4

Modern Cooking Solutions: Status and Challenges

The promotion of modern cooking solutions in EAP is a challenge that will require attention for at least the next 20 years. One the one hand, the promotion of modern cooking fuels—principally LPG and natural gas—is the responsibility of large energy companies that have difficulty in serving even the existing customer base in many EAP countries. Many such firms have not really begun to tackle the challenge of providing affordable modern fuels to poor sections of the population. On the other hand, the promotion of advanced cookstoves that can use biomass, charcoal, or coal cleanly and efficiently is not attractive to the private sector due to low affordability among poorer households, the main target group. In other words, it is not financially attractive to sell either modern fuels or advanced stoves to relatively poor populations.

The poorest sections of the population, who live primarily in rural communities form the "bottom-of-the-pyramid" opportunities. This population segment traditionally has been viewed as being relatively unattractive to investors. The economic and social benefits of reaching these markets with modern cooking fuels and advanced cookstoves are significant. The benefits include fewer premature deaths; improved health and productivity; hours of drudgery avoided, mostly for women; less pressure on the local ecosystem from wood collection; and perhaps even a reduction in greenhouse gases. International coalitions are giving increased attention to developing business models that promote modern cooking solutions for the poorest households (IEA 2010; UN Foundation 2010). In recent years, new options have emerged that may accelerate this access.

Relationship among Traditional Cooking Solutions, Health, and Poverty

The use of biomass and solid fuels for cooking is extremely common in EAP, even in countries with high rates of modern fuel use. This pervasive use of solid fuels—including wood, coal, straw, and dung—and traditional cookstoves[23] results in high levels of household air pollution, extensive daily drudgery required to collect fuels, and serious health impacts.

It is well known that open fires and primitive stoves are inefficient ways of converting energy into heat for cooking. The average amount of biomass cooking fuel used by a typical family can

23. The use of biomass energy in inefficient or open stoves is considered a traditional way of cooking. On the other hand, gas, LPG, kerosene, electricity, and biomass energy used in efficient or less polluting stoves are considered modern ways of cooking. Other examples could be used, but the general idea is that traditional ways of using energy typically are inefficient and somewhat polluting, whereas the opposite is true of modern energy use for cooking.

Table 4.1 Annual Premature Deaths Attributed to Air Pollution from Cooking with Solid Fuels in EAP Countries, 2007 *(mil)*

EAP Region	Pneumonia (children under 5 yrs)	Chronic obstructive lung disease (adults older than 30 yrs)	Cancer (adults older than 30 yrs)	Total premature deaths
Total	40,800	589,300	34,700	664,800

Source: WHO and UNDP 2009.

Note: According to the definitions used by WHO and UNDP 2009, solid fuels (SFU) refer to traditional biomass—wood, charcoal, dung, straw, and crop residues—and coal. The figures in this table were computed by WHO to ensure compatibility. Thus, they are not necessarily the official statistics of WHO member states, which may use alternative rigorous methods. The number of deaths attributable to indoor air pollution from solid fuel use was calculated without removing chronic obstructive pulmonary disease and lung cancer deaths, both attributable to smoking, thus leading to higher figures than previously reported. The percentages of population using SFU, which were used as an exposure measure to calculate the present death figures, were published in WHO 2006 and in the WHO Country Profiles of the environmental burden of disease (WHO and UNDP 2009). For global methodological reasons, WHO does not exclude smoking from its more recent statistics on the number of premature deaths due to solid fuel use. However, as noted above, not excluding smoking produces current figures that are higher than some previously published figures. For instance, excluding the number of deaths due to smoking would reduce the number of premature deaths due to chronic obstructive pulmonary disease by approximately 33 percent. Nevertheless, a very high number of premature deaths due to HH solid fuel use would remain.

be as high as two tons per year.[24] Indoor biomass cooking smoke also is associated with a number of diseases, including acute respiratory illnesses, cataracts, heart disease, and even cancer. Women and children in particular are exposed to indoor cooking smoke in the form of small particulates up to 20 times higher than the maximum recommended levels of the World Health Organization.[25] It is estimated that smoke from cooking fuels accounts for nearly 2 million premature deaths annually worldwide[26]—more than the deaths from malaria and tuberculosis combined.

In EAP, the number of deaths that can be attributed to cooking with coal and biomass fuels exceeds 600,000 per year (table 4.1). The Region accounts for approximately 33 percent of the world's deaths attributable to these diseases. Young children are especially vulnerable since they spend much time indoors close to their mothers, including while they are cooking. A meta-analysis of global studies on pneumonia risk in children under 5 years indicated that children exposed to smoke from solid fuels were over 1.8 times more likely to contract pneumonia than children in households who do not use solid fuels.[27] In addition, strong evidence supports the causal linkages between biomass combustion emissions and acute respiratory infection among children.[28] Thus, there also is significant evidence linking indoor air pollution to a variety of health problems prevalent in developing countries.

Biomass fuel often is collected from the local ecosystem, most often by women and children. This time-consuming drudgery diverts time from productive and family activities. Family members spend a considerable amount of their human energy collecting fuel, whether from common village land or farmers' fields. The time spent collecting fuel sometimes can be as high as one hour per day (World Bank 2002). Biomass fuel collection often entails walking long distances carrying heavy headloads and enduring safety hazards. Furthermore, it can lead to a gradual deterioration of the local environment and depletion of biomass supplies, meaning even longer walks and greater drudgery.

24. World Bank 2011a.
25. WHO 2005.
26. WHO and UNDP 2009.
27. Kammen and others 2002; Parikh and others 2001; Smith and others 2004: 1435–94.
28. Dherani and others 2008; Smith and others 2004.

Traditional Cooking Solutions and Poverty

Overall, the use of solid fuel and biomass is closely intertwined with poverty (figure 4.1). EAP countries conform to worldwide patterns in which the percentage of a country's population who use biomass for cooking is significantly related to the level of GDP per capita. Based on the cross-sectional data for 2007, the general pattern is that the use of biomass fuels declines as GDP per capita increases, although at a far slower rate (figure 4.1). The proportion of HH using biomass for cooking declines approximately 0.16 percent for every 1.0 percent of income growth.

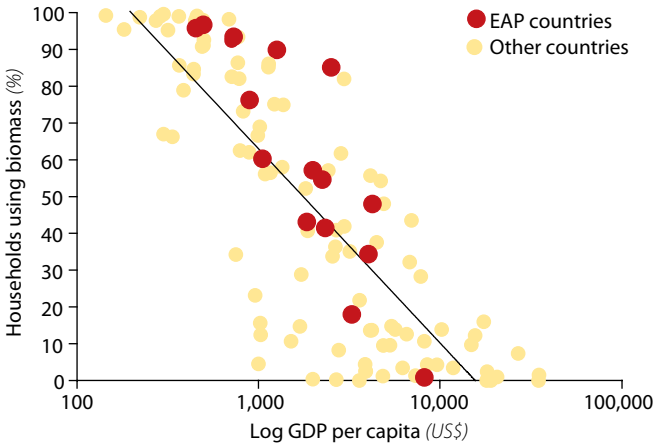
In EAP, the highest percentage of people using modern fuels for cooking is in the relatively higher income urban communities of Indonesia, the Philippines, and Thailand. However, even in Thailand, whose LPG use is the highest in the Region, well over 33 percent of the population use solid fuels such as wood, straw, or charcoal as their main cooking fuels (WHO and UNDP 2009). Perhaps because coal is used for heating and cooking, the countries in the next group are China, Mongolia, and Vietnam. The remaining countries in the Region, which have lower GDP per capita, are heavily dependent on biomass fuels such as wood or agricultural residues for cooking. In this third group, which includes Cambodia, Lao PDR, and Myanmar, 70 percent–90 percent of the people use biomass energy for cooking.

Gender Dimensions of Clean Cooking

Although women have cooked with traditional biomass stoves for millennia, it is only in recent years that the accompanying health risks and work burden, as outlined above, have been fully understood. The past "invisibility" of this issue to policymakers explains, in part, why governments and international organizations previously failed to assign this issue the priority it deserves. Much of the time and energy women spend on domestic tasks remains invisible to policymakers since nonmarket productive work is not counted in economic statistics or national accounts (box 4.1).

At present, in part because women are at the lowest level of paid and unpaid work, women's energy uses often are not considered

Figure 4.1 Household Biomass Energy Use versus GDP per Capita in Developing Countries, 2007



Source: WHO and UNDP 2009.

a priority by policymakers, who are focused on high-profile energy projects. In formulating policies and investment priorities, energy policymakers should take account of women's nonmarket productive work. Clearly, the lives of women—especially poor women—and children stand to benefit significantly from energy programs that take into account the output produced by women and the burdens they bear in the production process. However, it must be acknowledged that the relationship between interventions and changed exposure to cooking smoke is complex. For instance, in China it was found that, in cold climate regions, the type of stove had more of an impact on exposure to pollution than the programs that attempted to change cooking behavior (World Bank 2007a). The conclusion was that, to have an impact on lower exposure to pollution levels, training in fire-tending techniques needs to be coupled with the use of different stoves.

Solutions for reducing the burdens on women from traditional cooking practices are likely to involve smaller, demand-side interventions and investments different from the more visible large-scale energy projects. The strategies for small-scale electricity goods and services such as solar home systems and lamps actually are very similar to those that involve the development and implementation of clean cooking solutions. Depending

Box 4.1 Women's "Invisible" Work

The language used to describe nonmarket productive work has contributed to the invisibility of women's time- and energy-intensive work. For example, cooking is considered "active labor" when cooked food is sold, but "economically inactive labor" when it is not. Similarly, housework is "productive" when performed by a paid domestic servant, but "nonproductive" when no payment is involved. Those who care for children at an orphanage are considered "occupied," while mothers who care for their children at home are "unoccupied." An electric pump that transports water is counted as part of the economy, whereas a woman who carries water is not. A water mill that grinds grain is "economic output," but a woman who performs the same task with mortar and pestle does not count. Trucks that consume fossil fuel to transport crops are considered part of GDP, while women who carry headloads of crops never show up in national accounts.

Source: Cecelski 1995.

on the possibilities within countries, it may be possible to merge these similar agendas to achieve the scale necessary to enable larger and more visible investments.

Status of Cooking Fuel Use in EAP

The widespread use of biomass energy is one reason that the quality of stoves used by households in developing countries is so critical. Approximately 50 percent of people in the East Asia and the Pacific Region use solid fuels—coal, wood, dung, and agricultural residue—as their main cooking fuels (table 4.2). Of these, close to one-half billion people rely on biomass energy for cooking, and for these populations, the collection of biomass is a frequent and very arduous task.

There are significant rural and urban differences in cooking fuel use in EAP. Modern fuels such as LPG and, to a lesser extent, electricity are fairly prevalent in urban areas. Kerosene, coal, and charcoal are transitional fuels because they generally are bought, not self-collected, and are more convenient to use than traditional biomass fuels. As might be expected, the number of people in rural areas cooking with solid fuels is higher than in urban areas. Although the health implications of cooking with these fuels are similar, most of the solid fuels burned in rural areas are not purchased but are collected from the local environment. The traditional fuels, comprising wood, straw, and dung, generally are the predominant type of cooking fuels in most rural areas in the Region (figure 4.2).

The countries that face the greatest challenges in moving to modern cooking systems are Cambodia, Lao PDR, and Mongolia in both urban and rural areas. Indonesia, the Philippines, and Vietnam show a greater use of kerosene and charcoal, but also significant traditional use of biomass and solid fuels in rural areas. Even though its share of traditional fuel use is lower, China has by far the largest absolute number of people who still do not cook with modern fuels such as LPG or electricity.

Despite rapid modernization in the Region, the transition to modern cooking fuels and clean and efficient stoves has been much slower than electrification. The number of people who depend on traditional biomass fuels and coal in the Region is still quite high (figure 4.3). Close to 1 billion people still use solid fuels for cooking and heating. Of these, approximately 40 percent, or approximately 400 million people, mainly in China[29] and Vietnam, use coal. The other 600 million are dependent on wood, straw, or animal dung for cooking. Thus, cooking and/or heating with solid fuels remains pervasive in East Asia and the Pacific.

29. WHO and UNDP 2009; Government of China 2008; Carolina Population Center and NINFS 2008. Numbers provided by industrial and commercial sources may differ from this estimate, which is based on household surveys.

Table 4.2 Population Relying on Traditional and Modern Fuels in Developing Countries, 2007 *(mil)*

Country group	No. of people using solid fuels			People using modern fuels
	Traditional biomass	Coal	Total	LPG, kerosene, gas, electricity
Total developing country	2,564	436	2,999	2,294
Less developed countries	703	12	715	74
East Asia and the Pacific	552	427	986	948

Source: WHO and UNDP 2009; authors' calculations.

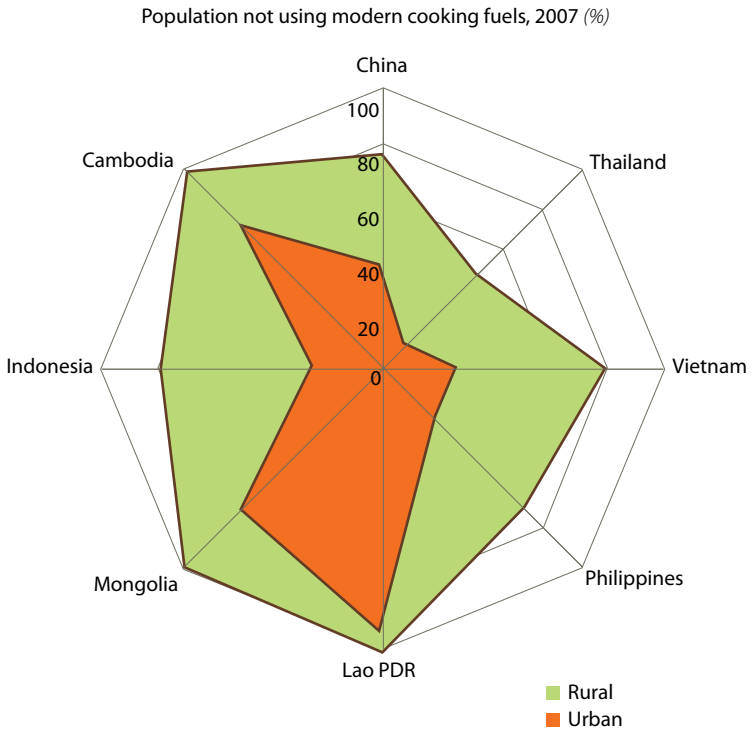
With the exception of China, most other EAP countries have not focused on developing significantly scaled-up programs to propagate clean and efficient cooking. In sum, cooking with solid fuels on traditional stoves appears to be the rule rather than the exception in EAP. Today, promising alternatives to such traditional cooking practices exist (chapter 5).

Households in China and Mongolia use stoves for heating, and these stoves have problems similar to those of cookstoves. Many of the traditional heating stoves burn fuel very inefficiently, leading to higher fuel costs and extensive pollution, especially in periurban areas. Studies conducted in Northern China on the impact of improved stoves on household air pollution showed that new stoves and better ventilation techniques resulted in much higher efficiency and lower emissions than did the old stoves (World Bank 2006a; World Bank 2007a). The new stoves decreased fuel consumption by 30 percent–50 percent. Measurements taken under controlled conditions show a more substantial reduction in concentrations of particulate matter (PM) and carbon monoxide (CO) (13 percent–15 percent). Thus, in the northern provinces of China and in Mongolia, this issue of traditional heating stoves is extremely important and can be addressed in a way similar to the promotion of clean cooking.

Policies to Encourage Clean and Efficient Cooking

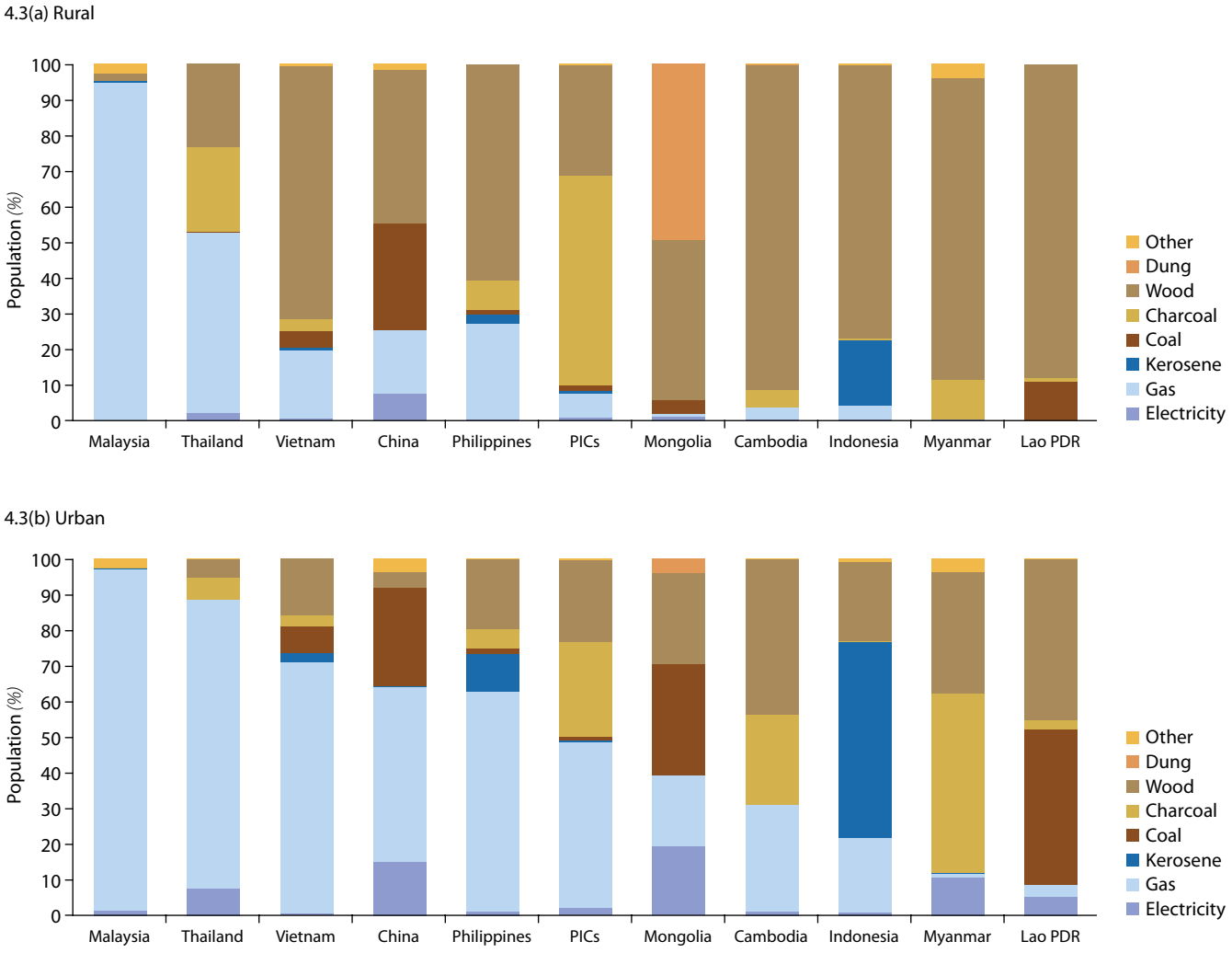
The extent of the adoption of modern fuels depends on three primary factors: (1) level of income, (2) price of the fuels, and (3) physical access to fuels (table 4.3). As their incomes rise, households in developing countries generally switch to LPG fuel and various types of specialized electric cooking appliances (Barnes and others 2005). However, even under optimistic projections of income growth, the use of biomass fuel among developing-country households will continue for years to come (IEA 2010). In

Figure 4.2 Rural-Urban Divide in Use of Modern Cooking Fuels in EAP Countries, 2008



Sources: WHO and UNDP 2009; authors' calculations.

Figure 4.3 Patterns of Cooking Fuel Use in EAP Countries



Source: WHO and UNDP 2009.
Note: The percentages are based on HH surveys conducted primarily 2006–08. Gas included biogas, piped gas, and LPG.

fact, there is evidence that people often switch to better types of cooking only in a partial and gradual manner. For instance, households may use LPG for boiling water and wood for cooking main meals before graduating completely to LPG (Masera and others 2000). Therefore, it is necessary to consider policies and programs that encourage faster adoption of modern fuels or stoves that offer more complete combustion of biomass fuels.

Urban and rural areas in EAP show clear income differences, making it important to tailor the promotion of modern cooking to each area. In urban areas, higher incomes and greater affordability result in greater use of modern fuels, whereas rural areas with lower incomes make greater use of transition or traditional fuels. During the coming decades, as urban incomes grow, the marketing of modern fuels by commercial companies will increase. Some countries such as Thailand already have reached almost universal levels of LPG use in urban areas. In low-income countries, if lower incomes and lower affordability persist even in urban areas, the use of transition

Table 4.3 Overview of Policies That Promote Clean and Efficient Cooking in Urban and Rural Areas

	Income and affordability	Fuel prices and subsidies	Access
Urban	***Overview:*** Higher incomes, good access, and greater affordability mean the higher use of modern fuels by high-income groups, and of transition or traditional fuels by lower income groups.	***Overview:*** All fuels are priced. Taxes and subsidies impact fuel adoption and use. Traditional fuel prices often follow the price of modern fuels so it is important not to tax modern fuels excessively.	***Overview:*** Modern fuels and transition fuels are available. Some countries have set fuel import limits. These generally should be avoided.
	Policies Improve affordability by providing microcredit or loans to lower upfront payments. Applicable grant programs also may be used to lower costs to consumers.	**Policies** *Modern and transition fuels:* Minimize taxes or subsidies. *Traditional fuels:* Prices are set by market but often adjust to price of modern or transition fuels. For this reason, modern or transition fuel taxes increase energy costs of the poor and should be avoided.	**Policies** *LPG:* Partial subsidies for stoves and cylinders. *Kerosene:* Partial subsidies for clean-burning stoves. *Solid fuels:* Technical assistance to develop and market stoves; partial subsidies for improved or advanced stoves.
Rural	***Overview:*** Lower incomes, poor access, and lower affordability mean greater use of transition and traditional fuels. More efficient improved or advanced stoves can lower fuel costs and improve affordability.	***Overview:*** Modern and transition fuels are priced above affordable levels for those with low income.	***Overview:*** Modern and transition fuels often are not distributed in rural areas, but traditional fuels are always available.
	Policies Improve affordability by providing microcredit or loans to lower upfront payments. Applicable grant programs also may be used to lower costs to consumers.	**Policies** *Modern and transition fuels:* Price at level similar to fuel prices in urban markets, perhaps through cross-subsidy mechanism that makes up for higher distribution costs. *Traditional fuels:* Let market set price; encourage local tree planting; and encourage local forest management to increase sustainable supply.	**Policies** *Modern and transition fuels:* Encourage greater distribution of modern and transition fuels and partial subsidies for stoves and/or cylinders. *Traditional and solid fuels:* Provide technical assistance for better stove development and partial subsidies for improved and advanced stoves. *Biogas:* Promote biogas systems to farmers with animals; include partial subsidies.

Sources: Derived from Barnes and others 2005; World Bank 1996; World Bank 2002.
Note: Modern fuels are electricity and any form of gas. Transition fuels are kerosene, coal, and charcoal. Traditional fuels are wood, straw, and dung.

and traditional fuels will continue to be high. In Cambodia, over 40 percent of the urban population still uses traditional fuels. For these reasons, it is appropriate to approach urban and rural energy in different ways when considering programs to promote clean cooking (table 4.3).

Prices: Modern Fuels and Interfuel Substitution

Fuel prices have a very significant impact on energy consumption patterns for cooking. In most rural areas, biomass energy is available from the local environment, and the cost is the labor time used to collect it. Therefore, it is not surprising that low-income HH in rural areas use biomass fuels for a large percentage of their cooking needs.

Petroleum-based fuels for cooking—mainly LPG—are preferred in higher income urban areas because these fuels are convenient and easy to use, even though they are more expensive than biomass fuels. Often no financial help is provided to the poor households because it is assumed that they eventually will catch up and switch to petroleum fuels. However, the cost differentials to do so are quite high. Thus, strong reasons exist for policymakers to seek attractive alternatives that use the same biomass fuels in more efficient and modern ways.

EAP countries have adopted a wide range of policies to tax or subsidize cooking fuels. These policies generally are related to the availability of the relevant natural resources in a country. If a country is required to import a fuel, the tendency is to tax it. If the fuel is produced within the country, subsidies are more likely. Until recently, kerosene subsidies in Indonesia traditionally were very high. As a result, the country stands out in the Region as using kerosene extensively for cooking in both rural and urban areas. The problem with keeping prices high is that the fuel inevitably is purchased and used in other sectors such as transport and industry (von Moltke and others 2003). In contrast, in China, coal is readily available and has a relatively low price. The consequence is that close to 30 percent of people in both urban and rural areas in China use coal as their main cooking fuel. Thus, it is better to have prices that are not significantly higher or lower than international benchmarks. However, in recent years, coal prices have steadily increased and may have encouraged a transition to improved cooking stoves.

Improving Affordability of Modern Cooking Fuels

The access to various cooking fuels often is related to import policies and the affordability of purchasing the stove and fuel. Until the early 1990s, to conserve foreign exchange and to use the readily available and relatively inexpensive coal in the country, China limited the import of LPG. This policy resulted in LPG being rationed informally so that even people who could afford the fuel could not purchase it.[30] Since the early 1990s, as the country opened its LPG market to competition from international investors, China's LPG consumption grew rapidly by an annual rate of 18 percent. At the end of the decade, China had become the world's third largest LPG consumer, following the United States and Japan. Presently, to conserve their foreign exchange for other goods and products, small countries in the Region including Cambodia and Lao PDR have very limited capacity to import cooking fuels. The nature of import policies is one reason that the majority of their populations remains dependent on solid fuels for cooking. The solution to such obstacles is to adopt appropriate cooking fuel import policies and perhaps provide subsidies or loans to the poor to pay the upfront costs of both modern and advanced solid fuel cookstoves.

Likewise, low-income households often cannot afford the upfront cost of an LPG stove even if they can afford to buy the fuel. Furthermore, LPG cylinders often contain a month's supply. Distribution of fuels in large container sizes can make these fuels unaffordable to poor people. Their response is to avoid adopting LPG. Instead, they purchase small amounts of kerosene several times a month. The solution to such obstacles is to adopt suitable cooking fuel import policies, and perhaps provide subsidies or loans to the

30. Tian 2002.

poor to pay the upfront costs of both modern and advanced solid fuel cookstoves.

To achieve both efficiency and equity, it is important for governments to rationalize taxes on modern fuels because the prices of modern fuels effectively set an upper limit for the prices of traditional fuels used by the urban poor (Barnes and others 2005). A tax on modern fuels also drives many middle-class HH to continue their reliance on wood beyond the point at which they otherwise would have switched to cleaner fuels. This tax puts additional pressure on the wood-based biomass resources around cities. Clearly, restrictions or bottlenecks on the distribution of transition fuels such as kerosene should be eliminated. Imports of petroleum products in limited quantities and subsequent subsidies and rationing should be avoided because the poor have difficulties in obtaining ration cards. Moreover, the limited supply means that the fuel has no cap effect on the price of fuelwood. Abandoning targeted subsidies and loosening fuel import restrictions may be needed to clear the bottlenecks or blocks to the adoption of transition fuels (Bacon and others 2010). Transition fuels are comparatively attractive and efficient, so it may be more productive to provide credits to low-income consumers to purchase efficient stoves than to subsidize the fuels purchased by the consumers.

Thailand has one of EAP's most successful programs to promote LPG use and has the highest level of LPG use in the Region. Thailand does have the advantage of being an LPG producer so is able to price the fuel below world market levels. However, the main reason for the success of the LPG program was that the government established an oil price stabilization fund for domestic petroleum prices. This fund was used to provide financing for storage facilities intended to keep the price of LPG in rural areas at levels similar to the price in Bangkok (box 4.2).

To summarize, with the exception of electricity, which is not used extensively for cooking, it will be necessary to work with oil and gas companies to promote LPG or kerosene for cooking. The established best practices for providing access to LPG for the people in the Region and elsewhere are:

- Possibly provide grants for stoves but not for fuel
- Distribute LPG in small bottles and make them widely available at a prorated price similar to LPG in larger bottles
- Devise financial and regulatory incentives to distribution companies to expand LPG markets
- Apply tax policies that do not make LPG or kerosene unaffordable or raise the prices of traditional alternatives such as fuelwood.

Advances in Cookstoves and Biogas Systems

Improved and Advanced Stoves

For rural areas, a major emphasis on marketing and promoting new efficient solid fuel stoves and biogas energy systems is needed. To date, there have been some very successful improved-stoves programs in the Region; in China, people have adopted over 100 million improved cookstoves (Sinton and others 2004; Smith and others 1993). However, even the best of these stoves still have a significant way to go to match the combustion efficiency of modern fuels. Today, manufacturers in China and some other EAP countries have begun producing newer high-efficiency and high-combustion stoves (figure 4.4). For rural areas, it also is possible to promote biogas energy systems for farmers who have animals. Biogas systems can provide clean gas for cooking and have been disseminated with some success in China and Vietnam.

Existing regional cookstove programs in China and Cambodia. While several EAP countries have conducted fairly successful improved stove programs, China's National Improved Stove Program (NISP) stands out as a remarkable success. It was implemented during the 1980s and 1990s by the county rural energy agencies, supported by the Ministry of Agriculture and other entities. The two focal points of this program were energy efficiency and removing indoor smoke through chimneys.

Box 4.2 Promoting LPG Use: Thailand's Successful Approach

The use of liquefied petroleum gas (LPG) for cooking in Thailand began in the mid-1970s. At that time, large petroleum companies such as Shell, Esso, and Caltex began selling LPG for households in Bangkok. LPG sold by these companies was largely a byproduct from their oil refineries in the country and a small amount from imports. However, the use of LPG initially was limited to a small group of higher-income HH in Bangkok. The reason was that LPG distribution was limited to Bangkok, and the price of LPG was very high compared with the prices of the widely available firewood and charcoal. In the early 1980s, the use of LPG gradually spread to upper-middle- and middle-income HH in Bangkok. The government began a series of efforts to promote the use of LPG for cooking by all HH in Bangkok and throughout the country. The price of LPG was set at the cost of production, which included regulated profit margins, rather than at world market prices.

In 1986, to promote the use of LPG among HH who lived in the provincial cities and rural areas, a government decree set a uniform wholesale pricing policy for LPG. The decree stated that wholesale prices at the five large regional storage facilities serving consumers outside the Greater Bangkok Metropolitan Area would be the same as the wholesale price in the Bangkok Metro Area. Using the fuel levy from Thailand's Oil Stabilization Fund, the government subsidizes the costs to transport LPG from the three main LPG storage facilities to regional storage facilities, which also serve as the distribution centers for those regions.

In addition, as part of the effort to promote the entry of new LPG distributors into the country, especially outside the Bangkok Metro Area, the government instructed the state-owned oil company, which owns storage facilities. The state-owned company allows other LPG suppliers/distributors and traders to use the company-owned storage facility free of charge. As a result, the number of LPG suppliers/distributors in the country has increased from 3 to 6.

Although the *amount* of LPG used for cooking has increased by an annual average of approximately 10 percent for the past 25 years, the *share* of LPG used for cooking declined from the peak of 78 percent in 1989 to approximately 50 percent in 2009. This decline was due to two compounding factors: the increasing use of LPG (a) for automobiles and (b) as the feedstock for the petrochemical industry for the past 10 years, caused in part by the low price of LPG in Thailand.

Source: Tuntivate 2010.

Over 100 million NISP improved stoves are still in use in the China. They have resulted in the largest improvement in energy efficiency among EAP countries and perhaps all regions (Smith and Deng 2010). China's experience supplies ample evidence that the development of a program for better stoves can succeed.

The two drawbacks of the NISP stoves are that their combustion efficiency is low and they cannot achieve a very clean burning. Consequently, although smoke was moved outside of the houses through the chimneys, thus resolving some of the indoor air pollution problems, the chimneys did not alleviate the general build-up of pollution levels in the communities.

The National Improved Stove Program ended in the late 1990s. With the exception of grant-funded programs in very poor areas, Chinese government support for commercializing stoves has ceased. Some manufacturers still are producing and selling the legacy stoves. However, more recently, the private sector began selling highly efficient and cleaner burning stove models (box 4.3). In fact, this development can be characterized as the emergence of a new generation of more advanced stoves. They are quite durable and have low emissions and high efficiency. Many of them have received significant consumer testing before being introduced to the public. Presently, advanced biomass stoves are being produced in limited quantities and are

Box 4.3 New Efficient and Cleaner Burning Stoves for China: Scope for Renewed Efforts

In China, with the extensive use of coal for heating in many regions, the market for commercial coal heating stoves is very strong. Each year, China produces approximately 2 million efficient coal stoves. Nevertheless, much larger numbers of such improved coal stoves must be produced soon to serve the nearly 50 million coal-using households in China.

In comparison to China's promotion of improved coal stoves, its promotion of more efficient and cleaner burning biomass stoves has lagged far behind. Most active government support for biomass stove programs has been curtailed. Moreover, the role of the county rural energy units, which actively supported the previous programs, has been assumed by the private sector. Many biomass-using households rely on the cooking technologies developed decades ago and still being disseminated by the private sector.

However, the development and production of new biomass stoves has not kept pace with the dimensions of the challenges to promote clean cooking. Approximately only 180,000 low-emission, high-efficiency biomass stoves are being produced and sold every year in China. Although the production of such stoves has been rising, it will take many years to reach the nearly 130 million households who use biomass as their main cooking fuel. China clearly needs to build on its earlier successful stove programs and undertake more active interventions. Options include developing an innovative new generation of cleaner burning biomass stoves, developing better marketing techniques to promote them, and encouraging the private sector to both market and sell a new generation of more advanced biomass stoves.

Source: Jia 2011.

not sold or promoted widely. The impacts that these stoves could have on both improving health and reducing drudgery could be quite significant for China. The possibility exists that if these new stoves were produced on a larger scale, their costs could be lowered significantly, enabling them to be sold widely in EAP. Already, some of these new advanced biomass stoves are being manufactured in China and exported to many parts of the world.

New possibilities exist to promote improved stoves on a wide scale in the Region. For instance, in Cambodia, GERES, an NGO, is working to convert traditional stove makers into improved stove makers and to turn traditional stove customers into consumers of improved charcoal stoves.[31] The GERES program also is one of the first improved stove programs to participate in the international carbon market. An important achievement of the GERES program has been to set up a viable supply chain for the manufacture and delivery of the New Lao Stove (NLS), while ensuring product quality and service (box 4.4).

While, in the past, there have been problems in implementing improved stove programs in EAP and around the world, there also have been successful instances from which to draw

Figure 4.4 Testing New Generation of Stoves in China

Photograph: Ashden Awards.

31. Groupe Energies Renouvelables, Environnement et Solidarités.

Box 4.4 Setting up a Supply Chain for New Lao Charcoal Stoves in Cambodia

Since 1994, GERES (Groupe Energies Renouvelables, Environnement et Solidarités), an NGO, has been working in Cambodia to develop energy-efficient solutions designed to conserve the environment and improve the living conditions of the Cambodian population. In 1999 GERES stimulated the introduction of the New Lao Stove (NLS), supported by trainers from Thailand, where it was being marketed under the name, "Thai Bucket." The technical design of the NLS is an updraft combustion stove with a grate. After training a group of existing cookstove producers, Lao PDR began the initial comparative tests against the competing traditional model known as the Traditional Lao Stove. The New Lao Stove is a charcoal stove, but similar stoves are manufactured by international firms specializing in wood stove development and sales.

The more innovative aspect of the GERES effort is the successful institutional model for selling the stoves, rather than the design of the stove itself. One challenge that emerged during project implementation was the large number of decentralized production units. Having approximately 31 scattered production centers made it difficult to control the quality of the stove. GERES addressed this challenge by consolidating the scattered production centers to five centralized facilities. Next, the NGO set up a local supply chain, selected a trial area, and trained producers to produce stoves first for this area, and then for the country. The entire supply chain has the extensive participation of women, who are managing retail shops and promoting stoves.

Box figure 4.4.1 Cooking with New Lao Stove

Photograph: www.geres-cambodia.org/

From 2003 to 2010, the sales of the NLS in Cambodia totaled 1 million units, well ahead of projections. According to the manufacturer, compared with traditional stoves, the New Lao Stove can save a considerable quantity of charcoal. Due to its proven ability to reduce CO_2 emissions, in 2006 GERES Cambodia was the first project developer in the world to put forward an improved cookstove project to trade on the carbon market. The price of the stove is US$2–$4.

Sources: www.geres.eu; World Bank 2011.

lessons. Furthermore, the outlook for improved stoves is encouraging as new varieties of stoves are developed and new alliances are formed to break through the barriers to wide dissemination. Expanding such efforts would greatly benefit the Region.

Biogas Systems, Gasification, and LPG: Encourage Commercialization and Marketing

The use of biogas systems for cooking is based on methane gas that can be used in a manner similar to LPG. The biogas system is a small niche technology that can transform biomass into clean-burning gas for modern cooking. The technology is well proven, although the use of biogas is limited to farmers who have two or more farm animals. In addition to new varieties of cookstoves, smaller niche cooking technologies such as biogas systems can play significant roles in improving cooking practices (REN21 2010). The introduction of biogas for cooking has been a slow but steady process in developing countries, in part because the manure feedstock limits the market for household biogas systems to animal owners.

However, after roughly 25 years of design experimentation, the technology is entering a new phase. China now has some 25 million biogas systems, with an estimated 3 million added

Box 4.5 Biogas Energy and Carbon Financing in the World Bank's Hubei Eco-Farming Project, China

The Government of China sees biogas use as a means to improve the lives of rural households and address global and local environmental issues. For these reasons, in 2001 the country launched a large National Rural Biogas Program. To date, investments total more than RMB 3 billion (approximately US$375 million). This program has resulted in 7.2 million rural households in China cooking with biogas.

Recently, a World-Bank-funded Eco-Farming Project was initiated to complement the government's efforts and support further expansion of the rural biogas program. The project is located primarily in the region of Hubei, a rural mountainous district in China whose main economic activity is agriculture. Households in this region are being given the opportunity to install biogas digesters that use animal waste to generate gas for use in domestic heating, lighting, and cooking. Under the Carbon Development Mechanism (CDM) component of the project, more than 33,000 households—or approximately 165,000 people—are benefitting from the installation of domestic digesters, which are displacing more carbon-intensive traditional domestic fuels such as firewood, coal, coke, and crop residues.

The Eco-Farming Project also assists farmer households to integrate biogas in their agricultural production systems to improve their environmental impact, quality, and efficiency; and to improve the households' living conditions. For the sustainable operation and maintenance (O&M) of the biogas systems, the project will (1) strengthen rural energy and agricultural extension services as well as local extension and training facilities, and (2) provide equipment and materials for the service systems; training for counties, townships, farmer technicians, and farmers; and support to farmer biogas organizations.

In addition, the project illustrates how the CDM mechanism can be leveraged effectively through biogas applications to:

- Reduce the time spent by women collecting firewood or travelling to purchase fuel
- Significantly reduce the amount of household income spent on fuel
- Improve indoor air quality in homes due to the smoke-free combustion of biogas compared to traditional fuels
- Enhance sanitation services by improving swine manure handling techniques, as well as providing a connected latrine for households.

Sources: UNFCC 2010; World Bank 2008c.

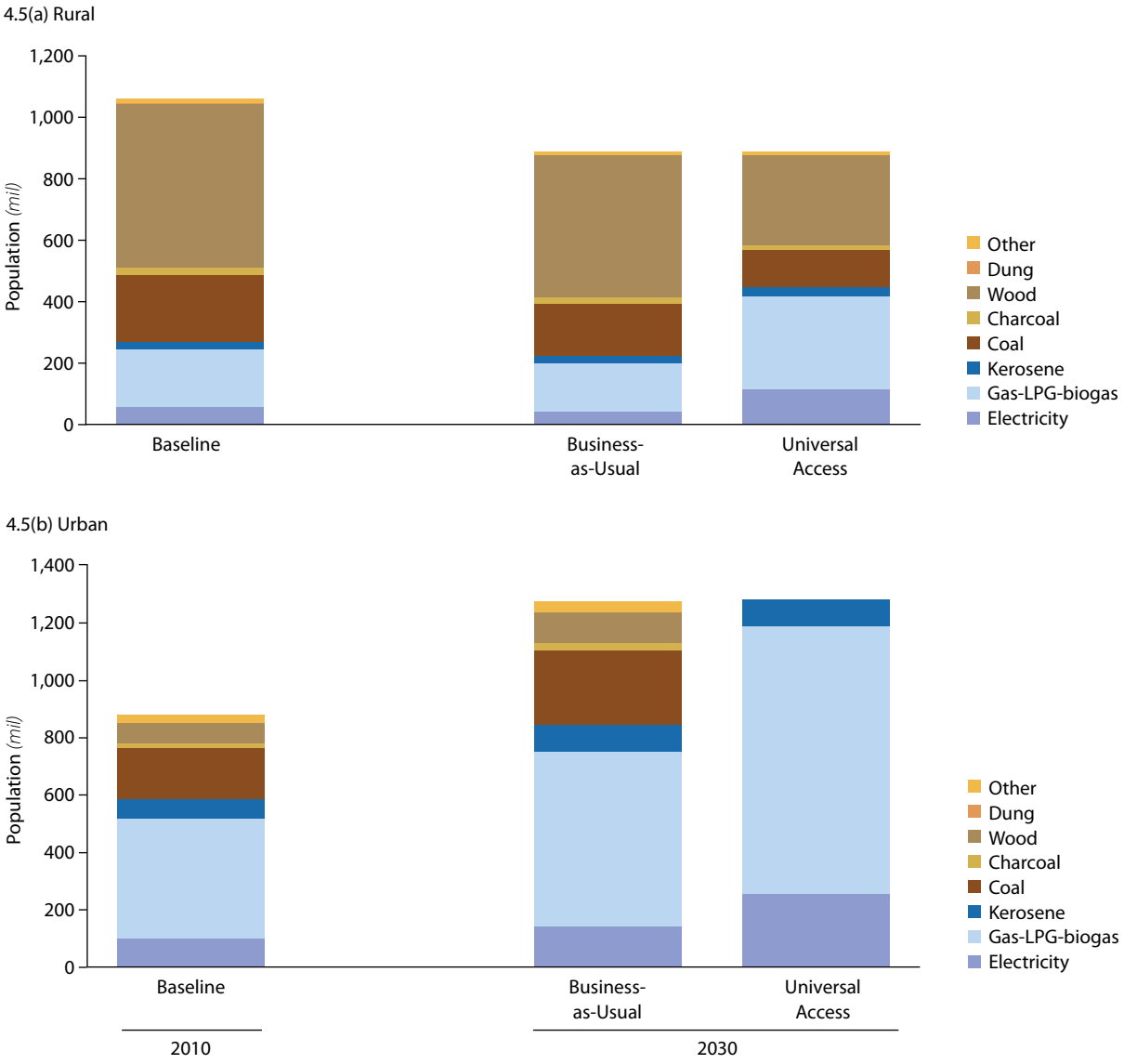
during 2009 (REN21 2010) (box 4.5). Vietnam has more than 150,000 systems. Outside EAP, Nepal's Biogas Support Program combines the participation of the private sector, microfinance organizations, community groups, and NGOs. During the last decade, this program steadily has increased biogas systems: close to 200,000 systems have been implemented.

The use of LPG has been expanding rapidly in China, Thailand, Vietnam, and other countries in the Region. Continuing the incentives to use LPG is a wise policy. Large companies are not likely to be interested in promoting LPG in rural areas due to the costs of extending the supply network and the relatively low incomes and affordability on the part of rural consumers. Consequently, there is a strong need for the government to provide incentives for expanding the availability and use of LPG through appropriate policy interventions.

Two Scenarios for Modern Cooking Solutions

Due to increasing urbanization, by 2030 over 50 percent of the EAP population will reside in urban areas. This report has developed two scenarios for both urban and rural areas that predict fuel use for 2030 based on the changes in

Figure 4.5 Baseline (2010) and Projected (2030) Cooking Fuel Use in EAP



Sources: WHO and UNDP 2009; UN-DESA 2008; authors' calculations.

population and rural-urban population patterns. These scenarios closely resemble those for electricity but are more complicated due to the complex relationship between income growth and interfuel substitution. The first scenario is relatively conservative and involves interfuel substitution caused mainly by urbanization. The second scenario is for near-universal access to clean cooking fuels, and involves significant increases in the rural use of LPG, biogas energy, and better cookstoves. The following sections define these scenarios more precisely. (See also figure 4.5.)

Business-as-Usual Scenario

The Business-as-Usual scenario for clean cooking involves no growth in the percentage of EAP households using modern fuels (mainly LPG and electricity) in urban or rural areas. However, due to increasing urbanization, the absolute number of people using modern fuels will increase.

Under this scenario, by 2030 rural areas still will have 665 million people who use solid fuels for cooking. Of these, 460 million still will depend on wood straw or dung. In contrast, in urban areas, only 100 million people still will be using traditional fuels and 250 million using coal for cooking, for a total of 350 million people who will not be using modern fuels.

Universal Access Scenario

For the Universal Access scenario, this report assumes that by 2030 the entire population in EAP urban areas will be using modern fuels (electricity, LPG, or kerosene). However, rural populations will make only a partial switch to modern fuels due to lower incomes and the lack of availability of modern fuels. Overall, compared to the Business-as-Usual scenario, under Universal Access, by 2030 an estimated additional 435 million urban households will be using modern energy. Moreover, and importantly, the rural population using traditional fuels will have adopted clean and efficient stoves. For rural areas, compared to the Business-as-Usual scenario, Universal Access assumes approximately 20 percent growth in the use of modern fuels. Universal Access also assumes that 300 million rural HH still will be using traditional fuels, and over 130 million still will be cooking with charcoal or coal by 2030.

According to these scenarios, two quite different types of challenges exist. The urban areas will gain population so must develop the requisite energy infrastructure, mainly through the types of energy that are provided through large commercial networks. This energy includes electricity, LPG, and kerosene. In contrast, in rural areas, some growth of cooking with LPG and kerosene is expected. However, it also will be necessary to address the problems arising from the use of solid fuels as the main cooking sources (table 1.4). This challenge will be to address the issue of clean cooking in both urban and rural areas with related but somewhat different strategies.

Urban challenges. The main challenges in urban areas will be to develop the commercial fuel infrastructure to serve approximately 230 million new customers under the Business-as-Usual scenario and 430 million new customers under the Universal Access scenario by 2030. These challenges will require significant levels of increased electricity generation as well as investments in developing importing and processing facilities for gas and LPG. These investments could generate new market opportunities for commercial development of these fuels. However, expanding decentralized market infrastructure is much more difficult than serving large customers. For some of the smaller countries, foreign exchange may be a constraint. Finally, to achieve their energy access goals, many countries in the Region may have to consider reforming their pricing and related policies regarding modern fuels.

Rural challenges. Difficulties are even more pronounced in reaching out to rural customers in remote areas. The comparatively low population densities of rural areas means that commercial fuel companies often do not wish to serve in such areas due to high costs, low-income consumers, and the relatively low number of new consumers. However, even more challenging will be the development of BoP models to market and introduce large numbers of improved solid fuel stoves in rural areas. To scale up, governments must address six fundamental issues (World Bank 2011a):

1. Few countries have national institutions/agencies to promote cookstove programs.
2. Stove models suitable for BoP populations have been developed and continue to evolve, but these models have not yet been disseminated on a large scale.
3. Existing loan funds administered by financial groups generally are not used to finance clean and efficient biomass stoves.
4. No well-accepted standards, or even quasi-standards, exist to qualify the stoves as safe, durable, efficient, and clean burning.
5. Support for the technical development of clean and efficient stoves is limited.
6. Most petroleum fuel companies in the Region lack incentives to provide access to such fuels as LPG in rural areas.

If they are to achieve universal access to clean and efficient cooking in the next 2 decades, EAP countries must address these 2 challenges of achieving a high level of commercial fuel marketing and scaling up the use of better solid fuel stoves.

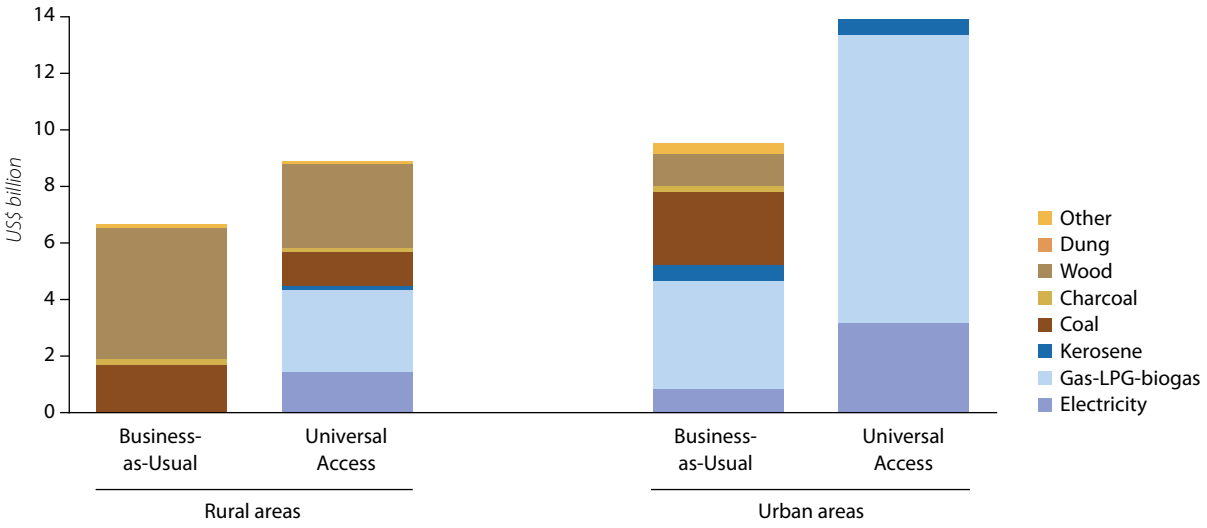
Financing Requirements for Clean Cooking

The investment projections under the 2 scenarios are based on the projected population growth from 2010 to 2030. The Business-as-Usual scenario assumes that interfuel substitution will occur passively, primarily from urbanization. In contrast, the Universal Access scenario assumes that governments will make significant shifts in policies to actively encourage better cooking practices. The financing for these scenarios will come mainly from the households who purchase the cooking fuels. However, some government interventions may be required to promote this transition to more modern cooking methods. For both the urban and the rural scenarios, the costs of the cooking practices are assumed to be similar. Thus, the differences between urban and rural areas will be the different types of fuels and the different numbers of people according to the population projections.

Even though it is recognized that a stove will not last 20 years, the costs are based on the cost of only the first stove that a household buys because it is difficult to estimate the number of stoves that a household will need over 20 years. The assumed prices are US$100 for modern fuel stoves (such as LPG stoves) and US$50 for high-quality solid fuel stoves. The investments necessary for LPG do not include the associated new storage or distribution costs required to enable retailers to sell the fuel to the urban poor or those in rural areas. Thus, these investment figures are approximations that are intended primarily to indicate the minimum investments necessary to promote a clean cooking agenda. The modern fuel stove investments are intended only for the incremental stoves being purchased by new users who are part of rapid urbanization.

The total investment costs of the Business-as-Usual scenario are an estimated $16 billion (figure 4.6). In rural areas, the total would be approximately $6.6 billion, including $4.6 billion for wood stoves and $1.7 billion for coal stoves. In urban areas, the cost of the stoves would total $9.5 billion, including $1 billion for wood stoves, $2.5 billion for coal stoves, and $4.4 billion for modern fuel stoves. Under the

Figure 4.6 Investment Needs for Modern Cookstoves under Business-as-Usual and Universal Access Scenarios by Cooking Fuel



Sources: WHO and UNDP 2009; authors' calculations.

Universal Access scenario, the required investments rise from $16 billion to $22 billion. The additional investments (above the Business-as-Usual scenario) for urban areas by 2030 would be $4 billion; and for rural areas, $2 billion. Promoting the modern fuel stove would cost approximately $4 billion dollars.

Given the potential benefits, these are not excessively large investment amounts, Most of these expenses will be borne by household consumers. However, to move from the Business-as-Usual scenario to the Universal Access scenario will require both innovations in the way that the problem is perceived by policymakers and technical innovations in the way that household energy services are delivered to consumers. It is obvious that new investments are required to move from the Business-as-Usual to the Universal Access scenario for EAP households.

Implementation Requirements

Efforts to improve access to modern fuels require cooperation and coordination among multiple sectors: rural, forests, environmental, social, and financial. The deployment of improved cookstoves is a logistically challenging exercise that requires coordinating appropriate technology and designs, distribution channels, financing mechanisms, and service support. As part of overall Regional energy plans, the problems associated with the high number of people cooking with solid fuels in the Region need to be more actively addressed.

Similar to the electricity sector, for modern fuels, large government or private commercial enterprises already exist that deal with modern fuels such as kerosene or LPG. However, these enterprises generally lack sufficient incentives to extend their market reach to the poor in urban areas and to rural areas in which population densities and commercial markets are less desirable. Thus, countries that have lagged in expanding the use of modern fuels should put in place incentives to encourage firms to reach out to the people who still use solid fuels with traditional means of cooking.

To develop better solid fuel stoves, there would have to be a period of technical assistance for market and technical stove development. It would be followed by a period in which government would encourage improved stove adoption through partial subsidies or microcredit loans for the stoves themselves. Assuming a commercial approach to the promotion of clean cooking, governments generally need to focus on the ways to promote market development for interventions that are clean, efficient, safe, and reliable. It is likely that such promotional efforts would require high levels of TA and specialized institutions to deal with the problem. In addition, for such small interventions, generally the private sector, NGOs, and microfinance organizations would have to market and promote the stoves, so a period of support would be necessary to strengthen the capacity of these organizations to undertake such activities.