect and how to protect them.

For coastal protection, capital costs range from US$2 billion to US$56 billion per year, on average, between 2015 and 2030, depending on construction costs and the protection strategy pursued. This represents between 0.006 percent and 0.05 percent of LMICs' GDP per year, on average, for the least expensive strategy (constant relative risk) and between 0.04 percent and 0.19 percent of LMICs' GDP per year, on average, for the most expensive one (optimal protection) (figure 1, panel a).

For river flood protection, capital costs range from US$20 billion to US$280 billion per year, on average, between 2015 and 2030, depending on the protection strategy pursued, when using the same range of construction costs as for coastal flood

BOX 1 Picking an acceptable level of risk

The protection strategy determines which coastal and inland areas invest in "hard" protection (surge barriers or dikes) and the level of protection (such as the return period of floods that the protection can manage). Absent this protection, communities would need either to cope with floods and their impacts or to retreat.

For river flood protection, three strategies are examined: (a) achieving an optimal level of protection based on a simple cost-benefit analysis that minimizes the sum of protection costs (capital and maintenance) and residual flood damage (to assets) to 2100; (b) keeping the current *absolute* level of flood risk constant in each country, in U.S. dollars; and (c) keeping the current *relative* level of flood risk constant in each country, as a percent of GDP.

For coastal protection, the same three strategies are examined, and a fourth one is added: the "low-risk-tolerance" strategy, which entails keeping average annual losses below 0.01 percent of local GDP for protected areas (defined on the basis of density). We take this (high) Dutch standard as the acceptable risk standard in a low-risk-tolerance world.

protection (red dots in figure 1, panel b). This represents between 0.05 percent and 0.81 percent of LMICs' GDP per year on average. Contrary to coastal flood protection, where investment costs are highest under the optimal strategy as defined by a cost-benefit analysis, for river floods, investment costs are more than twice as high in the low-risk strategy (keeping absolute risk levels constant) as in what the cost-benefit analysis suggests is the optimal level of investment. This is because 1 kilometer of dike along the coast can protect, on average, many more square kilometers of land than 1 kilometer of dike along a river.

To increase the efficiency of dikes, policy makers will need to adopt complementary policies—such as land-use planning to prevent people from settling in flood-prone areas or nature-based solutions to increase water storage, decrease runoff, and reduce the cost of dikes. Also needed will be early-warning systems and communication about residual risk.

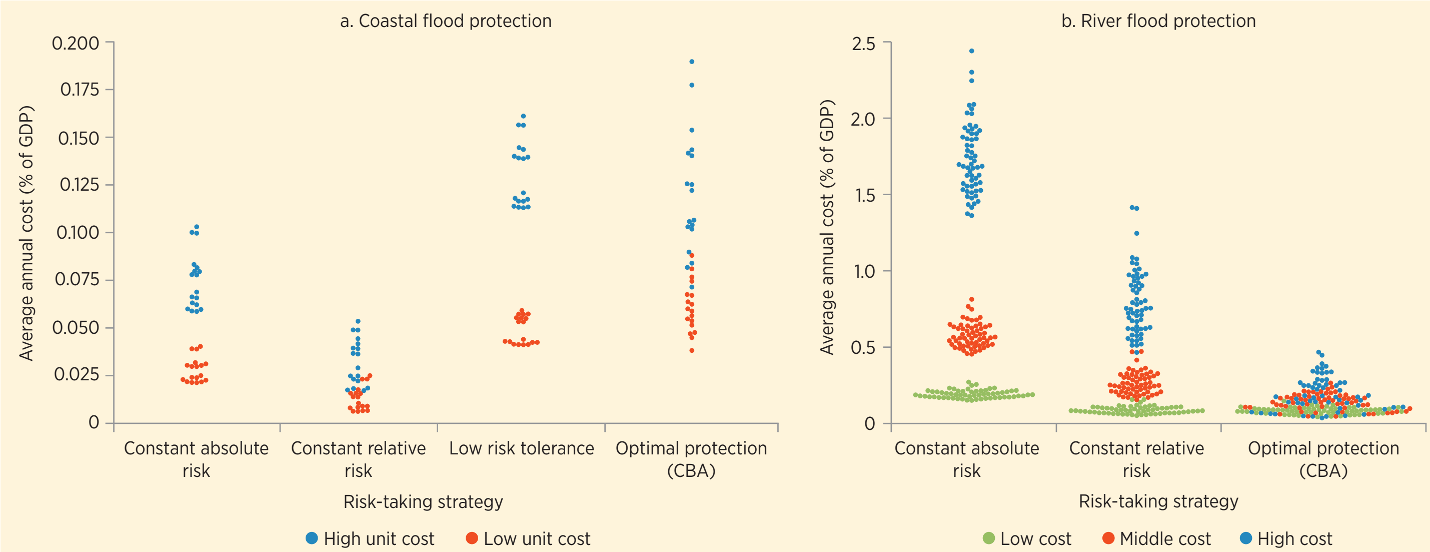
Maintenance matters greatly

Once maintenance costs are factored in, LMICs would have to spend between 0.10 percent and 0.52 percent of their GDP per year for coastal and river flood protection by 2030 if they followed the economically optimal strategy, depending on construction costs, economic growth, urbanization, and climate change.

Although these costs appear affordable, the development of appropriate institutions and governance mechanisms to deliver maintenance as well as the necessary funding streams is essential for an infrastructure-based protection strategy to be effective. Failure to do so would increase risk and could result in catastrophic failures, putting lives, not just assets, at risk. Absent a firm commitment to reliable maintenance, a combination of land-use planning and retreat should be favored.

FIGURE 1 Protection levels and construction costs shape capital costs

Average annual cost of investment in LMICs, by construction costs and risk-taking strategy, 2015–30



Sources: See figure 5.1 (for panel a) and figure 5.3 (for panel b) in the full report.
Note: CBA = cost-benefit analysis; LMICs = low- and middle-income countries.

SKU 33270

BEYOND THE GAP

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

Policy Note 6/6

Full Decarbonization Need Not Cost More Than Polluting Alternatives

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). The report not only 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 6—one of six drawn from *Beyond the Gap*—discusses the impact of climate change mitigation on infrastructure needs. Policy Note 1 provides an overview of the report, Policy Note 2 focuses on water and irrigation, Policy Note 3 focuses on the power sector, Policy Note 4 focuses on transport, and Policy Note 5 focuses on flood protection.

The international community has agreed to limit climate change to 2°C, which will entail all sectors—water and sanitation, transportation, electricity, irrigation, and flood protection—to be decarbonized by the second half of the century. *Beyond the Gap* offers a careful and systematic approach to estimating the infrastructure funding needs (capital as well as operations and maintenance) to close the service gap in low- and middle-income countries (LMICs), while limiting climate change to 2°C warming.

The report builds numerous scenarios to explore the many paths through which decarbonization could potentially be achieved for transport and power, which together account for the majority of emissions. It also examines the cost implications of low-carbon pathways compared with "business-as-usual" ones. This policy note highlights the key findings on climate policy.

Low-carbon infrastructure investment pathways can cost less than traditional, more polluting, ones

The key is in the planning and the policies that accompany the investments. To keep costs down, early on countries will have to (a) direct all electricity investments toward renewable energy and improve their energy efficiency; (b) plan for compact cities organized around mass transit, nonmotorized modes, and shared electric mobility; and (c) make sure their rail systems are reliable and attractive to passengers and freight. Only with such prompt action can countries be on the right path for full decarbonization by the second half of the century, while limiting investments to 3.3 percent of gross domestic product (GDP) annually in new electricity and transport infrastructure and 4.5 percent of GDP for all sectors together.

In the power sector, LMICs can move toward CO_2-free power supply and reach universal access to electricity by investing an average of 2.2 percent of GDP annually by 2030. This goal can be achieved by relying on solar minigrids and microgrids in rural areas and investing early in renewable electricity to avoid having to strand assets later on. Costs can be reduced even further (possibly as low as 1 percent of LMICs' GDP per year, on average) if countries invest in energy efficiency and demand management (figure 1). Conversely, if countries keep investing in fossil fuels up to 2025 before stranding their coal assets by 2030, or if they fail to manage a growing demand for electricity, a decarbonized power system would cost much more, possibly up to 3 percent of GDP per year for new investments.

In the transport sector, LMICs can move toward a CO_2-free transport system and improve mobility services by investing an average of 1.3 percent of GDP per year by 2030. This goal can be achieved by adopting land-use planning and policies to make rail more attractive. In cities, transit-oriented development—the combination of land-use planning and transport planning to create compact cities organized around reliable mass transit—can deliver low-carbon transport systems at an infrastructure cost 20 percent lower than traditional car-based transport systems. The development of electric shared mobility also helps to reduce emissions and lowers the need for parking infrastructure. For the overall transport system, a shift toward more rail can be achieved at a reasonable cost, but only if accompanied by an increase in

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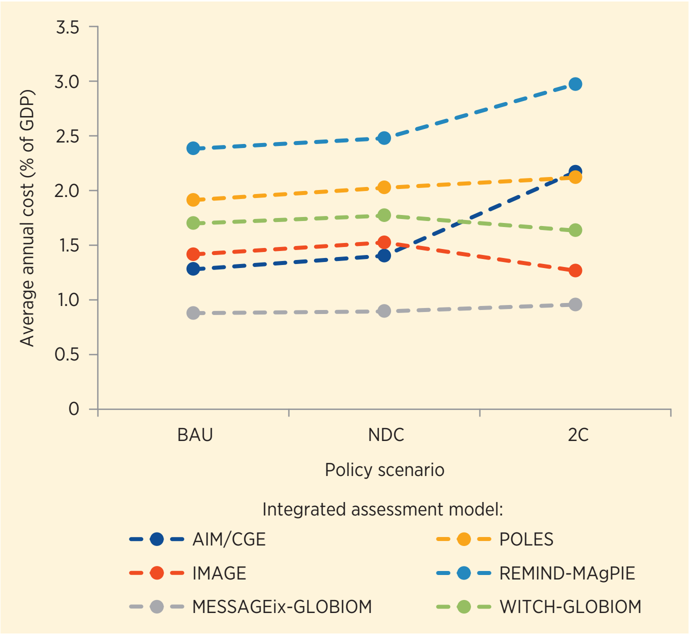
FIGURE 1 A 2C world may cost less than the business-as-usual one—or a lot more

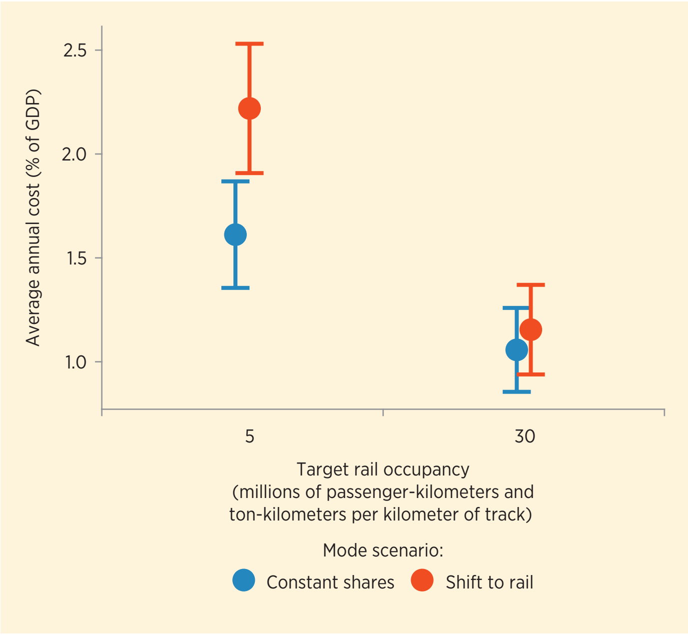
Average annual cost of investment in the power sector in LMICs, by policy scenario and integrated assessment model used, 2015-30



Source: See figure 3.9 in the full report.
Note: BAU = investment needed if countries follow a business-as-usual trajectory; LMICs = low- and middle-income countries; NDC = cost of implementIng measures announced by countries in their nationally determined contribution to the Paris Agreement on Climate Change; 2C = measures needed for an emissions trajectory consistent with keeping climate warming below 2°C.

FIGURE 2 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.

operational efficiency of the infrastructure—for example, if LMICs reach the rail occupancy rates prevalent in China or the Republic of Korea (figure 2). Failure to increase the efficiency of rail systems could increase the cost to between 2 percent and 2.5 percent of GDP per year to deliver the same mobility service.

The international community and climate finance should focus on helping countries achieve decarbonization objectives at the lowest possible cost by supporting better planning and policies

Low-carbon infrastructure pathways can be reached at low or high cost depending on the effectiveness of the planning process and the policies in place to ensure that the investments will deliver services efficiently. The additional cost that may exist at the individual investment level—for example, an electric bus versus a diesel bus—can often be offset by better planning or more compact cities. Moreover, given the scale of the transformations needed to have zero-carbon electricity and transport systems, a strategy that relies on technology as the sole lever to reduce emissions would be unaffordable.

Climate finance will be needed for some projects, to help finance the extra cost of the low-carbon option compared with the polluting alternative. There may also be significant financing needs for those low-carbon options that have higher upfront costs that pay off over time. But focusing on an incremental cost of climate change mitigation is the wrong way of looking at the problem.

Further, effective infrastructure services require a careful allocation of resources across planning, capital, maintenance, and operations. In the case of low-carbon pathways, the key to spending better and minimizing the capital investments required is to spend more on policies and planning.

The point, therefore, is that low-carbon pathways may end up costing less than high-carbon ones if international resources are used to help countries plan better and put in place policies that increase the efficiency of infrastructure investments.

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