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.

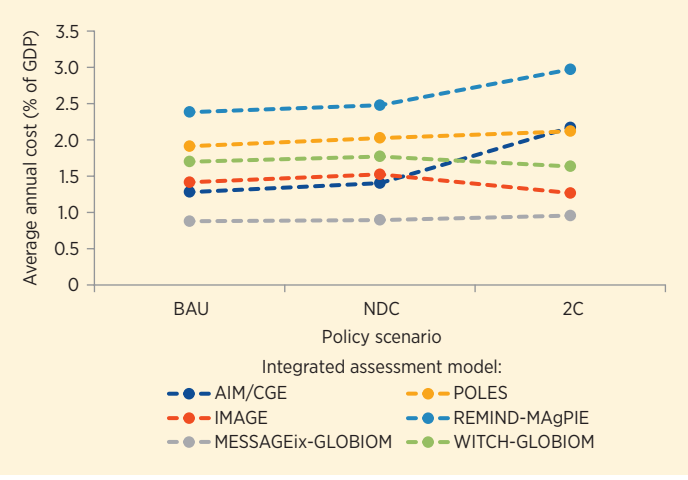
Decarbonizing electricity need not cost more than polluting alternatives

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.

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