

Bringing (solar) power to the people

Solar home systems can help to bridge the electrification gap in developing countries—if certain conditions are met.

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About a billion people have no access to electricity. While progress in lessening that figure has been steady, it is still likely to be at least 870 million in 2020.¹ Expanding the grid is part of the answer to the question of how to bring power to these people, but it is not the only one. Many countries in sub-Saharan Africa and South Asia,² which make up 90 percent of the world's unelectrified population, are also exploring off-grid solutions, including solar home systems (SHSs). So are countries in the Caribbean and Southeast Asia, which account for most of the remaining unelectrified population. The global market for SHSs has grown 23 percent a year since 2012,³ representing more than four million units installed.

Solar systems can serve homes that are too remote, that are too poor, or whose energy consumption is too low to make a grid connection economical (see sidebar “What a solar home system does”). They can also be useful for households connected to the grid whose power supply is still unreliable. Our assessment of the 39 countries that represent more than 90 percent of the unelectrified population found that, based on projected grid expansion, population growth, and consumers' ability to pay, as many as 150 million households could benefit from SHSs by 2020 (Exhibit 1).

That number of households is the potential. For it to become reality—or perhaps even outperform projections—we have analyzed what countries are doing best when deploying SHSs and why they are succeeding. On that basis, we identified the key issues developing markets need to face if they want to encourage the formation of a healthy and sustainable SHS market. Our conclusion is a hopeful one: none of these problems is insoluble. In fact, there are good examples at work in each instance.

Conditions for success

The following five factors matter most in attracting investment to the sector:

- **Off-grid regulations.** A positive regulatory environment for SHSs includes recognizing them as a possible electrification solution; articulating how grid expansion will evolve; accepting global product standards; and imposing low or no import duties on solar products and accessories.
- **Business environment.** Solar companies need a stable environment in which to operate. This includes clear policies on licensing, employment practices, and repatriating profits. As SHS companies are usually financed in US dollars or euros but SHSs are paid for in local currencies, SHS companies value a stable local currency. Volatile exchange rates can wipe out their profits.
- **Logistics and channels.** Distributing SHSs in rural areas can be difficult. Therefore, good road networks and the ability to create broad networks of distribution partners, such as post offices, banking agents, microfinance institutions, and even gas stations, are critical to fostering large-scale deployment.
- **Affordability and willingness to pay.** There must be enough customers with sufficient cash flow either to purchase an SHS system outright or make a deposit and then follow up with regular payments (called “pay-as-you-go”). They must also be willing to pay based on trade-offs with their current energy spending and positive perceptions of solar products.
- **Ease of payment.** To keep the cost of collection low, when the pay-as-you-go model is used, an intermediary is required to facilitate payments. Access to these intermediaries, such as mobile money providers and microfinance institutions, is critical.

After evaluating these five factors, as well as other indicators, we evaluated countries according to their readiness for widespread SHS adoption (see sidebar

What a solar home system does

This article focuses on solar home systems (SHSs) that provide what the World Bank has defined as Tier 1 and Tier 2 levels of electrification—that is, the basic lighting, mobile-telephone charging, and entertainment needs of a typical rural, low-income household in sub-Saharan Africa or South Asia (exhibit). Tier 1 and 2 systems include a small solar panel ranging from the size of a shoebox to that of a small suitcase. The size depends on the wattage, with a minimum of three watts for Tier 1 and 50 watts for Tier 2. The panel, placed on the roof of the home,

connects to a battery it recharges. In East Africa, Tier 1 systems typically include two to four light points on cables that can be hung from separate places. In addition, the SHS can charge a flashlight, a mobile telephone, and a radio.

In a recent analysis, we found that the lifetime cost of a Tier 1 or 2 SHS in Kenya was two to three times lower than that of a grid connection; systems of this size are also rapidly scalable in both rural and low-income urban areas.

Exhibit **New business models and technologies are making solar home systems (SHSs) accessible to more and more people.**

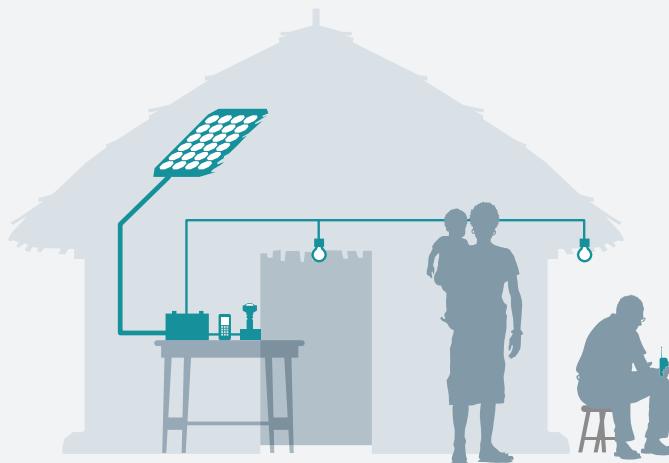
How a Tier 1 SHS works

Example: rural Kenya

A small photovoltaic panel collects solar energy.

A battery stores energy and distributes power to various accessories.

A Tier 1 system typically charges a mobile telephone, flashlight, and radio and also powers 2 to 4 lights.



“Understanding our analysis of SHS readiness”). This ranks the 39 countries that compose more than 90 percent of the global unelectrified population on how ready they are to increase SHS deployment (Exhibit 2).

In broad terms, countries fall into four levels of readiness (Exhibit 3). Top-level countries score

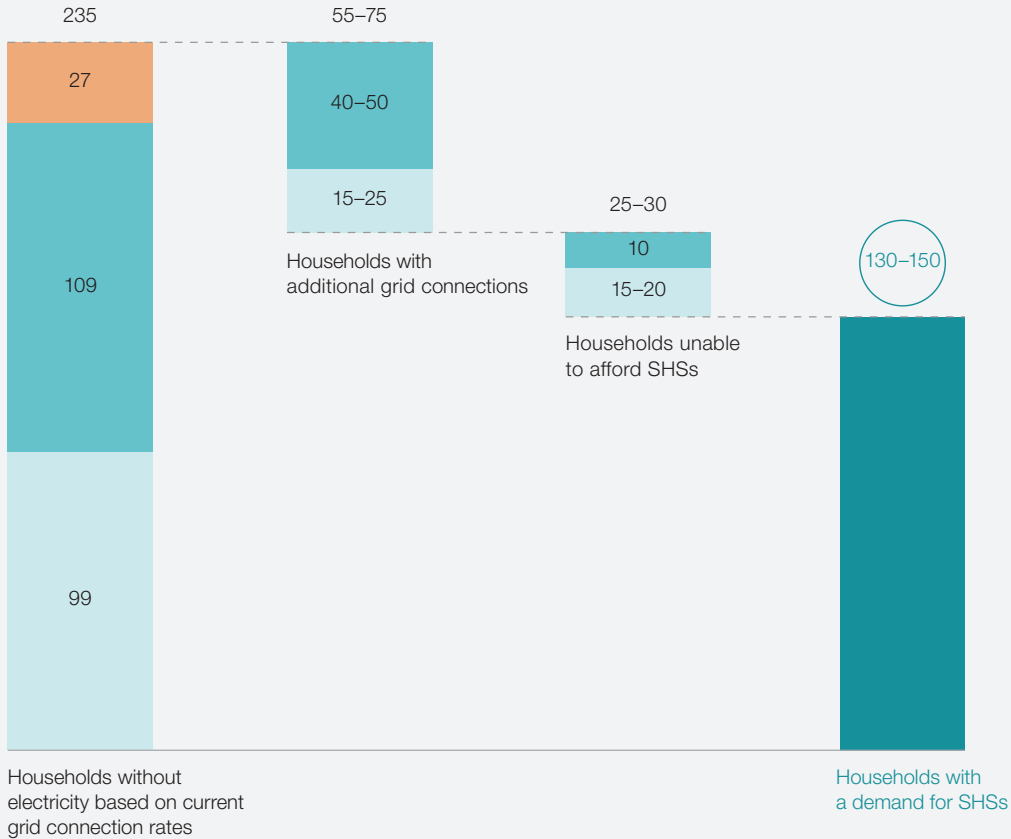
well on all indicators, although all have room for improvement on at least one indicator. They appear primed for SHS growth.

Countries in the second level typically face logistics and distribution challenges but have most other elements, including off-grid regulations,

Exhibit 1 Up to 150 million households could be in the market for solar home systems (SHSs) by 2020.

- Top 5 countries by unelectrified population¹
- Population growth by 2020
- Other 34 countries
- Estimated total by 2020

Estimated number of households by 2020, million



¹ Bangladesh, Democratic Republic of the Congo, Ethiopia, India, and Nigeria.
Source: McKinsey analysis

affordability and willingness to pay, business environment, and ease of payment, in place. The implication is that their governments have done well to create the right regulatory structure but that longer-term investment initiatives are required to improve the logistics.

The third-level markets also have logistics and channel difficulties, and they struggle with other issues as well. Their governments will need to devise new policies and improve the regulatory environment to attract SHS investment.

Countries in the bottom level tend to be the poorest, so they also fall short on affordability and willingness to pay. Even if governments in these countries installed a first-class regulatory and business environment, there might not be enough consumer buying power, at least at first, to support wide-scale SHS investment.

Creating a positive environment for SHS investment

Our analysis of SHS readiness shows that different countries have different challenges in areas such as electrification strategy, consumer awareness, product quality, payment solutions, financing, and logistics. In this section, we outline these principles with specific case examples that can help countries improve their solar home system readiness.

Electrification strategy

Recognizing SHSs as a viable alternative to grid-based electrification means that countries can count SHS deployment toward overall electrification targets. Doing so creates certainty for private companies seeking to invest in the sector.

To achieve its renewable energy targets, the Bangladesh government prioritized off-grid technologies to bring electricity to rural populations.⁴ Not only does the government-run IDCOL explicitly support rural SHSs, but so do regulatory agencies. Bangladesh's Renewable Energy Policy of 2008 provided a framework that has enabled SHSs to scale up quickly; by the end of 2014, more than 3 million SHS kits had been distributed. Similarly, in the Philippines, government agencies articulated and then acted on policy and budget proposals to support electrical cooperatives in providing SHSs to rural households.⁵

It is important to keep in mind that customers who have a grid connection might still be in the market for an SHS as either a backup or a lower-cost alternative. Therefore, while an electrification

strategy may focus SHS on low-income consumers or rural areas, it should not restrict the SHSs to them.

Consumer awareness

Successful consumer-education campaigns inform people about the costs and benefits of SHSs. In Kenya, for example, Lighting Africa sponsored road shows, media campaigns, and product-discussion forums to inform people about how home-based solar works.⁶ It even managed a product placement in one of the country's most popular television shows. The campaign, which ran from 2009 to 2013, reached millions of Kenyans, and the uptake of solar lighting rose sharply. Coordinating campaigns with system providers will ensure that solar products are available as demand builds.

Product quality

Bad products can slow consumer acceptance and give SHSs a poor reputation. Therefore, countries should consider adopting the internationally accepted Lighting Global product standards, building awareness of the problems associated with poor-quality products, and monitoring the sales of substandard products. A Bangladesh government program made its financial support to SHS developers conditional on acceptance of these standards. The developers had to purchase their kits from approved suppliers as well as submit to technical audits of installation and maintenance.

Payment solutions

In the areas of the world most in need of electricity, many households are short of cash; they might be able, however, to pay back the capital investment over time on a pay-as-you-go basis—think of it as a mortgage for solar power. The customer pays a deposit (\$15 to \$35), then covers the balance in regular payments over nine to 36 months. Payment time frames depend on the provider, the size of the system, the amount of the deposit, the payment amounts, and what accessories are included. This

Understanding our analysis of SHS readiness

We evaluated 19 components that are relevant to the five factors—off-grid regulations, business environment, logistics and channels, affordability and willingness to pay, and ease of payment—that matter most in attracting investment to the sector (exhibit). We scored each component from 1 to 4, with 1 being the least ready to increase solar-home-system deployment. We also defined specific thresholds for each score. For example, for GDP per

capita, a score of 1 was for less than \$500, 2 was for greater than \$500 and less than \$1,000, 3 was for greater than \$1,000 and less than \$1,500, and 4 was \$1,500 and up. We defined these thresholds based on expert interviews and our analysis of success factors in the most promising off-grid markets. Then we averaged the total score for each factor.

Exhibit **Nineteen components make up the five factors that define solar readiness.**

5 Factors	19 Components	Source
Off-grid regulations	• Officially approved electrification plan	→ World Bank Group RISE ¹ indicators
	• Regulatory framework for minigrids	→ World Bank Group RISE ¹ indicators
	• Regulatory framework for standalone systems	→ World Bank Group RISE ¹ indicators
	• Level of import duties on solar products	→ International Trade Centre MacMap ²
Business environment	• Level of sales tax on solar products	→ EY RECAI ³
	• Ease of doing business	→ World Bank Group Doing Business Index
	• Corruption index	→ Transparency International Corruption Perceptions Index
	• Investment environment	→ The Heritage Foundation Index of Economic Freedom
Logistics and channels	• Currency stability, % depreciation of local currency versus US dollar, 2012–17	→ IHS Markit
	• Microfinance network coverage, population per microfinance branch	→ International Monetary Fund Financial Access Survey
	• Trade logistics	→ World Bank Group Logistics Performance Index
Affordability and willingness to pay	• Road density, km of tarred road per square km	→ Central Intelligence Agency World Factbook
	• GDP per capita, US dollars	→ World Bank Group national accounts data
	• Consumer affordability of electricity, cost of subsistence consumption	→ World Bank Group RISE ¹ indicators
Ease of payment	• Perception of solar systems by end users, positive or negative	→ Press search
	• Use of mobile money, % of population aged ≥15 with a mobile money account	→ World Bank Group Global Findex Database
	• Mobile telephone penetration, mobile subscriptions per 100 people	→ ITU ⁴
	• Mobile coverage, % of population covered by a cellular network	→ GSM Association
	• Access to banking, % of population aged ≥15 with a bank account	→ World Bank Group Global Findex Database

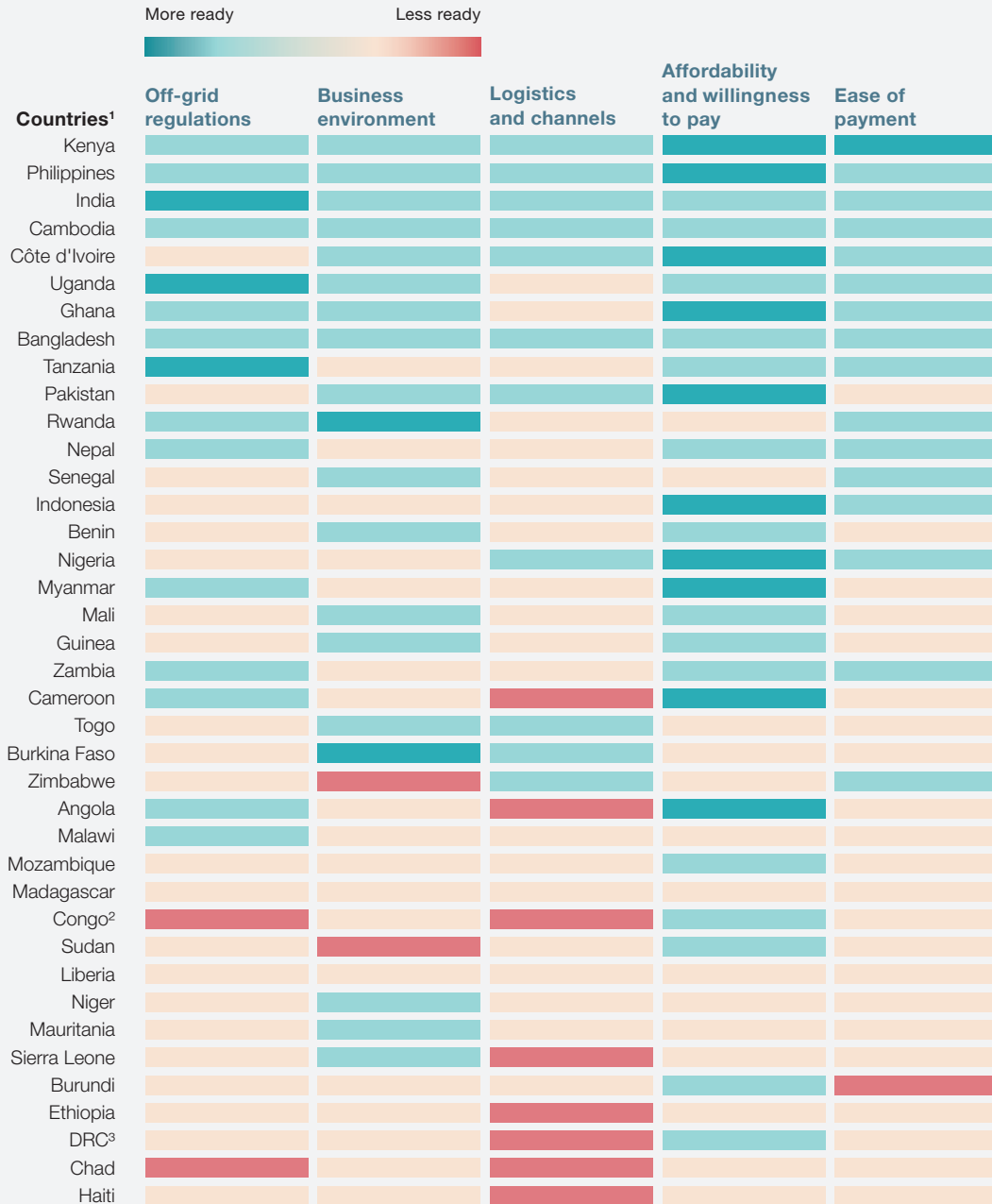
¹Regulatory Indicators for Sustainable Energy.

²Market Access Map.

³Renewable Energy Country Attractiveness Index.

⁴International Telecommunication Union.

Exhibit 2 We analyzed how ready countries are to increase deployment of solar home systems.



¹ Countries are listed, top to bottom, based on their overall readiness score.

² Republic of the Congo.

³ Democratic Republic of the Congo.

Exhibit 3 There are four levels of readiness for solar homes systems (SHSs).

Levels	Examples
<p>1 Most SHS ready Good market, logistics, and regulatory conditions</p>	India Kenya Philippines
<p>2 Relatively positive business environment and regulations but challenging logistics</p>	Ghana Tanzania Uganda
<p>3 Relatively positive enabling environment but poor off-grid regulations and challenging conditions for logistics and channels</p>	Guinea Mali Senegal
<p>4 Least SHS ready Challenging market, regulatory, and logistics conditions as well as low affordability</p>	Chad Haiti Liberia

approach makes SHSs affordable to households that cannot buy an entire system outright, which can cost \$150 to \$300.⁷

In Kenya, we looked at how much unelectrified households spend on kerosene, batteries, and mobile-telephone charging; the latter is often done on a pay-per-charge basis at small shops using car batteries.⁸ We found that 70 percent of those assessed spend between 780 and 2,250 Kenyan shillings (\$8 and \$23) per month on these items. On that basis, they could afford a Tier 1 SHS (the most basic level according to the World Bank’s standards). Consumers can use Kenya’s M-Pesa mobile-money platform to finance their solar purchases, sometimes paying a little every day, other times by the month. Companies in Kenya will often set their repayment levels at the point at which the cost of the M-Pesa transaction is low—even at zero.

For solar financing for customers to work for both sides, transaction costs must be low. Countries can

help mobile-money use gain momentum by building awareness and easing regulation, for instance, by granting licenses to nonbanking entities. Governments can also work with microfinance institutions (MFIs) to support solar-specific credit lines. This was the case in Bangladesh, where MFIs collaborated with local SHS partners to cover as much as 80 percent of the price through microloans. Governments need to avoid concessions or subsidies that could distort the market and harm successful private-sector business models (see sidebar “Is there a role for subsidies?”)

Financing for SHS companies

Countries are experimenting with expanding access to SHS by providing credit facilities through local banks or other debt providers and by guaranteeing loans to SHS companies. Multiple countries are testing results-based financing—payments to SHS companies to incentivize sales. For example, Tanzania is piloting results-based financing to

Is there a role for subsidies?

The use of subsidies, whether related to energy, food, or any other product or service, can be controversial.

Those who favor them argue that well-designed subsidies for solar home systems (SHSs) could help expand their access to the poor. In the process, the market expands faster than it would have without subsidies, thus triggering economies of scale that push prices lower.

Opponents argue that subsidies are rarely well designed or managed and often deliver results opposite to those intended. Therefore, SHS subsidies could constrain the business models of private companies or lead to distribution of products that then go unmaintained, unused, or resold.

Among the 39 countries we analyzed, several have instituted or proposed SHS-subsidy programs. Here are examples of non-consumer-oriented subsidy programs:

- **The concession model.** In Senegal, providers can bid for subsidies and receive tax exemptions to deploy renewable-energy solutions within specified concession areas. As of early 2017, however, only three of the ten designated concessions were operating, and the program was not meeting electrification

targets. Companies also reported difficulties with product technical requirements.

- **Grants and refinancing.** Microfinance institutions (MFIs) in Bangladesh receive direct subsidies on the primary SHS through grants from donor agencies; this cuts the cost to end users. In addition, Bangladesh's government-run IDCOL grants long-term, reduced interest rate loans to partner organizations, including MFIs, to encourage them to finance SHSs for low-income buyers. IDCOL also provides lower-interest financing to SHS buyers (rates of 10 percent to 12 percent compared with commercial rates of 16 percent).
- **Start-up subsidies.** A pilot program in Tanzania's Lake Zone region provides access to a financing facility for start-up costs for small-scale lighting and basic electricity-supply technologies.
- **Tax preferences.** While not a classic subsidy, governments can remove or reduce taxes and duties for solar components and accessories to lower costs and provide an incentive to the market. The Philippines, for one, grants duty-free imports on renewable-energy components as well as tax exemptions on sales of related equipment.

encourage sales to an underserved region in the Lake Zone. This program also provides professional management support from TIB Development Bank. Within the first year, more than 10,000 households benefitted from the pilot. Another example of this principle is the India Ministry of New and Renewable Energy program that reduces the cost of

borrowing from local banks for solar providers, thus enabling greater access to financing.

Logistics and channels

The costs of distribution and customer acquisition can be particularly high in remote, poor, and lightly populated areas—the very places that could

benefit most from the technology. Distribution partnerships can help to overcome these challenges. For example, companies in Cameroon and Kenya have collaborated with fuel providers possessing a broad network of gas stations. In another case, a solar distributor in Kenya worked with the local government to store SHSs in neighborhood police stations. That reduced the need for companies to find and pay for storage in remote areas, which can be costly. To acquire new customers, one Nigerian company is marketing its solar products through telecommunications kiosks.



Solar home systems have proved their value by bringing light and power to the homes of tens of millions of people. But sunny optimism is not a business model. Like any other product or technology, the economics and practicalities must work. Spreading solar power further and faster to those who need it might not be easy, but it is certainly possible—as countries around the world are demonstrating. ■

¹ This estimate is based on McKinsey's bottom-up analysis of the 39 countries that compose more than 90 percent of the unelectrified population. It considers expected population and electrification growth; the latter is based on government plans, funding for electrification, and expected delivery against electrification targets. For the remaining countries, which compose less than 10 percent of the unelectrified population, population-growth and historical electrification-growth rates were applied.

² Sub-Saharan Africa refers to the continent outside North Africa, which is Algeria, Egypt, Libya, Morocco, and Tunisia. South Asia refers to Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka.

³ The Voice of the Off-Grid Solar Energy Industry, gogla.org.

⁴ *Scaling up renewable energy in low income countries: Investment plan for Bangladesh*, Sustainable and Renewable Energy Development Authority, October 2015, climateinvestmentfunds.org.

⁵ *NEA draws up new policy to fast-track rural electrification*, National Electrification Administration, September 2017, nea.gov.ph; Ronnel W. Domingo, "Microgrids, solar pushed to bring electricity to rural areas," INQUIRER.net, September 19, 2017, business.inquirer.net.

⁶ Lighting Africa, lightingafrica.org.

⁷ McKinsey research and analysis in Kenya in 2016 done on behalf of Power Africa/USAID.

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