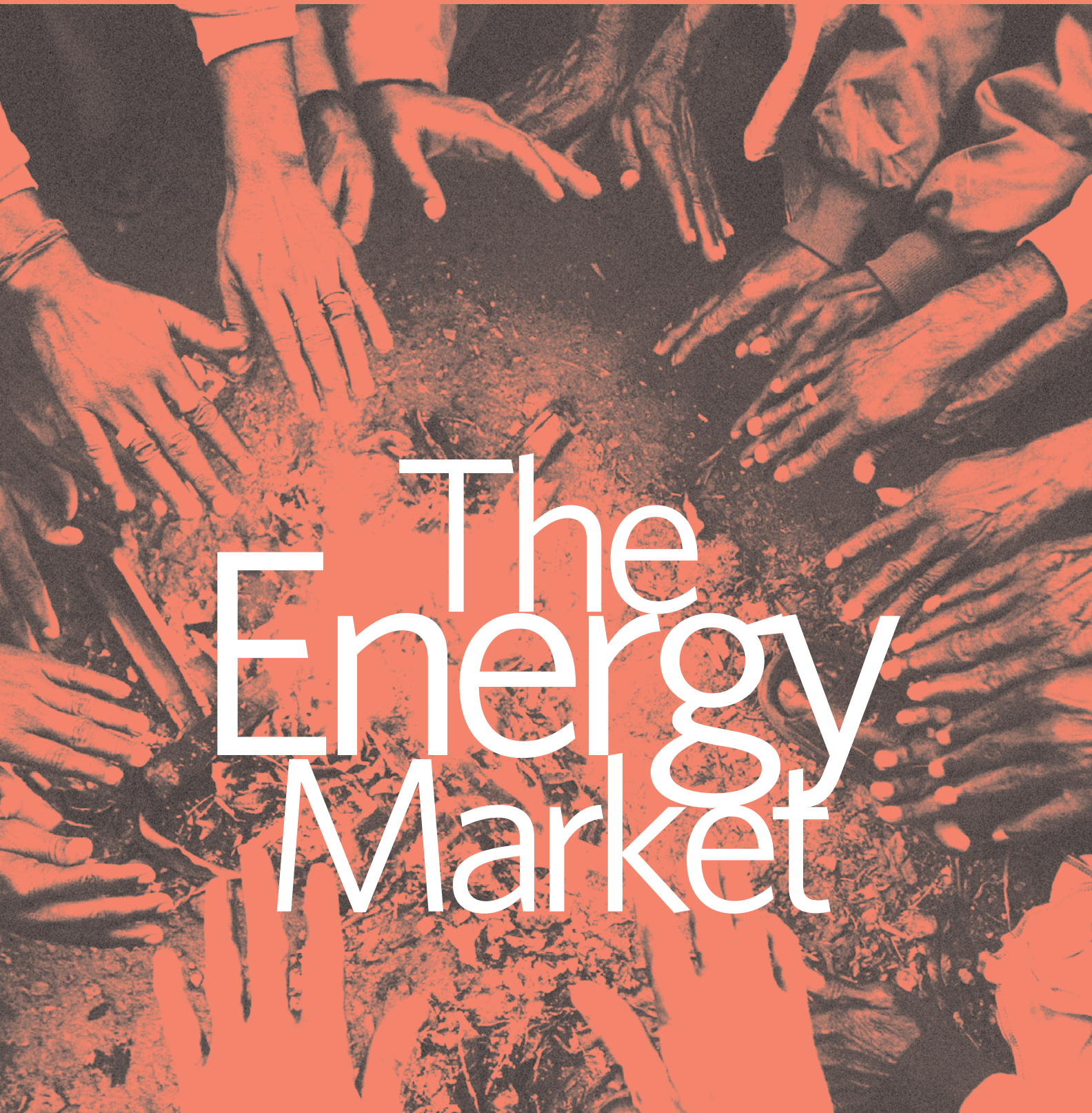
CHAPTER SEVEN



The Energy Market

Lack of clean, affordable energy is part of the poverty trap. Pollution from indoor use of harmful fuels for cooking and lighting leads to significant health problems. Gathering biomass fuels takes time that could be better spent—in school or at work. And the higher cost of inefficient energy-using devices and the lack of access to modern energy sources such as electricity become part of the BOP penalty—the added cost of being poor.

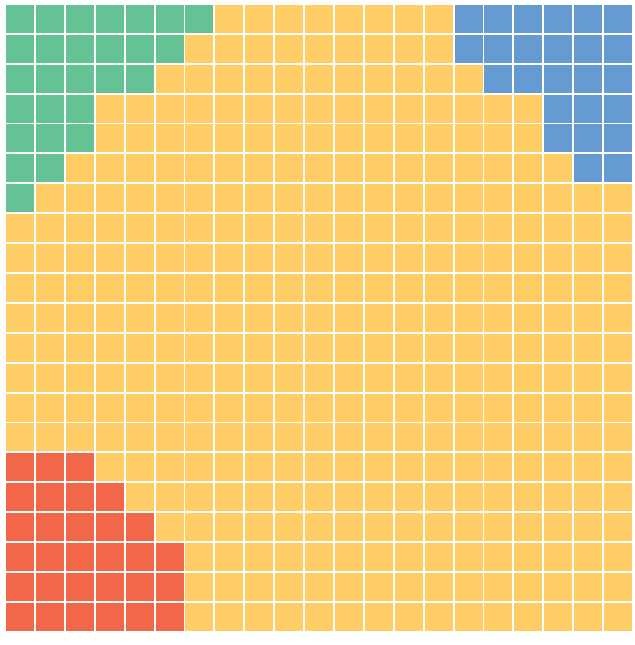
Together, private sector solutions and public institutional reforms are working to close the energy gap. Innovative approaches and new business investments are bringing energy services to BOP markets. While earlier efforts to extend grids beyond major urban centers often met with difficulties and even failure, rural electrification initiatives in Latin America suggest that creative solutions can be found. Where publicly regulated grids cannot reach, off-grid solutions are becoming more widespread—using hydropower, solar photovoltaics, and hybrid solutions. New technologies, such as light-emitting diodes (LEDs), and modern improvements of old ones, such as biomass-burning cookstoves, are increasingly available at affordable prices to both urban and remote rural populations.

How large is the market?

The measured BOP household market for energy is $228 billion, representing the annual spending of 2.1 billion people in 34 countries. The total BOP household energy market in Africa, Asia, Eastern Europe, and Latin America and the Caribbean is estimated to be $433 billion, representing the spending of 3.96 billion people (see box 1.5 in chapter 1 for the estimation method).

Asia has the largest BOP energy market, with measured annual spending of $177 billion by 1.5 billion people. The estimated total BOP energy market in the region (including the Middle East) is $351 billion (2.9 billion people). Latin America's measured BOP energy market is $25 bil-

BOP spending on energy
$433.4 billion

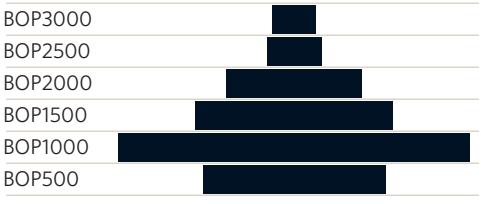


	$ billions (PPP)
Africa	26.6
Asia	350.9
Eastern Europe	25.4
Latin America	30.5

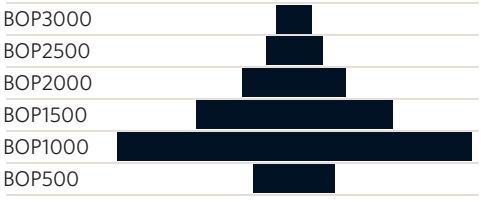
Each square represents approximately $1 Billion

BOP households devote an average of 7% of their expenditures to energy. In most measured countries, the share of household spending devoted to energy does not change significantly as incomes rise.

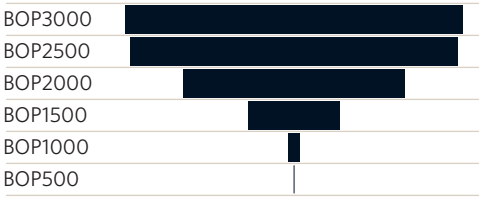
Côte d'Ivoire
TOTAL ENERGY SPENDING BY INCOME SEGMENT



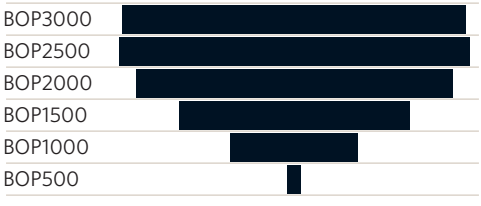
Indonesia
TOTAL ENERGY SPENDING BY INCOME SEGMENT



Ukraine
TOTAL ENERGY SPENDING BY INCOME SEGMENT



Colombia
TOTAL ENERGY SPENDING BY INCOME SEGMENT



lion (269.5 million people), and its estimated total market $31 billion (360 million people). While Africa has the smallest measured BOP energy market, at $12 billion (253.3 million people), its estimated total BOP energy market is $27 billion (486 million people). Eastern Europe, with a Soviet-era legacy of cheap and reasonably universal electricity, shows BOP energy spending of $14 billion (138.9 million people) and an estimated total BOP market of $25 billion (254 million people).

In Africa, Eastern Europe, and Latin America energy ranks third in BOP household expenditures, trailing food and housing. In Asia energy ranks second, surpassing housing, because of the high levels of energy spending reported in India.

In national energy markets the BOP represents a significant share in virtually all 34 countries for which standardized survey data exist. It accounts for more than 90% of recorded spending in such populous countries as Indonesia, Nigeria, and Pakistan—and more than 50% in Brazil, India, Sri Lanka, Uganda, Peru, and Bolivia (case studies 7.1 and 7.2). The BOP share falls short of 50% in only 7 of the 34 countries: FYR Macedonia (20%), Paraguay (30%), Colombia (35%), South Africa (41%), Russia (44%), Ukraine (47%), and Mexico (48%).

The smallest BOP market shares by region are recorded in South Africa, Thailand, FYR Macedonia, and Paraguay. The largest are in Nigeria, Tajikistan and Pakistan (a virtual tie in Asia), Uzbekistan, and Jamaica.

How is the market segmented?

Developing-country energy markets are predominantly in the BOP. Moreover, nearly a quarter of all recorded energy spending occurs in the bottom two BOP income segments—BOP500 and BOP1000, where per capita income is $1.50 and $3 a day.

Market concentration in these two income groups is most pronounced in Asia and Africa, where bottom-heavy BOP markets predominate. In Indonesia, for example, where the BOP accounts for 95% of national energy spending, 50% of the spending occurs in the BOP500 and BOP1000 segments. In Burundi, where the BOP carries similar weight, at 89% of the national energy market, the BOP500 and BOP1000 segments account for 62% of this market.

South Africa has a different market segmentation than other measured countries in Africa. While the BOP makes up 74% of the population, it accounts for only 41% of total energy spending. Distribution of the BOP energy market across income groups is more balanced, split evenly between the lower three BOP income segments and the upper three. The more dominant mid-market population segment outspends the BOP population by 32%.

Top-heavy BOP energy markets and larger mid-market spending are found in much of Eastern Europe and Latin America. In Ukraine the top three BOP income groups account for 90% of BOP spending, while the mid-market segment, 40% of the national population, slightly outweighs the BOP market. In Colombia the top three BOP income groups represent 73% of the BOP energy market, while the mid-market segment, 42% of the national population, accounts for an energy market nearly twice the size of the BOP market.

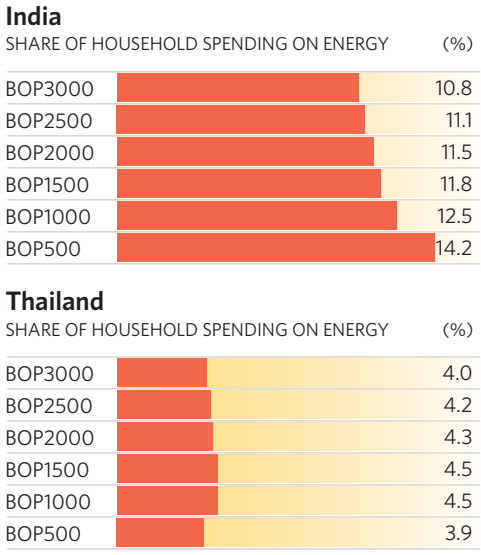
What do households spend?

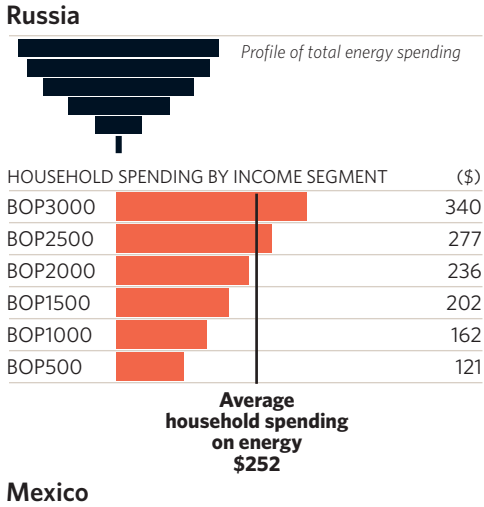
Across measured countries BOP households devote an average of 9% of their expenditures to energy. Asia shows the largest share, at 10%, with all other regions clustering around the average. In most measured countries, the share of household spending devoted to energy does not change significantly as incomes rise.

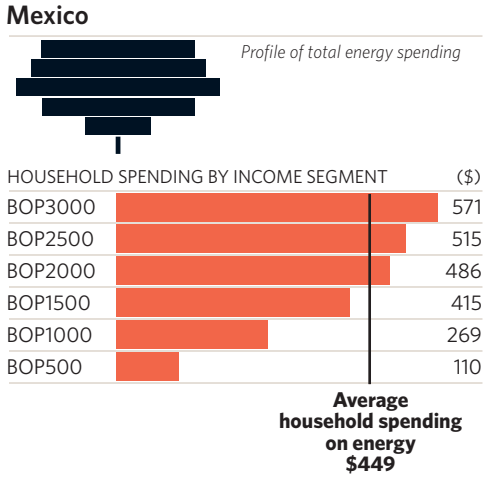
Households in the BOP500 income group spend an average of $148 a year on energy, equivalent to around $0.40 a day. In the BOP1000 group the average rises to $264 a year ($0.72 a day), and in the BOP1500 segment to $379 a year ($1 a day).

These amounts may be small, but the large populations in the bottom three income segments create big markets. In the 34 countries for which standardized data on energy spending are available, energy expenditures total $9.5 billion a year in the BOP500 segment, $60.5 billion in BOP1000, and $64.0 billion in BOP1500.

Differences in access to electricity between rural and urban areas create different patterns of energy spending. In Brazil, for example, the 6.5 million rural BOP households spend $661.3 million a year on energy, or $102 per household—while the 25.3 million urban BOP households spend $10.1 billion, or $397 per household. On average, an urban BOP household in Brazil spends 289% more on energy than its rural counterpart.







CASE STUDY 7.1 **NIGERIA:**

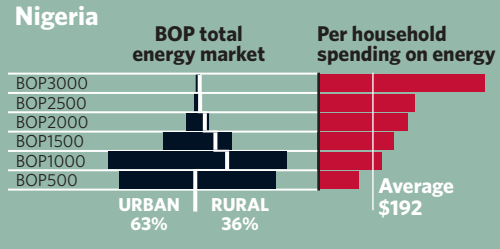
WHERE THE BOP IS THE MARKET

Nigeria's national household energy market has the biggest BOP share in Africa: 99.4%. At $5.1 billion, the market is also the second largest recorded in Africa (after South Africa's). The distribution of the market closely tracks the distribution of the population—both skew heavily toward the lowest BOP income groups. The BOP500 income segment accounts for 36% of national energy spending, the BOP1000 for 40%, and the BOP1500 for 16%. (Burkina Faso is the only other measured country in any region with more than a third of its national energy market in the BOP500 segment.)

Nigeria has more households in the BOP500 income group—13 million, 49% of the national total—than any other African nation has in its entire country. India, with nearly nine times the population of Nigeria, has less than a third as many households in the BOP500 segment—3.6 million.

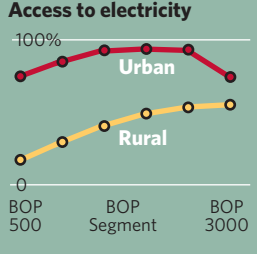
Nigeria's BOP500 households earn between $1 and $2 a day in per capita income. Yet they spend an average of $140 a year on energy, or some $0.40 a day—for a total of $1.8 billion a year for this income segment.

This spending by BOP500 households is split roughly evenly between urban and rural markets: 52% ($940 million) in urban areas, 48% ($883 million) in rural areas. (The national energy market is somewhat more heavily urban weighted: 63% urban, 37% rural.) Rural BOP500 households report average energy spending of $130 a year, half that of their urban counterparts, at $267. But rural BOP500 households outnumber urban ones nearly two to one, equalizing the market sizes.



Only 35% of BOP500 households in Nigeria report having access to electricity, but this is still the second highest rate in this income group among surveyed African countries. The share of households with access to electricity climbs to 57% in BOP1000, 74% in BOP1500, and 82% in BOP2000. Stark differences show up between rural and urban areas: only 14% of rural BOP500 households report having access to electricity, compared with 72% of urban ones.

For rural BOP500 households without electricity, kerosene is the dominant fuel source for lighting: 79% report it as their primary source, compared with only 25% of urban BOP500 households. For cooking, firewood is the primary fuel source for both urban and rural BOP500 households, reported by 80% on average. Among BOP2000 households firewood use falls to 31%, replaced by kerosene for 59% of households.



Patterns of fuel use vary across income groups as well as between rural and urban areas. In Africa, Asia, and Latin America firewood is the main fuel source used for cooking in the lower BOP income groups.

Patterns of fuel use vary across income groups as well as between rural and urban areas. In Africa, Asia, and Latin America firewood is the main fuel source used for cooking in the lower BOP income groups. In Thailand firewood is reported as the primary source by 79% of households in BOP500, 45% in BOP1000, and 27% in BOP1500.

Far more rural than urban BOP households—in all income segments—use firewood as their primary fuel source for cooking. In Gabon 48% of urban households in BOP500 report firewood as their primary fuel source, while 86% of their rural counterparts do. Across all BOP income segments, however, only 20% of urban households use primarily firewood, compared with 76% of rural households—a share nearly four times as large.

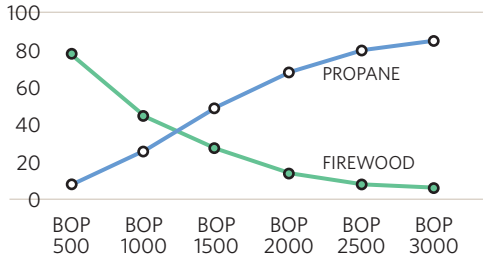
In higher income segments propane or liquefied petroleum gas (LPG) becomes the most common substitute for firewood. In Bolivia this is the primary fuel source for 87% of households in BOP2500, 87% in BOP3000, and 93% in the mid-market segment (compared with 13% in BOP500). Use in Nepal is reported by 60%, 75%, and 94% in the same groups (<1% in BOP500). In African countries fuel sources used in the mid-market segment are more varied, with the most prevalent being propane or LPG in Cameroon, Côte d'Ivoire, Malawi, and Rwanda; kerosene in Burundi, Djibouti, and Nigeria; and electricity in Malawi and Uganda.

For lighting, kerosene is the predominant fuel source in lower BOP income groups in Africa and Asia. In Malawi 89% of households in the BOP500 segment report it as their primary lighting fuel, compared with only 7% in the mid-market segment. In Bhutan the share for BOP500 households is 64%, while there is no recorded use in the mid-market segment.

Electricity replaces kerosene in the mid-market segment, where it is predominant across regions. In Burkina Faso electricity is the primary

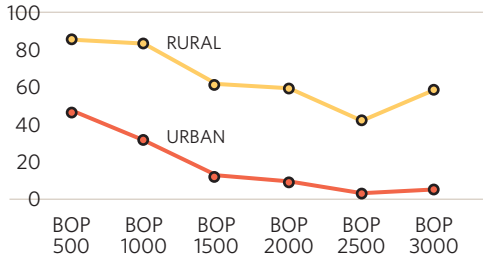
Thailand

PERCENT OF HOUSEHOLDS BY PRIMARY COOKING FUEL



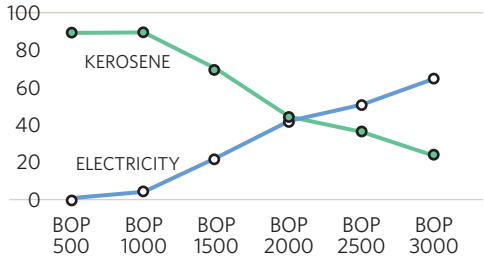
Gabon

PERCENT OF HOUSEHOLDS USING FIREWOOD AS THE PRIMARY COOKING FUEL



Malawi

PERCENT OF HOUSEHOLDS BY PRIMARY LIGHTING



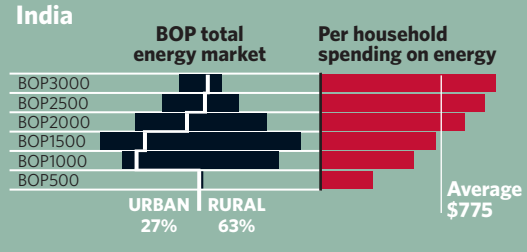
CASE STUDY 7.2 **INDIA: SMALL EXPENDITURES ADD UP TO A HUGE MARKET**

India has the largest measured energy market in Asia, with $163 billion in annual household spending. Some 52% of that market is in the bottom three BOP income groups (70% of the population), and 81% in the bottom five (92% of the population). Annual per household spending averages $342 in BOP500, $606 in BOP1000, and $751 in BOP1500.

Rural areas account for 63% of the national energy market, or $102 billion in annual spending—and 70% of the BOP market, or $99.7 billion. The urban BOP energy market represents $42.3 billion in spending.

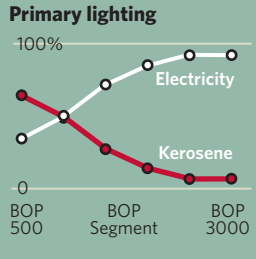
For rural BOP households, energy spending averages around $705 a year, or $2 a day. For urban BOP households the average is $1,008 a year, around $2.75 a day. Per household spending in the mid-market segment averages $1,236 in rural areas and $1,368 in urban areas.

The rural BOP energy market shows a large concentration in the lowest BOP income groups: 69% is in the bottom three, compared with just 23% in the urban BOP energy market. This concentration is due in part to the small mid-market population in rural areas. While the mid-market population's energy spending in rural areas amounts to $2.3 billion, it is nearly nine times as much in urban areas, at $18.7 billion. In contrast, the bottom three BOP income segments in rural areas spend $70 billion on energy—nearly 45% of all national per household energy spending. Yet in each of these three BOP income segments household energy spending averages less than $2 a day.

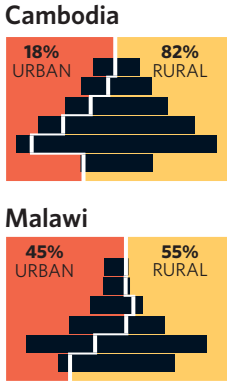


Kerosene is the most common lighting fuel for the lowest two BOP income groups—reported as the primary source by 65% of BOP500 households and 50% of BOP1000 ones. Kerosene use rates fall off dramatically in higher income segments, dropping to 7% in BOP2500 and BOP3000 and only 1% in the mid market. Electricity becomes the main lighting source in BOP2500 and higher income levels.

Firewood is the primary fuel source for cooking in the lower BOP income groups in India, reported by 75% of surveyed households in BOP500, 78% in BOP1000, and 60% in BOP1500. Use falls to only 23% of households in BOP2500 and 15% in BOP3000. Propane or LPG becomes the main fuel source for cooking in higher income groups, reported by 65% of households in BOP2500, 79% in BOP3000, and 87% in the mid market.



Africa's BOP energy markets maintain a roughly even split between urban and rural areas. Asia's markets, in contrast, are decidedly skewed toward rural areas.



Total BOP energy spending by income segment, urban and rural

lighting source for 8% of households in the BOP; in the mid-market segment this share rises to 78%.

Where is the market?

Measured BOP spending on energy splits approximately 40% urban, 60% rural. But rural BOP households spend on average 44% less on energy than do urban BOP households. The larger populations in rural areas balance out the markets—and represent significant market opportunities for energy to power lighting, cooking, and productive enterprises (case studies 7.3–7.6).

Africa's BOP energy markets, at 55% urban, maintain a roughly even split between urban and rural areas. Yet rural BOP households spend only a third as much on energy as their urban counterparts on average, the largest such discrepancy among regions. In Malawi, for example, while the BOP energy market is 55% rural, rural BOP households spend only 15% as much on energy as their urban counterparts.

Asia's BOP energy markets, in contrast, are decidedly skewed toward rural areas (Indonesia is the lone exception). In Cambodia the BOP energy market is 82% rural.

Eastern Europe's BOP energy markets are predominantly urban. This region, where access to electricity is nearly universal, has the smallest gap between rural and urban energy spending. In Ukraine, where the BOP energy market is 67% urban, urban BOP households spend only 17% more on energy than their rural counterparts.

Latin America's BOP energy markets also tilt decidedly toward uban areas (with Guatemala

CASE STUDY 7.3 POWERING UP: HARNESSING SUBSIDIES FOR RURAL ELECTRIFICATION IN CHILE

In the mid-1990s Chile, an early reformer in the electricity sector, set out to achieve rural electrification through a program involving the private sector. The goal: provide electricity to 50% of the rural population—one million people. The program offered a one-time direct subsidy to private electricity distribution companies to cover part of the capital investment; operating costs would have to be covered through tariffs. Four principles guided the program: decentralized decision making, joint financing, competition, and appropriate technologies.

The program has been a success in several ways. It exceeded its target, reaching 75% of the unserved population by 1999. Projects were financially sustainable enough to allow the government to reduce its investment stake, as planned. Regional governments performed well, as did community groups and the private energy companies. While most power has come through grid extension, isolated areas have experimented successfully with wind, biomass, hydropower, and photovoltaic systems. Finally, while the average state subsidy per dwelling increased by 50% from 1995 to 1999 (from $1,080 to $1,510), the cost to government has been acceptable—especially in light of the social goal achieved—and within expected budgetary limits.

Early and continual consultation helped ensure satisfaction and support among customers. And rural communities have proved to be good customers: bill payment rates are high, and electricity use is steadily rising as economic activity grows (Jadresic 2000).

This case shows the value of the strategy of **unconventional partnering.**

CASE STUDY 7.4 **THINKNG SMALL TO SOLVE BIG:**

HARNESSING SUBSIDIES FOR RURAL ELECTRIFICATION IN CHILE

Through technological innovation, many large companies are working to solve big problems with small devices. The energy giant Shell aims to create sustainable market systems to sell 20 million affordable stoves in India by 2010. And with the support of its private sector–focused Shell Foundation, two Indian NGOs, the Appropriate Rural Technology Institute and Development Alternatives, are developing and marketing low-polluting biomass fuels and cooking devices.

Another oil giant, BP, is rolling out a stove that can use either biomass or liquefied natural gas. With NGO partners, BP is also developing innovative distribution models, micro-financing for the stoves, and small-scale entrepreneurship. Dutch multinational Philips has developed an efficient wood-burning stove that cuts emissions of pollutants by 90% over traditional wood fires (Philips Research 2006). German industrial leaders Bosch and Siemens have teamed up to develop Protos, a plant oil stove, now on the market in the Philippines.

All these efforts marry high-tech academic research and civil society engagement with a market-driven business model. They illustrate a strategy of focusing on the BOP, combined in some cases with **unconventional partnering.**

the lone exception). In Mexico urban areas account for 76% of BOP spending on energy, with urban BOP households spending roughly 50% more on energy than their rural counterparts.

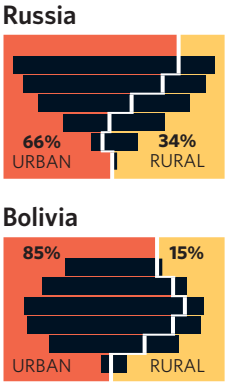
Is there evidence of a BOP penalty?

Income is clearly related to access to energy and to the type of energy source used for different purposes. The BOP consistently has less access to electricity than the mid-market segment. And access increases as BOP incomes rise, a consistent pattern across countries and regions.

Rural areas show a larger and more persistent BOP penalty in access to electricity across income groups: in any income group access is invariably lower in rural than in urban areas. In Bangladesh 37% of urban households in BOP500 have access, compared with only 4% of their rural counterparts. Among households in all BOP income segments in Bangladesh, the share is 81% in urban areas, 20% in rural.

Overall, 36% of BOP households lack access to electricity—while only 6% of mid-market households lack access. Reported access rates are 51% in the BOP500 income segment, 63% in BOP1000, and 74% in BOP1500.

But these averages conceal marked differences across regions. In Eastern Europe access to electricity is virtually universal. FYR Macedonia, Russia, and Ukraine all show 99% access in the BOP and at least 95% in BOP500. Latin America and Asia show access rates similar to one another across the lowest BOP income segments, albeit lower than Eastern



Total BOP energy spending by income segment, urban and rural

Overall, 36% of BOP households lack access to electricity—while only 6% of mid-market households lack access. Reported access rates are 51% in the BOP500 income segment, 63% in BOP1000, and 74% in BOP1500.

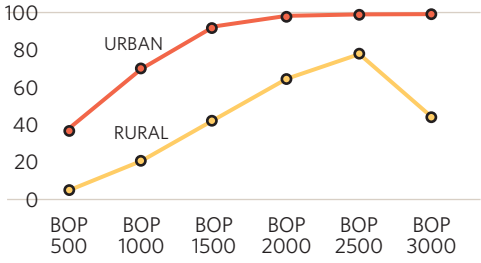
Europe and with higher variance across measured countries. High access rates occur in Brazil, where coverage in BOP500 is 85%, and in Indonesia, with 82% in the same segment.

Africa, in contrast, has severely depressed rates of access to electricity. Gabon has the largest share of BOP500 households reporting access, at 54%. But only 16% of all BOP households in Sierra Leone have access to electricity, and less than 10% in Burkina Faso, Malawi, Rwanda, and Uganda. The situation is most extreme in Africa's rural areas: the share of BOP households with access to electricity in rural areas is only a fifth that in urban areas.

Bringing electricity to low-income communities involves inherent difficulties. But new solutions are emerging for at least some of the problems related to the BOP penalty (case study 7.3).

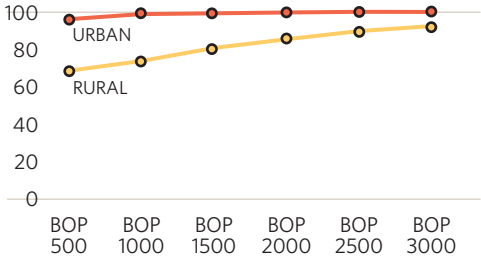
Bangladesh

PERCENT OF HOUSEHOLDS WITH ACCESS TO ELECTRICITY



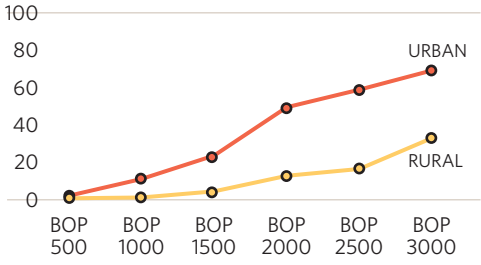
Brazil

PERCENT OF HOUSEHOLDS WITH ACCESS TO ELECTRICITY



Uganda

PERCENT OF HOUSEHOLDS WITH ACCESS TO ELECTRICITY



CASE STUDY 7.5 **HERE COMES THE SUN:**

SOLAR BECOMING MORE EFFICIENT, MORE AFFORDABLE

Solar photovoltaic systems are making headway for general household use in off-grid situations. Market-based enterprises are replacing earlier government-run programs. Solar panels are becoming increasingly efficient, with the cost per kilowatt-hour of electricity produced continuing to decline. And "clean tech" solutions are finding favor in the capital markets, so enterprise funding is more readily available.

The Solar Electric Light Company (Selco), a small company in India, and the Solar Electric Light Fund (SELF), an NGO, both provide household-size photovoltaic systems at an affordable cost, with financing options, in a number of countries. A well-funded new company, Orb Energy, staffed by solar power veterans, is building both commercial and residential units for the Indian market. E+Co, a pioneering energy fund, is now just one of many capital funds investing broadly in solar photovoltaic, geothermal, wind, biomass generators, and small hydropower systems.

In Brazil, IDEAAS offers a full-service solar photovoltaic system without requiring customer purchase—a business model not unlike grid utilities. This profitable social enterprise has reduced the number of rural Brazilians without electricity from 60 million in the mid-1990s to fewer than 12 million today.

All these cases, centering on context-specific innovation, illustrate a strategy of **focusing on the BOP.**

CASE STUDY 7.6 **PORTABLE POWER: LIGHT YOU CAN CARRY AND WEAR**

High-brightness, solid-state lighting produces a digital light of 80 lumens per watt, enough to read, work, or travel by. Kennedy & Violich Architecture has embedded high-brightness light-emitting diodes (LEDs) in flexible photovoltaic solar panels. The result is a light-producing textile that is lightweight, fully portable, and off the grid.

Among the devices in production is the "Portable Workshop," a foldable textile workspace weighing 14 ounces and providing 2.5 hours of light at 160 lumens. Recharging takes four hours, through a shoulder sash with photocells or a canopy that also shades the user. For nighttime use the device can be configured to provide ambient or task lighting or to light the way for travel.

The Light Up the World Foundation, in partnership with Stanford Business School, has developed LED-based products for rural use ranging from a flashlight-size device to an on- or off-grid device for ambient or task lighting. Devices can be powered in several ways—solar, hydro, wind, or human effort. One device successful in Nepal is the pedal generator—safe, rugged, economical, able to charge multiple batteries simultaneously, and easy to maintain, repair, and transport, even over difficult terrain.

The foundation now produces multiple configurations of its systems for individuals, households, and village institutions such as schools and clinics. Its systems have been installed in more than 14,000 homes, benefiting more than 100,000 people, and plans for large-scale rollout are under way.

Though a nonprofit, the foundation puts enterprise development at the core of its mission. Through "social pricing" arrangements with component suppliers, it helps new businesses get established in local markets and provides mentoring and training to support their sustainable development.

Both these cases illustrate a strategy of **focusing on the BOP.**

In Africa, rural BOP households spend only a third as much on energy as their urban counterparts on average, the largest such discrepancy among regions.

Endnotes

1. Reported household expenditures in a given country should be regarded as a minimum estimate of actual expenditures, because surveys may not have collected information on all types of energy-related spending.
2. For more on these entities, see http://www.shellfoundation.org, http://www.arti-india.org, and http://www.devalt.org.
3. BSH (Bosch und Siemens Hausgeräte GmbH), "BSH Presents Ecological Plant Oil Stove for Developing Countries," http://www.plantoilcooker.org (accessed January 13, 2007).
4. Selco, "What We Provide," http://www.selco-india.com/what-we-provide.html; Solar Electric Light Fund, "Solar Technology," http://www.self.org/shs_tech.asp (accessed January 13, 2007).
5. E+Co, "E+Co Enterprises," http://www.eandco.net/enterprise_home.php (accessed January 13, 2007).
6. IDEAAS (Instituto para o Desenvolvimento de Energias Alternativas e da Auto Sustentabilidade), "Projects," http://www.ideaas.org.br/id_proj_luz_agora_eng.htm (accessed January 13, 2007).
7. Portable Light Project, "Portable Light," http://www.tcaup.umich.edu/portablelight/portable.swf (accessed January 13, 2007).
8. Economist, "Lighting Up the World," September 21, 2006, http://www.economist.com/science/tq/displayStory.cfm?story_id=7904248.