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COOKSTOVES AND OBSTACLES TO TECHNOLOGY ADOPTION BY THE POOR

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Mark Thurber is Assistant Director for Research at the Program on Energy and Sustainable Development. Dr. Thurber's research interests include how institutional factors affect the diffusion of technologies—both large-scale, infrastructure-intensive ones such as for central electricity generation or carbon capture and storage (CCS) as well as small, highly-distributed ones such as improved cookstoves or generators for the very poor. He also focuses on the strategy and performance relative to competitors of firms that have both connections to government and a broadly commercial character, which include some national oil companies. Dr. Thurber is currently engaged in detailed studies of the national oil companies of Norway and Nigeria.

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Cookstoves and Obstacles to Technology Adoption by the Poor

Xander Slaski and Mark Thurber

Despite the potentially huge health benefits[1] of programs to disseminate improved cookstoves in the developing world, such programs have struggled to make an impact over several decades of effort.[2] The entrance of commercial players into the cookstove space in recent years has the potential to bring innovative and hard-headed thinking to the question of how to scale cookstove adoption.[3] Entrepreneurship in supplying cookstoves meshes nicely with the idea that serving the urgent needs of the millions at the "bottom of the pyramid" can be profitable (and thus sustainable and scalable) as well.[4]

At the same time, if new cookstove business models (whether purely for-profit or not) are to be successful, they must take into account a critical and often-overlooked fact: not all "bottom of the pyramid products" are created equal. Some are very readily adopted by the poor—examples include Coca-Cola and cell phones. Other products, like cookstoves, present many more obstacles that must be overcome for successful dissemination. We suggest that there are three principal dimensions affecting adoption of any radically new product or service by the poor: motivation, affordability, and level of engagement required. We describe the role of these different factors in the form of a stylized decision tree in Figure 1.

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[1] See Luke Naeher et al, 2007, "Woodsmoke Health Effects: A Review," *Inhalation Toxicology* 19, 67–106. Also see the extensive body of research on the health effects of indoor air pollution from Professor Kirk Smith, UC Berkeley.

[2] Progress has been slow since cookstoves were introduced in the early 1980s. Programs that distributed more than 10,000 stoves are the exception, and the one major success has been China's national program with more than 100 million stoves disseminated. For a detailed examination of the China case see Kirk R. Smith et al., 1993, "One Million Improved Cookstoves in China: How Was it Done?" *World Development* Vol. 21 No. 6. Meanwhile, the IEA predicts that the number of people reliant on biomass as their primary energy source will increase from 2.5 billion in 2008 to 2.7 billion in 2030. See *2008 World Energy Outlook*, International Energy Agency.

[3] While there have been small-scale entrepreneurs in the cookstove business for some time, only recently have major international corporations entered the business. Salient examples include BP (which has sold operations to First Energy India), EnviroFit (partnering with the Shell Foundation), Philips, and Siemens.

[4] C. K. Prahalad, 2004, *The Fortune at the Bottom of the Pyramid: Eliminating Poverty Through Profits* (Philadelphia: Wharton School Publishing).

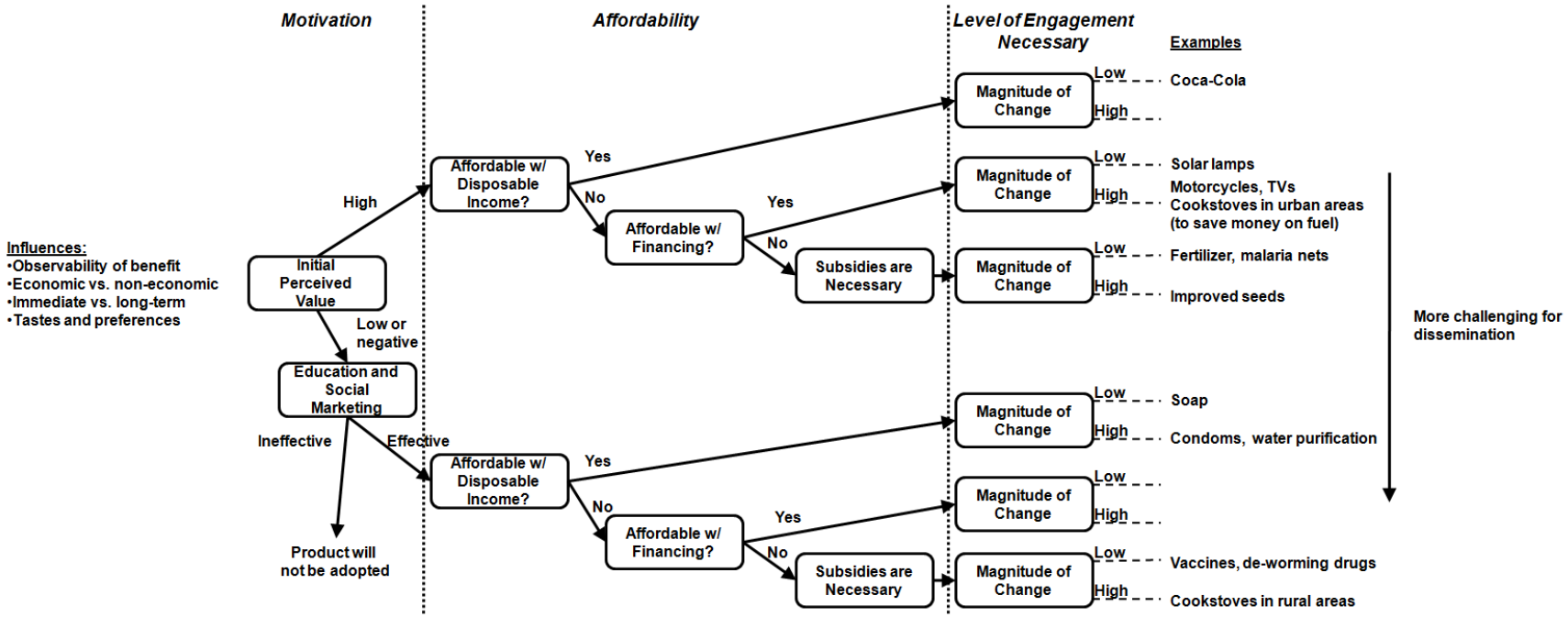

Figure 1. A stylized decision tree describing challenges to adoption of new technologies for the poor. Key obstacles are low motivation, low affordability, and high required user engagement. On the right of the diagram, we suggest some example products or services with different combinations of these characteristics; as one moves down the list of examples, dissemination becomes more difficult because more obstacles are in play.

The first and most important determinant of adoption of a new technology is inherent motivation, which is connected with the perceived value of the new product or service. Cookstove programs are most successful when the cookstove is seen by prospective customers to provide concrete and observable benefits. In urban areas, where fuelwood is often purchased, users are motivated by stoves that save money. [5] In rural areas where fuel is scarce or in refugee camps, people similarly see the value of fuel-saving stoves, which help reduce long or dangerous trips to collect wood. The value that outside observers usually see as paramount—the improvement of health through elimination of indoor air pollution—rarely ranks highly in the calculus of purchasers.[6] Education about this benefit has for the most part been ineffective; even when informed about health benefits, users do not seem to value them highly enough to overcome preferences for traditional cooking methods.[7] What have worked better are efforts that actually create and market new perceived value associated with the stove. A stove could be seen, for example, as contributing to a cleaner kitchen, adding new cooking functionality, or providing a status symbol associated with modernity. (Note that these other forms of value may hold more appeal to those who are already living above a subsistence level, pointing to the inherent challenge of dissemination to the very poor.) The commercial players who will be most successful in the cookstove space are those who are most innovative in creating these kinds of observable value for their customers.

Motivated customers will overcome many obstacles to purchase a product, but real barriers can still remain, the most important of which is affordability. Some products can be sold in small volumes to bring them within the reach of the poor, but this strategy is not applicable to

[5] See Doug Barnes et al., 2005, *The Urban Household Energy Transition* (Washington, DC: Resources for the Future Press).

[6] Doug Barnes et al., 1994, "What Makes People Cook with Improved Biomass Stoves? A Comparative International Review of Stove Programs," World Bank Technical Paper #242. Successful programs have focused on saving fuel, particularly where fuel is purchased or collecting fuel is a substantial burden. For example, the most successful improved stove program to date, the Chinese national program, focused on fuel savings rather than decreased emissions.

[7] See YL Jin et al., 2005, "Knowledge of Hazards from Indoor Air Pollution from Household Energy Use in Rural China," Partnership for Clean Indoor Air. The study offers data on knowledge of IAP in China. While no doubt there are geographic variations worldwide, in rural China knowledge of IAP was approximately 60%, indicating that most people were aware that indoor air pollution was a health hazard. See also Enis Baris, 2007, "Household Energy, Indoor Air Pollution and Health: A multi-sectoral Intervention Program in Rural China," Energy Sector Management Assistance Program, World Bank. The study concludes that education is largely ineffective in convincing users of traditional stoves to switch to improved stoves.

cookstoves. For most low-income consumers, stoves are simply not affordable with disposable income. Stoves can be made affordable to some with financing, especially in urban areas or anywhere where fuelwood is purchased.[8] However, people at the absolute bottom of the pyramid—those living on less than $1 or $2 per day—will not be able to afford a stove even with financing.[9] In such cases, subsidies are necessary. The challenge is to ensure that such subsidies do not destroy nascent markets and are targeted as effectively as possible to the very poorest. Other cases—for example, mosquito nets to prevent malaria—have demonstrated that subsidies can be effective in encouraging widespread uptake of a product when motivation exists.[10] [11] [12] [13] On the other hand, various studies have shown that subsidized stoves turn into little more than scrap if target customers do not value the product to begin with.[14]

A final barrier to adoption of a new technology by the poor can be the magnitude of the change entailed. Public health interventions such as vaccinations demonstrate that education plus subsidies can yield results at scale.[15] However, the level of user engagement required in receiving a vaccination is fundamentally different from that needed to change one's approach to cooking. Cooking touches on an entire lifestyle, which can include gathering wood (an activity

[8] Wood use is approximately four times higher in rural areas and overwhelmingly more likely to be collected rather than purchased. See Narasimha D. Rao, 2009, "*Service Reliability and Household Energy Choices,"* presentation at Stanford University.

[9] While estimates (and cutoffs for poverty differ), World Bank Development Indicators estimate that 2.6 billion people live on less than $2 per day. See *World Development Report 2007/2008*. Additionally, 75% of the world's poor are in rural areas—precisely the areas where fuelwood is likely to be collected rather than purchased.

[10] Surveys indicate that malaria nets distributed at no cost are almost all used as intended by the target audience. See Helen Guyatt et al., 2003, "Use of bednets given free to pregnant women in Kenya" *Lancet* 362, 1549–50. The same is not true of cookstoves, which are frequently rejected when offered at no cost. Nets seem to be most valued for improving sleep, protecting from bothersome bites.

[11] O. Onwujekwe et al., 2005, "Increasing coverage of insecticide-treated nets in rural Nigeria: implications of consumer knowledge, preferences and expenditures for malaria prevention," *Malaria Journal* 4:29, 1475-2875.

[12] See J. A. Alaii, 2003, "Factors affecting use of permethrin-treated bed nets during a randomized controlled trial in western Kenya," *The American Journal of Tropical Medicine and Hygiene* 68 (4 Suppl), 137–141.

[13] See K. Ahorlu, 1997, "Malaria-related beliefs and behaviour in southern Ghana: implications for treatment, prevention and control," *Tropical Medicine and International Health* Vol. 2 No. 5, 488–499.

[14] A particularly famous example is the Indian national stove program, examined in greater depth in Doug Barnes et al., 1994, "What Makes People Cook with Improved Biomass Stoves? A Comparative International Review of Stove Programs," World Bank Technical Paper #242. However, there are numerous anecdotal accounts of failed stoves programs where the key factor was lack of user motivation, indicating that many consumers simply do not want stoves. A forthcoming paper by Grant Miller of Stanford University finds that 31% of a community in Bangladesh rejects improved cookstoves offered at no cost.

[15] For an examination of de-worming drugs and a major public health intervention in Kenya, see Edward Miguel et al., 2004, "Worms: Identifying Impacts on Education and Health in the Presence of Treatment Externalities*,"* *Econometrica* Vol. 72 No. 1, 159–217.

with a strong social component) as well as cooking (an activity heavily influenced by tradition). Changes in lifestyle may bring significant benefits—the ability to replace wood gathering with productive economic activities, for example—but they are not undertaken lightly.[16] In addition, products like improved cookstoves that are more complicated than traditional technologies may require training and ongoing correct use to reap their benefits. Once again, even extremely complicated products with significant associated lifestyle changes may be successfully adopted by the poor where significant inherent motivation exists. Motorcycles and electricity are examples among the somewhat higher income groups. Where such motivation is lacking, however, the spread of products requiring significant user engagement and change will be doomed from the start.

What has made rural cookstove programs particularly difficult is that they face all three of the challenges described above. They are expensive, imply a significant change in user habits, and, worst of all, are usually not highly valued by potential users at the offset. For entrepreneurs to fully succeed in the cookstove space, they will need to be creative in addressing all three of these obstacles, not to mention the generic but nonetheless very difficult challenges of developing cost-effective supply chains to remote rural areas. Most important of all are efforts to create compelling perceived value for consumers which goes beyond outsiders' perceptions of the value that should already exist, such as for health. Because of the significance of the lifestyle change presented by a change in cooking methods, deep motivation on the part of consumers is required. Skilful design can be a key part of making the stoves as easy to use, robust, and highly valued as possible. The extent to which companies can profitably provide stoves to the poorest of the poor will then depend on how creatively they can apply tools of financing where possible and make subsidies available where necessary through partnerships with governments and NGOs.

[16] Fuelwood collection times vary widely and are highly dependent on the local biomass resource. In areas with abundant fuelwood, collection times may be insignificant. In areas where an excessive population has strained local resources—refugee camps being the salient example—it may require upwards of half the day to collect biomass. Anecdotally, 2 or 3 hours a day is not uncommon.