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Research Project

Low-cost energy technologies for Universal Access

EXECUTIVE SUMMARY:

Preliminary candidate list of appropriate technologies, business models and enabling environment for Universal Access to Modern Heat

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Executive Summary

This document catalogs appropriate technologies, business models and enabling environment for universal access to modern heat, focusing on domestic water heating and cooking. It is one of the three working papers for a Phase I research project on Universal Energy Access funded by the ENEL Foundation. The overall goal for the project is to develop a set of strategic options to assist policy makers in developing countries in their efforts to provide universal access to electricity and modern heat. At the same time, the work will inform global businesses about possible pathways to universal access appropriate to different countries and regions, and thus about the opportunities for them to participate. As a first step, we have researched various appropriate technologies, which are described in detail in this document (WP2-modern heat) and in Working Paper 1 (WP1-electricity). We have also investigated business practices that have been adopted around the world for dissemination of these technologies, as well as successful regulatory, governance and financing frameworks. In this document, in addition to describing our findings related to modern heat, we include a brief discussion of promising future technologies not yet ready for commercial deployment.

1. COOKING

Although the International Energy Agency (IEA) considers electricity as the most critical energy carrier for development, the sheer number of people relying on traditional biomass for cooking is nearly two times the people without electricity access. Under business-as-usual scenario, the number is projected to rise from 2.7 billion today to 2.8 billion in 2030. Lack of access to clean and affordable modern cooking fuels has a direct impact on health and social well being of a person. The IEA estimates that household air pollution from the use of biomass in inefficient stoves leads to over 1.9 million premature deaths per year.

In this project, a multi-tiered framework developed by the World Bank along with ESMAP under the Sustainable Energy for All (SE4all) initiative is taken as a baseline consideration, where Tier 0 is a selfmade cookstove using biomass and Tier 5 is Biogas-LPG-Electricity-Natural gas (BLEN) cookstoves. In between are the transition stages towards universal access by using advanced cookstoves with solid or liquid fuels with various degrees of conformity, convenience and adequacy (CCA). It is important to measure the CCA factor along with the technical performance of a cooking solution to obtain a comprehensive measure of access. Conformity is measured by the use of chimney/hood, and maintenance/cleanliness of stove; convenience is measured by household time spend on fuel collection/preparation (<12 hrs/week), stove preparation (<15 min/meal) and ease of cooking being satisfactory; adequacy is obtained when the primary stove fulfills most cooking needs of the household, and it is not constrained by availability of fuel, cultural fit or number of burners. Among 2.7 billion people using biomass for cooking, many of them still use traditional three-stone fire, which is highly inefficient and polluting. Moving the entire population to adopt BLEN cookstove would be economically as well as logistically impractical. Therefore there are various intermediary technologies that will have to be considered for universal access. Advanced cookstove is among the first. These modern cookstoves burning biomass are designed to be more efficient than traditional three-stone fire. Few stove designs such as GERES' bucket stove, and MWOTO gasifier stove have been successfully implemented around the world. The major drawback for such advanced cookstove has been the lack of accepted standards and certifying institutions to qualify the stoves as safe, durable and efficient products. Many products in the market are not well designed and there is very little quality control.

Another clean burning cookstove is a solar cooker that utilizes renewable resources. This is a widely used technology in more than 114 countries. With the daily solar irradiance in the range of 4-7 kWh/m_2, most of the countries in Africa and south Asia can utilize solar cookers to meet their daily cooking demand.

The biggest drawback for the technology is the convenience issue where early morning and late afternoon traditional cooking times do not coincide with the availability of solar energy.

Thus, advanced technologies in thermal storage are critical for the acceptance of the solar cooker as the ultimate cooking solution.
Modern cooking fuels such as liquefied petroleum gas (LPG), biofuels, and Dimethyl Ether (DME) are the ultimate clean solution for household cooking. Adoption of such modern fuels and stoves will depend mainly on income level, regulatory pricing policy (subsidy), physical access to fuel (supply chain) and cultural preference. In urban areas, LPG is the commercially viable choice of many; however in rural areas, the issues of affordability, refill cost, and supply chain have hampered the distribution.
During technical and economical assessment for universal access, later in the project, the environmental impact will also be considered. Especially for biomass use, the environmental impact is critical due to issues such as deforestation, land quality, air quality etc. Operational lifetime of a technology will be considered for the impact evaluation. Attributes such as CO_2, and black carbon emissions will be used as optimizing parameters in the overall assessment model.
Privately funded business models are hard to find in ventures involving universal access, primarily due to low return margins and high default risk. Most technology dissemination has been through government, non-profit, non-governmental organization (NGO), or cooperative models. However, operational challenges and bureaucracies hinder progress, scalability and quality of products. Public private partnerships are increasingly becoming a common choice where just one entity cannot handle all the issues, and also it is the means of addressing salient issues and sharing risks.

2. WATER HEATING

Water heating is one of the major applications within residential energy consumption. Electric and natural gas water heaters are the most common heaters used in countries such as United States, Japan, and Germany. Due to high equipment and maintenance cost, and unavailability of electricity/natural gas, these water-heating options are not widely used in developing countries. In most rural parts, biomass burning is the easiest way of heating water. Where available, electricity is used in the urban sector for water heating.
Solar water heater is potentially a low-cost option for residential as well as commercial use that can provide modern energy access with no added fuel cost. China has the largest solar water heater cumulated capacity in operation (~118GW_{th}). High penetration rates in countries such as China, Israel and Cyprus can be attributed to successful regulatory frameworks and energy policies. For example, both China and Israel have solar obligations in place since 80's that require new buildings to have solar energy provide a minimum share of the heating demand. China developed the technology along with an integrated domestic supply chain that allowed it to be the largest manufacturer in the world; 90% of which is to provide for its domestic demand. Much time was devoted by the public sector to raise awareness among end customers and finance sector early on to promote the technology and help with financing. Similar strategies can be applied in other countries for successful dissemination of this technology.

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