ENERGY UPDATE

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Powering Economic and Social Development through Expanded Access to Modern Energy Services

## SPECIAL REPORT: "FUELING HEALTH SOLUTIONS: THE ENERGY-HEALTH NEXUS"

### Energy for Improved Health Care Service Delivery



### Energy for Clean Water and Better Health



### Energy, Air Pollution, and Disease



## NOTES FROM THE FIELD



**ENERGY UPDATE**

Is the bimonthly newsletter of the Energy Team, Office of Infrastructure and Engineering, Bureau for Economic Growth, Agriculture and Trade (USAID/EGAT/I&E/Energy Team).

**IN THE NEXT ISSUE**

**"Transformational Development: Lessons from the Energy Transition in Europe and Eurasia"**

**SUBMIT ARTICLES**

Initial submissions must be 500 words or less in length and include contact information.

**The submission deadline is March 23rd, 2007.** Please e-mail your articles to the Editor, Davida Wood (dwood@usaid.gov).

Articles are accepted for publication from employees of USAID, associated organizations, contractors, and other partners in development.

**LETTER FROM THE GUEST EDITOR**

This issue of Energy Update examines relationships between energy and health. To many observers, especially those based in headquarters, the links between these sectors may seem remote. But those in the field soon learn differently. Too often implementation plans run awry as ambitious health delivery programs run up against the poor infrastructure of developing countries. And many energy experts are unaware of the potential health benefits of energy interventions. This issue aims to try and bridge the knowledge "gap," by highlighting some of the efforts being undertaken by USAID and its partners. The articles have been written by experts from both the health and energy fields, to ensure that viewpoints of both sectors are represented.

Two main groups of articles highlight the energy-health nexus. The first focuses on interventions in which energy is an enabler of health outcomes. Several articles in this group look at the impact of electricity (or lack thereof) on the ability of health providers to provide essential services, and the need to incorporate energy considerations into health program design. Heather D'Agnes and Patricia Stephenson of USAID's Global Health Bureau, and John Pittman, of the Center for Disease Control in Atlanta, lay the foundation by identifying critical electricity needs of healthcare providers. These include maintaining the cold chain for blood, vaccines, lab reagents, and other drugs; powering lab and diagnostic equipment; providing lighting so doctors, nurses, and midwives can see what they're doing; and enabling the use of office equipment and electronic communications devices. Recent efforts by the USAID energy team to address some of these issues are highlighted in an excerpt of a recent Energy Team publication entitled "Powering Health," and an article looking at efforts to strengthen the PEPFAR programs in Guyana and Rwanda.

A subset of articles addresses the links between energy, water, and health, examining efforts to provide clean drinking water to rural populations. Affordability and sustainability of any intervention are always critical issues, and Robert Russo provides a case study of how a hospital energy efficiency project in Bulgaria resulted in lower secondary infection rates as well as increased operating revenues for the facility.

The other group of articles examines cases in which energy use directly contributes to health problems, and what can be done to mitigate the negative health impacts. John Borrazzo of USAID's Global Health Bureau examines recent research into the links between household energy use, indoor air pollution, and respiratory disease. His article is followed by a case study of an integrated energy conservation/indoor air pollution-reduction project in Peru, which combines micro-enterprise development, technology transfer, and social marketing to create a sustainable model for other USAID programs. The impact of energy use on ambient air pollution is addressed in two articles from the US Environmental Protection Agency, which has been helping African countries build their capacity to monitor and reduce harmful emissions from fuel combustion and vehicle use.

We hope that this issue promotes further dialogue and partnership between the energy and health sectors.

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# FUELING HEALTH SOLUTIONS: THE ENERGY-HEALTH NEXUS

## Energy for Improved Health Care Service Delivery

### The View from Maternal Health

Those of us in the international health field recognize the direct links between the work we do and the energy needs that our work demands. However, rarely do we think about strategically addressing those needs and ensuring that our energy demands are met in a technically sound and appropriate manner. Recently, a small group of health professionals in maternal and reproductive health met to identify areas in which the lack of reliable energy supply limits the reach of particular health interventions. As we looked at this list, we realized that quite a bit of work remains to be done to educate health professionals about the importance of making wise investments in energy activities in order to deliver health services effectively and efficiently. Here are just a few of the issues we uncovered.

***Cold Chain Issues***: Cold chain issues exist across the health sector. The cold chain for storage of immunizations often cannot be used for cold storage of HIV test kits or for medicines. Not only is this a matter of policy (policies can be flexible), but it is often a matter of capacity and location vis-à-vis service delivery sites. Consider the example of postpartum hemorrhage. Postpartum hemorrhage is the number one killer of women in childbirth and accounts for more maternal deaths than any other cause. However, there is a simple and effective intervention to prevent it called Active Management of the Third Stage of Labor (AMTSL). AMTSL includes an injection of oxytocin immediately after the birth of the baby. Use of AMTSL has been severely hampered by the fact that oxytocin needs to be refrigerated for long-term storage. In warm weather conditions the product can deteriorate quickly. Health professionals can deliver and store this in capital cities and in regional and even district hospitals when refrigeration is available. However, these are not the places where most births occur. Women who deliver in or near rural clinics are generally the ones to suffer, as these clinics rarely have electricity to operate a refrigerator.

***Basic lighting for clinical purposes***: Good lighting is required for in-clinic sites that offer gynecological examinations, long acting and permanent methods of contraception such as IUD insertion and vasectomy, and cervical cancer screening. Good lighting is especially important in clinical sites that offer safe motherhood and newborn services since many deliveries occur at night.

***Powering data collection tools***: Health and population data from country-wide health surveys such as the Demographic Health Survey (DHS) have traditionally been collected via paper and pencil. With cheaper costs for computers and mobile technology, new data collection tools such as handheld PDAs and laptops are being introduced to reduce the time and cost of collecting these large-scale population-based surveys. Survey collectors, however, spend days out in rural areas without any access to electricity supply to recharge their equipment. In order to save data and continue the collection process, surveyors need mobile solutions to energy generation to recharge and power their data collection devices.

Often, health professionals will make hasty investments when investing in energy systems without much consideration of the specifics of their energy needs. Moreover, health professionals rarely think of the training needs of those health providers who will need to maintain and manage alternative energy sources to ensure longer shelf life and sustainability of the energy source.

There is a clear need for more education and guidance for the health sector as it moves toward investing in more dependable energy sources for health services and products in developing countries. We will need clear, concise information on what products to invest in for the developing country context, specifications on energy efficient products we should be buying to outfit health centers and laboratories, and assistance in training partners to maintain the equipment.

For more information, contact Heather D'Agnes (hdagnes@usaid.gov), and Patricia Stephenson (pstephenson@usaid.gov), USAID/Bureau for Global Health.

## Energy and Health: Fatal Consequences

***Maintaining Blood Safety***

The 17 year old girl had been bleeding for four days when she arrived at the Sacré-Cœur hospital in the small town of Milot, on Haiti's northern coast. She had recently seen a local healer for pregnancy-related care, but the treatment had damaged her reproductive organs. She arrived at the hospital bleeding, infected, and in need of a transfusion to replace the blood she had lost. Doctors sent a courier to the blood bank in nearby Cap Haitien, a large city some 15 kilometers from Milot. Hours passed. The girl continued to bleed. Twenty-four hours after arriving at the hospital, she died.

The blood never arrived.

A subsequent investigation determined that the Cap Haitien blood bank had been unable to store any blood during this period due to a lack of electricity to power the cold chain. The refrigerators in the blood bank normally operated on a meager diet of electrical current from the local electricity grid (2-6 hours per day), generator power, and propane. However, during the period in which the girl died, a perfect storm of grid failures, lack of generator maintenance and inadequate propane supplies left the refrigerators quiet and empty.

The importance of stable and reliable electricity for blood banks cannot be overstated. "If blood transfusions are going to be part of the standard of care in developing countries, we have to think about ways to leverage cost-effective technologies to ensure the cold chain," says Dr. Malhi Cho, a blood transfusion specialist and consultant with the Pan American Health Organization in Haiti.

Dr. Lawrence Marum, the blood safety team lead at the Centers for Disease Control and Prevention's Global AIDS Program, agrees. "To ensure safe and timely transfusions a country needs a willing population of voluntary, low risk blood donors, effective laboratories to screen the blood, and a distribution system that maintains the blood under cold chain conditions from donor to recipient. Electric power for refrigeration is a critical element throughout this chain."

To address this need, the Haitian National Blood Transfusion Service is now investigating alternative energy options, including solar power and generator-fed inverter/battery systems for the national network of blood banks.

***Refrigeration is a critical element in maintaining blood safety for transfusions and other procedures.***

For more information, contact John Pitman (cgx5@cdc.gov), ATA Services, contractor to the CDC Global AIDS Program, and Dr. Ernst Noel, acting director, Haitian National Blood Transfusion Service, Port-au-Prince, Haiti.

## Partnering with PEPFAR

The President's Emergency Plan for AIDS Relief (PEPFAR) was launched by the US government in 2003 and targets 15 focus countries which are among the most severely affected by the HIV/AIDS pandemic. Collectively, they are home to approximately half of the world's 39 million HIV-positive people and to almost 8 million children orphaned or made vulnerable by HIV/AIDS. They also share another daunting commonality – a majority of the population in nearly all of the focus countries lack access to modern energy services. In 6 of the 15 target countries electrification rates are estimated to be below 10% while a total of 292 million people lack electricity in the PEPFAR countries (see Table 1 on the following page).

The EGAT/I&E/Energy Team has recently launched a program to provide technical support to PEPFAR programs finding lack of reliable energy services a barrier to achieving their programmatic objectives. This program is designed to help PEPFAR programs integrate energy issues into their overall planning, in order to ensure provision of energy services at priority health facilities in the most cost-effective and sustainable manner possible.

**Table 1: Electricity Coverage in PEPFAR Focus Countries**

| PEPFAR Focus Country | Electrification rate (%) | Population Without Electricity (millions) | Population with Electricity (millions) |
|---|---|---|---|
| Ethiopia | 2.6 | 67.2 | 1.8 |
| Uganda | 4 | 24 | 1 |
| Mozambique | 8.7 | 16.9 | 1.6 |
| Kenya | 9.1 | 28.7 | 2.9 |
| Tanzania | 9.2 | 33 | 3.3 |
| Zambia | 18.4 | 8.7 | 2 |
| Botswana | 26.4 | 1.3 | 0.5 |
| Haiti | 33.5 | 5.5 | 2.8 |
| Namibia | 34.7 | 1.3 | 0.7 |
| Nigeria | 44.9 | 66.6 | 54.3 |
| Cote d'Ivoire | 50.7 | 8.1 | 8.3 |
| South Africa | 67.1 | 14.7 | 30 |
| Vietnam | 79.6 | 16.3 | 63.9 |
| Guyana ** | NA | NA | NA |
| Rwanda* | 6 | NA | NA |
| **Total** | | **292.3** | **173.1** |

*Source: World Energy Outlook 2004*

** Rwanda data from the World Bank, http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2005/01/07/000112742_20050107100715/Rendered/INDEX/30253.txt*

*** Data not available for Guyana*

The USAID/EGAT/I&E/Energy Team has recently completed an assessment of options for improving energy services at key health facilities in Guyana and has been assisting the PEPFAR program in Rwanda with its ongoing efforts to electrify district hospitals and rural health centers across the country.

### Guyana

The acquisition of reliable and affordable power poses a challenge to nearly every health facility in Guyana. Grid-connected regional hospitals located on the coast suffer from expensive, unreliable, and poor quality power while health clinics in the interior often rely on a variety of expensive, intermittent and poor quality energy sources or have no electricity at all. At the request of the PEPFAR program in Guyana and the Guyana Ministry of Health, the USAID/EGAT/I&E/Energy Team led a two week assessment trip in December 2006 to evaluate options for addressing these energy challenges.

The assessment team recommended a wide range of options to address the energy needs of Guyana's diverse set of health care facilities. Many non-renewable energy investments – such as uninterrupted power supplies (UPS), power conditioning systems, and backup generators--should be top priority to address the power quality and reliability issues of the large grid-connected facilities along the coast. District hospitals located in the interior are more likely to require investments in solar/diesel hybrid systems.

The Mahdia Regional Hospital, for example, receives power from a quasi grid from 6pm – 6am, runs a generator from 10 a.m. – 2 p.m., and has a solar panel to power a vaccine refrigerator. The quasi-grid and generator are currently delivering low voltage power which has damaged laboratory equipment, lighting, and dental equipment. This poor quality power is not cheap -- the hospital pays over $3.00 per kWh – 10 times the cost of electricity in the capital city of Georgetown and 30 times the cost of power in Washington, DC!

The assessment team found that Guyana had a poor track record concerning the sustainability of previous health facility solar electrification programs. Thirteen of 21 solar systems installed between 1982 and 2004 were inoperable, due to theft, improper training of local staff, poor system design, and lack of maintenance. The sustainability of any future solar electrification efforts requires that training, maintenance protocols, and design standards be a central component of the investment.

***Unreliable supply of electricity is the #1 problem at the Mahdia Regional Hospital in Guyana.***

Based on the EGAT/I&E/Energy Team's assessment, the Guyana PEPFAR program and Minister of Health are currently considering site-specific recommendations to: 1) install solar or solar/diesel hybrid systems to provide power to interior hospitals; 2) institute design standards and maintenance protocols for all future health facility solar installations; 3) purchase power-conditioning systems to reduce equipment damage from poor quality grid power; 4) install uninterrupted power supply systems to mitigate service disruption resulting from daily power outages; and 5) review plans for new infrastructure to ensure energy efficient measures, such as natural lighting and cooling, are incorporated.

**Rwanda**

The electricity grid in Rwanda reaches an estimated 6% of the population, mostly in and around the capital. Facilities that are not connected to the grid must generate their own power or go without. The grid itself is also unreliable, as problems with the central generation and transmission systems have led to frequent black-outs over the past few years. It is not uncommon for health facilities to lose power for periods of 4-48 hours.

PEPFAR partners in Rwanda are currently working in over 70 facilities, including district hospitals, rural health centers, blood banks, and pharmacies. Some of the partners have begun installing distributed (on-site) energy generation technology in the facilities at which they work, and at least two have received supplemental funds to purchase solar systems. However, none of the implementing partners have in-house energy expertise, impeding their ability to review energy system designs, create standard specifications for vendors, and ensure that the energy systems are maintained and operating properly. Local private-sector capacity to provide energy services, meanwhile, is also weak. And until now, there has been no mechanism through which partners could share information with one another or discuss lessons learned.

To help overcome these obstacles, the USAID/EGAT/I&E/Energy Team is working with USAID/Rwanda, the Center for Disease Control (CDC)/Rwanda, and Rwandan authorities to develop guidelines to help PEPFAR partners sustainably upgrade energy infrastructure in health facilities.

Following an assessment mission in January 2007, the EGAT/I&E/Energy Team and its consultants are currently in the process of developing energy equipment specifications for different categories of health facilities, and also plan to provide training to partner staff on how to maintain the equipment. Such training is vital, as the implementing partners report approximately 40% of their energy systems are not functioning.

USAID is also consulting with the World Bank/Global Environmental Facility (GEF), the Clinton Foundation, and other donors regarding how to improve the institutional capacity of the private sector to supply, install, and maintain energy equipment, especially solar equipment.

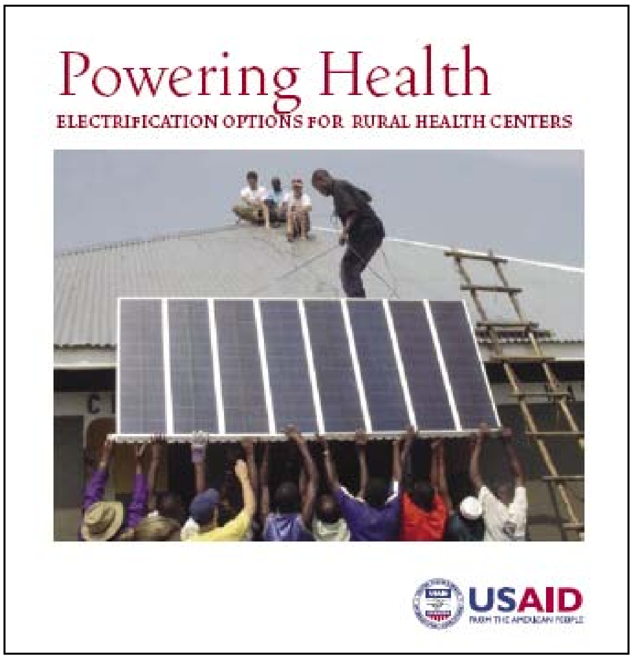
***Patients await treatment at the Bungwe Health Clinic in Rwanda.***

The specifications, guidelines, and training developed for Rwanda should be applicable to other PEPFAR programs, particularly those in sub-Saharan Africa. The Energy Team will work to share these products with the other programs, and address other needs as requested.

For more information, contact Jeffrey Haeni (jhaeni@usaid.gov), and Pamela Baldinger (pbaldinger@usaid.gov), USAID/EGAT/I&E/Energy Team.

## Powering Health: Electrification Options for Rural Health Centers

***Editor's Note****: This article is an excerpt from the USAID Energy Team's new publication, Powering Health. The publication is a resource for health professionals seeking to electrify health facilities that currently lack power or to ensure uninterrupted power for facilities that are connected to an unreliable power grid. Information is provided to help the user weigh the pros and cons of various energy systems, with a focus on appropriate solutions and special considerations for off-grid rural hospitals and health centers. The entire text can be downloaded from the USAID website at* *www.usaid.gov/our_work/economic_growth_and_trade/energy/publications/poweringhealth.pdf*




### Categorization of Health Clinics

The following section describes several types of health facilities. The energy demands of a health facility will be a critical component in the selection of the most appropriate electrification technology. Please note: these descriptions are provided as general comparative guidelines and are not precise descriptions of any one facility.

*Health Posts*

Health posts are the smallest, most basic health facility. These locations typically will not have a permanent doctor or nurse on staff. The health post may have a full- or part-time primary healthcare provider. Services available at health posts include the treatment of minor illnesses, the tending of minor injuries and, where possible, the provision of basic immunization services. Due to the limited medical equipment used, the overall energy demand of health posts is relatively low. The energy demands of a health post will be satisfied through Category I Health Clinic electrification options, while taking into account the reduced daily demand for energy.

*Health Clinics*

Health clinics are generally larger than health posts and employ one or more full-time nurses. Clinics may also employ a part-time physician, depending on the size and location. A health clinic offers a wider array of services than a health post and will possess equipment allowing for more sophisticated diagnoses. Rural health clinics generally fall into one of three categories (Categories I, II and III), based on the type and number of medical devices used in the facility and the frequency with which they are used on a daily basis. Local resources may make specific energy options more or less advantageous in each location.

Other types of health facilities that require reliable and sustainable electrification include blood banks, stand-alone laboratories and pharmacies, and anti-retroviral treatment (ARV) clinics. Blood banks, stand-alone labs, and pharmacies will, depending on their size, utilize equipment similar to that found in Category I or II Health Clinics and will have similar energy needs. ARV clinics will have significant energy demands similar to those found in a Category III Health Clinic or higher. Energy requirements could be intensive for some ARV clinics due to the computer technology and additional equipment required to perform rapid blood analyses.

### Options for Meeting Health Clinic Needs

On the following page, a table titled "Health Clinic Energy Needs" illustrates the estimated cost of various energy technologies for a range of clinic sizes. In general, renewable energy options (e.g., photovoltaic (PV) system) will have higher capital costs than diesel or other fuel-based electricity generating options. However, over the long-term, renewable systems will have lower operating costs and produce fewer or no emissions. In renewable energy systems, battery maintenance, occasional cleaning, and theft-prevention will be the major recurring costs. A hybrid system using an alternative energy source (e.g., PV system) and a traditional generator (e.g., diesel) may have a higher up-front capital cost than a renewable-only system; however, hybrid systems provide greater exibility, including the ability for one system to support the other. For illustrative purposes, a PV/diesel hybrid is included in the table. Actual prices in a given location may vary considerably from those used in Table 1. The PV system design should also factor in local conditions, including climate variations (e.g. dryness, humidity).

**Category I Health Clinic (low energy requirements, 5 – 10 kWh/day)**

- **Typically located in a remote setting with limited services and a small staff**
- **Approximately 0 – 60 beds**
- **Electric power is required for:**
    - **lighting the facility during evening hours and to support limited surgical procedures (e.g. suturing)**
    - **maintaining the cold chain for vaccines, blood, and other medical supplies – one or two refrigerators may be used**
    - **utilizing basic lab equipment – a centrifuge, hematology mixer, microscope, incubator, and hand-powered aspirator**

**Category II Health Clinic (moderate energy requirements, 10 – 20 kWh/day)**

- **Approximately 60 – 120 beds**
- **Medical equipment similar to Category I Health Clinic; frequency of use and number of devices are key factors of differentiation between Category I and II health clinics**
- **Separate refrigerators may be used for food storage and cold chain**
- **Communication device, such as a radio, may be utilized**
- **May accommodate more sophisticated diagnostic medical equipment and perform more complex surgical procedures**

**Category III Health Clinic (high energy requirements, 20 – 30 kWh/day)**

- **Approximately 120 beds or more**
- **May serve as a regional referral center and coordinate communication between several smaller facilities and hospitals in large cities**
- **May need to communicate with remote health centers and hospitals by way of telephone, fax, computer, and Internet**
- **May contain sophisticated diagnostic devices (x-ray machine, CD4 counters, blood typing equipment, etc.) requiring additional power**

## Table I: Health Clinic Energy Needs

| 5kWh/DAY | | | | |
|---|---|---|---|---|
| **Technology** | **System Size** | **Capital ($)** | **Operating ($/year)** | **O&M Assumptions** |
| Solar Photovoltaic (PV) System with Batteries | 1200 W panels<br>20 kWh batteries | $12,000 system<br>$2,000 batteries | $500 | 1% of system cost per year (includes maintenance and component replacement, does not include security); Amortized cost of replacing the batteries every  ve years (20% of battery cost). |
| Wind Turbines with Batteries | 1,750 W turbine<br>20 kWh batteries | $10,000 system<br>$2,000 batteries | $600 | 2% of system cost per year; Amortized cost of replacing the batteries every  ve years. |
| Diesel Engine Generator | 2.5 kW | $2,000 | $1,400 | $0.0075/kWh maintenance, $0.67/kWh fuel ($1/liter for fuel is used), operating at 4kWh per day at 50% capacity, and replacement of engine every 10 years. |
| Hybrid Systems | 1,200 W panels<br>10 kWh batteries<br>500 W engine | $12,000 PV system<br>$1,000 batteries<br>$500 generator | $450 | 1% of PV system cost per year; battery replacement every  ve years; 200 hours of engine operation per year; replacement of engine every ten years. |
| Grid Extension | n/a | $10,000+ per mile | $200 | $0.10/kWh power. |
| **15kWh/DAY** | | | | |
| **Technology** | **System Size** | **Capital ($)** | **Operating ($/year)** | **O&M Assumptions** |
| Solar Photovoltaic (PV) System with Batteries | 3,600 W panels<br>60 kWh batteries | $36,000 system<br>$6,000 batteries | $1,550 | Same as above. |
| Wind Turbines with Batteries | 5,250 W turbine<br>20 kWh batteries | $28,000 system<br>$6,000 batteries | $1,750 | Same as above. |
| Diesel Engine Generator | 2.5 kW | $2,000 | $3,900 | Same as above, operating at 15 kWh at 50% capacity. |
| Hybrid Systems | 3,500 W panels<br>30 kWh batteries<br>1.5 kW engine | $35,000 PV system<br>$3,000 batteries<br>$1,000 generator | $1,350 | Same as above, with 200 hours of engine operation per year. |
| Grid Extension | n/a | $10,000+ per mile | $550 | Same as above. |
| **25kWh/DAY** | | | | |
| **Technology** | **System Size** | **Capital ($)** | **Operating ($/year)** | **O&M Assumptions** |
| Solar Photovoltaic (PV) System with Batteries | 6,000 W panels 100 kWh batteries | $55,000 system<br>$10,000 batteries | $2,550 | Same as above. |
| Wind Turbines with Batteries | 8,750 W turbine<br>100 kWh batteries | $44,000 system<br>$10,000 batteries | $2,900 | Same as above. |
| Diesel Engine Generator | 2.5 kW | $2,000 | $6,400 | Same as above, operating at 15 kWh per day at 67% capacity. |
| Hybrid Systems | 6,000 W panels<br>50 kWh batteries<br>2.5 kW engine | $55,000 PV system<br>$5,000 batteries<br>$2,000 generator | $2,200 | Same as above, with 200 hours of engine operation per year. |
| Grid Extension | n/a | $10,000+ per mile | $900 | Same as above. |

## Energy Efficiency in Hospitals

Under the Europe and Eurasia Bureau's program on Energy Efficiency in Central and Eastern Europe and the Baltics from 1996-2002, USAID funded 16 hospital energy efficiency projects in 5 countries—Bulgaria, the Czech Republic, Lithuania, Hungary, and Serbia. All were funded by grants except for three of the Bulgaria projects, which were financed by commercial loans to municipalities under Development Credit Authority (DCA) guarantees. The projects focused on upgrading heating, ventilation, and energy management control systems, as well as lighting, windows, water heating equipment, and combined heat and power (cogeneration) systems. The average project cost was $140,000, and average project payback was 2.9 years. While the primary focus of the projects was to demonstrate energy and financial savings to local officials, the projects also yielded important health benefits. A case study of one such project in Bulgaria follows.

### *Gabrovo, Bulgaria: Energy Investments, Health Benefits*

This project demonstrated to local mayors and hospital administrators the financial and health benefits possible through energy savings. The success of the project led to further energy efficiency investments by the hospital, and similar projects in the municipalities of Plovdiv, Stara Zagora and Varna. While the USAID team expected to see some direct health impacts since the heat recovery unit was installed to serve the surgery rooms, we were surprised to see the impacts beyond the actual surgery rooms – specifically, patients experienced lower rates of secondary infections (due to improved ventilation) and lower need for antibiotics to fight such infections.

*Technical Design:* The USAID project team worked with local energy engineering contractors in Bulgaria to collect baseline data, conduct an energy audit, design and specify the equipment, and procure and install the goods. The team found many opportunities to reduce thermal loss in the buildings, to reduce boiler plant losses, and to improve the ventilation system. The specific energy conservation measures sealed the building envelope, improved the heating system, and included an innovative heat recovery system.

Heat recovery had not been widely used in Bulgaria, and the Semco energy recovery system installed was the first heat recovery installation in a Bulgarian hospital and one of the first in Eastern European hospitals. Prior to installing the heat recovery system, the hospital could only obtain fresh air by exhausting heated air and bringing in fresh outside air – which then needed to be heated. So, with the system installed, we were able to recover the heat from exhaust air (in effect only exhausting the air contaminants), and reuse the heat so as to avoid burning fuel to heat incoming air.

*Financial Benefits*: The hospital energy efficiency project also introduced an innovative shared savings financing approach to Bulgaria. During the project implementation stage, the project team worked with the municipality and the hospital to establish a memorandum of understanding to share the savings – 70% of the savings would be retained by the hospital and 30% of the savings would go to the municipality and be used exclusively to finance other energy efficiency projects in Gabrovo. This financial component of the project was essential to the feasibility and the replicability of the project.

*Results*: Performance monitoring throughout the heating season confirmed the expected energy savings: a 20% reduction in the hospital's heating costs (or total savings of about $94/day), with a simple payback of 3.8 years. Due to the heat recovery system, which maintained very good air quality standards in the surgery rooms, the hospital reported a significant reduction in secondary infection rates, which in turn led to shorter hospital stays, thereby lowering health care costs. Thanks to this project, the hospital was able to use its savings from reduced energy purchases to buy medicine and equipment, to implement other energy efficiency projects, and to pay off its debt to the municipality. The municipality of Gabrovo was very impressed with the results and decided to use its share of the savings to finance additional energy efficiency projects. In an unanticipated indirect effect, the hospital director who was the project counterpart was subsequently elected mayor. Several other municipalities later implemented similar projects using the shared savings approach.

For more information, contact: Ira Birnbaum, (ibirnbaum@usaid.gov), USAID/Bureau for Europe & Eurasia, and Robert Russo, (rvrusso@enconservices.com), EnCon Services International.

## Energy, Clean Water, and Health

Poor water quality poses a major threat to human health in developing countries and water-borne illnesses are often a leading cause of childhood mortality. According to a 2004 World Health Organization (WHO) study, diarrheal diseases alone are responsible for the deaths of 1.8 million people every year, with 88% of the cases attributed to unsafe water supply, sanitation and hygiene (see reference 1). It is estimated that diarrhea accounts for 11% of all deaths in the poorest 20% of all countries. Improvements in water supply, sanitation facilities, and hygiene practices can result in a 65% reduction in deaths from diarrhea.

A variety of techniques for the treatment of household water is used in different parts of the world. Two of them, solar disinfection and boiling, rely on energy resources to purify water.

***Solar energy can prove an effective method for disinfecting drinking water. Credit: SODIS***

**Solar Disinfection**

Solar disinfection (SODIS) uses solar energy in the form of ultraviolet radiation and infrared heat to disinfect contaminated drinking water. Water to be treated for drinking is placed horizontally in transparent glass or plastic containers and exposed to full sunlight for about six hours.

Field investigations of the effectiveness of SODIS have been carried out on three continents. Bacteria are consistently destroyed upon exposure to sunlight for an adequate amount of time, but the duration of exposure required depends on the intensity of sunlight (which in turn depends on altitude, latitude, season, time of day, and cloud and/or pollution cover), the type of bacteria, the characteristics of the container (color, size, shape, thickness, transparency to sunlight, and orientation to sun), and depth and clarity of the water.

SODIS is simple, inexpensive, and provides good quality water and does not lead to the destruction of trees or other natural resources. SODIS is not without its limitations, however. SODIS does not remove chemical contaminants in drinking water, if any exist, and it does not change the taste or the odor of source water. So if these qualities are unacceptable in the source water, exposure to sunlight will not improve them.

**Boiling to Purify Water**

Health professionals often recommend boiling as a simple and effective method for making safe drinking water. Boiling water for at least 1 minute will kill any harmful parasites, bacteria, or viruses present in the water. In theory, the boiling of drinking water seems to be a rational and simple decision.

Cultural beliefs and preferences, however, can discourage drinking boiled water: in some cultures boiled water is considered appropriate only for the sick, and people often dislike the flat taste of boiled water.

Also, growing worldwide fuel shortages point to the need to examine the issue more closely. Can fuel scarce communities afford to boil drinking water? Some studies have shown that when collectible fuel is limited, the cost of boiling drinking water may be too expensive for the poor.

***Fuel scarcity can inhibit communities from boiling drinking water.***

A village study in Bangladesh (see reference 1), for example, categorized family income and determined household fuel consumption. Families in the lowest income categories spent approximately 22% of their yearly income on fuel, compared to 10% for those in the highest income bracket. Boiling of drinking-water would result in an 11% increase in the household budget for families in the lowest income categories compared with a 3% increase for families with high incomes (see reference 2).

With rising energy costs, the economic feasibility of boiling water compared to other water supply or treatment options must be considered by energy and health planners before recommending that village families boil their drinking-water.

For more information, contact Dan Campbell (CampbellDB@cdm.com), USAID Environmental Health webpage editor, and Rochelle Rainey (rrainey@usaid.gov), USAID/Bureau for Global Health.

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1.http://www.who.int/water_sanitation_health/diseases/burden/en/index.html

2."Boiling of drinking water: can a fuel-scarce community afford it?" RH Gilman and P. Skillicorn, WHO Bulletin 63 (1), pages 157-163, 1985.

## Power for Water

In Uganda, diarrheal diseases are responsible for 17% of deaths for children under 5 and account for 30,000 deaths per year in all age groups (see reference 1). In addition, families spend countless hours each day transporting water from source to point-of-use locations. In the conflict-affected regions in the North, the daily trek to get water increases the vulnerability of women to attack.

Recently, the USAID Energy Team partnered with the Coca-Cola Company, Geneva Global Foundation, Solar Lights for Africa, and Global Environmental and Technology Foundation (GETF) to implement an innovative program utilizing renewable energy to provide power to two hospitals in Uganda and clean water supply to the facilities and surrounding communities.

At the Kalungi Hospital, a 2.6 kW solar array was installed at a well site several kilometers away from the hospital. This array powers a direct submersible pump which pumps the water up a hill to a holding tank at the hospital. A pipeline runs back down the hill with spigots in several locations to provide clean water to the community. Purification of the water is completed in several stages. From the 12 m deep well a water passage was constructed which pre-filters water through two chambers. A UV water purification unit completes the purification process.

***School children from the Kalungi community gather clean water.***

In addition to the public health benefits, the water system offers an opportunity to improve the sustainability of the solar systems. Solar systems in developing countries often fail, in part, because of difficulty obtaining maintenance funds required to keep systems operational. The lack of revenue stream in many developing country health facilities which provide services free of charge magnifies this challenge. Operating budgets are typically developed at the beginning of each year and funds are not available to cover the unexpected failure of solar system components.

Combining hospital electrification projects with a community clean water pumping system is an innovative way to address this problem. At the Kalungi Hospital, excess water sold to the surrounding community provides a small revenue stream that can contribute to the maintenance costs for both the electricity generating and water pumping solar systems.

Moreover, the head doctor at the hospital expects the solar-powered water system to significantly reduce incidences of dysentery and other ailments transmitted through unclean water; improve the cleanliness and hygiene at the health clinic by allowing doctors and nurses to wash their hands and clean equipment between exams; and improve treatment by allowing patients to safely hydrate while visiting the clinic.

For more information contact Jeff Haeni, (jhaeni@usaid.gov), USAID/EGAT/I&E/Energy Team.

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1. World Health Organization, 2006. http://www.afro.who.int/home/countries/fact_sheets/uganda.pdf)

### Testing Solar Water Pumps in Mali

In 2003, USAID/Mali formed a partnership with a U.S. private pump manufacturer (Moving Water Industries), a local pump distributor (Sinergie), and local governments and communities to promote a water pumping and storage system based on a combination of solar and human energy. The system uses photovoltaic panels to power a reciprocating piston pump for groundwater at up to 60 m depths. Water may be pumped directly into 15 $m^3$ overhead storage tanks, or fed through an automatic chlorination disinfection system built into the unit. When solar energy is not available, users may also employ pedals to pump water at the rate of five hand pumps. The list price of the pumps is approximately $25K, but the USAID/Mali Mission was able to procure them at a much reduced cost as part of the alliance, for $15K each, including installation and support services by Synergie.

To date, the Solar PedalFlo has been installed on 26 boreholes in a variety of communities, with different government and NGO partners providing oversight for the program. Pilot sites were chosen based on a community's ability to link the new pumps with income generating projects at water points, and a willingness to commit to ongoing operation and maintenance of the system. A preliminary review of the status and performance of the pumps was conducted in 2005 by the Mission, which turned up a mixed record related to system performance, maintenance, community commitment and capacity for ongoing management, and actual uses of the water pumped.

The Mission found that pumps broke down for various reasons, and maintenance and repair were closely linked to the efficacy of the government or NGO partners in place to support the communities. Some management committees were regularly collecting user fees, and others were not. No communities were utilizing the purification function of the system, and the pedaling function was also used relatively infrequently. Finally, many communities only used the system for potable use only and did not support productive activities with the pump system, calling into question the cost-benefit of this level of investment. Starting in late 2006, the Mission will be supporting additional technical assistance for pump management through the West Africa Water Initiative (WAWI), and will be re-examining both site selection criteria and management success factors before installing the six remaining pumps available.

For more information, contact: Sharon Murray (smurray@usaid.gov), USAID/EGAT/Office of Natural Resource Management/Water Team.

## Energy, Air Pollution, and Disease

### Household Energy and Health

With so much of the world's population still relying on solid fuels for their household energy needs, it is not surprising that the burden of diseases associated with indoor air pollution (IAP) is also high. In fact, globally, exposure to IAP is the fourth leading risk factor for the burden of disease in high-mortality developing countries (after underweight; unsafe sex; and inadequate water supply, sanitation, and hygiene).

A recent World Health Organization publication, "Fuel for Life: Household Energy and Health" (WHO 2006), focused attention on this issue:

*"Cooking with wood, dung, coal and other solid fuels is a major risk factor for pneumonia among children and chronic respiratory disease among adults, with more than two thirds of these deaths occurring in South-East Asia and sub-Saharan Africa. Every year, the killer in the kitchen is responsible for 1.5 million deaths."*

The key health-damaging emission from cooking fires is fine particulate matter, which has been associated with pneumonia in children; chronic obstructive lung diseases, such as chronic bronchitis and emphysema, in adults; and lung cancer among women, from coal smoke. Pneumonia is the leading cause of death for children under five, responsible for over two million child deaths each year.

In addition, there is suggestive evidence for the impact of indoor air pollution in increasing the severity or prevalence of other health outcomes, including tuberculosis, low birth weight, cataracts, asthma, and cancers other than lung cancer.

Low birth weight is of particular interest because of its association with a number of discrete conditions directly associated with child deaths, including pneumonia and neonatal deaths that occur in the first 28 days of life, which are an increasingly large fraction of all child deaths. The current evidence is suggestive of important and consistent effects on low birth weight as well as stillbirth. The large numbers of women of child-bearing age exposed to smoke amongst the populations most at risk make better understanding this risk a high public health priority.

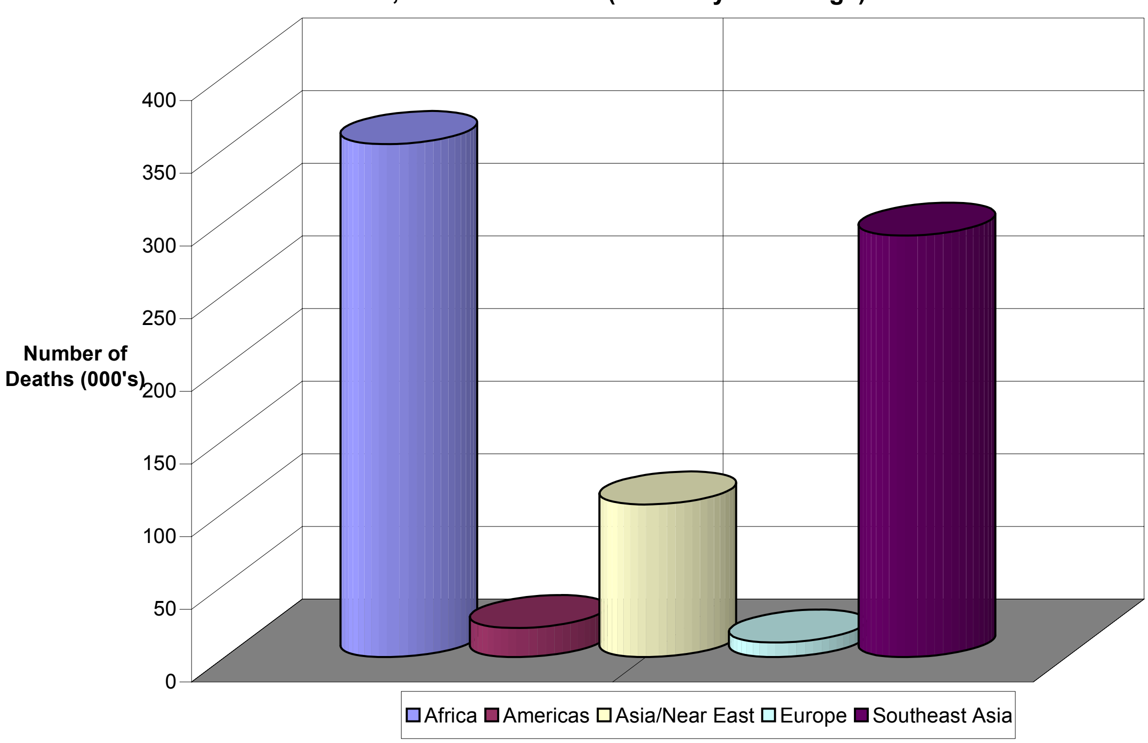
But even though we know that high exposure to indoor air pollution increases illness, there remains uncertainty about how much exposure reduction is required to reduce this risk. Because moving to significantly cleaner fuels may be out of the financial reach of the poor, most efforts to reduce exposure have focused on technological improvement to stoves, ventilation improvements including chimneys and windows, and behavioral interventions (e.g. keeping children out of smoky kitchens).

**Household Energy and Health Fast Facts**

- More than 3 billion people worldwide depend on solid fuels to meet basic energy needs: cooking, water boiling, and heating.
- Indoor air pollution from burning solid fuel ranks as one of the top 10 global health risks.
- Indoor air pollution causes 1.5 million deaths annually.
- In many cases women and their small children breathe in amounts of smoke equivalent to smoking two packs of cigarettes per day.
- Inhaling indoor smoke doubles the risk of pneumonia and other acute infections of the lower respiratory tract among children less than 5 years of age.
- Women exposed to indoor smoke are 3 times more likely to suffer from chronic bronchitis or emphysema than women who cook with electricity, gas or other cleaner fuels.
- Coal use for cooking doubles the risk of lung cancer, particularly among women.
- Studies have linked exposure to indoor smoke to asthma, cataracts, tuberculosis, low birth weight and other illnesses.

*Source: Fuel for Life, WHO, 2006*

**800,000 Child Deaths (under 5 years of age) Per Year Due to IAP**



The key question is whether the resulting exposure reductions are sufficient to result in reductions in disease that are of public health consequence.

Only recently has evidence begun to become available to answer this question. One important study is the RESPIRE trial, funded principally by the National Institute for Environmental Health Sciences of the National Institutes of Health and executed by a consortium of research groups led by the University of California at Berkeley's Environmental Health Sciences Division in the School of Public Health. This randomized intervention trial measured indoor and outdoor air pollution concentrations, including a focus on fine particulate; personal (child and mother) exposures; and health outcomes, in particular child pneumonia. The setting was 5365 households in the highlands of Guatemala, which included 534 eligible households – one-half received an improved stove at the beginning of the trial, one-half at its conclusion.

The results to-date suggest that a 50% reduction in personal exposure to IAP resulted in a 40% decline in non-viral severe pneumonia in young children. For women, respiratory symptoms were reduced for wheeze and chronic phlegm; there were smaller benefits for overall lung function. Importantly, the positive impact on chronic respiratory symptoms increased over time with reduced exposure.

One additional interesting finding was that personal exposures to fine particulates were not as dramatically reduced as kitchen exposures, which decreased by approximately 90%, on average. Women and children do not spend all of their time in the kitchen, exposure reductions in other rooms of the houses were not as great, and there is some evidence that outdoor exposures near the houses may have increased as a consequence of the introduction of chimneys to vent smoke outdoors.

The bottom line of the evidence to date is that exposure reductions of the magnitude feasible with current interventions can reduce the incidence of severe bacterial pneumonia in children by 35-40%, which is on par with other public health interventions. While impacts on overall or pneumonia-specific child mortality would help complete this picture, enough is known to justify investments to more fully understand the most effective approaches and the costs of health-focused interventions (*see the next article on how a model project in Peru aims to reduce indoor air pollution*).

For more information, contact John Borrazzo (jborrazzo@usaid.gov), USAID/Bureau for Global Health.

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*Fuel for Life: Household Energy and Health*; World Health Organization, 2006. Download this report at http://www.who.int/indoorair/publications/fuelforlife/en/ )

Visit http://ehs.sph.berkeley.edu/guat/ to download the following three references:

Smith KR, Bruce N, Arana B, Diaz A, Jenny A, Khalakdina A, McCracken J, Schei M, Gove S. "RESPIRE - the Guatemala Randomized Intervention Trial." International Society for Environmental Epidemiology 2006, Paris, France.

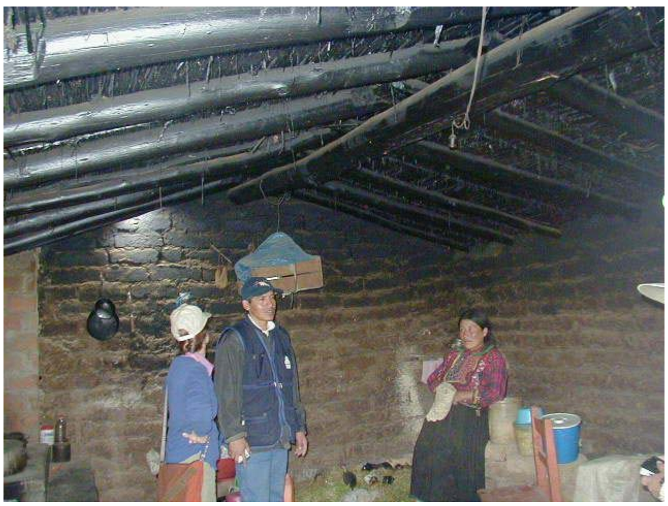
Smith KR, Bruce N, Weber MW, Hubbard A, Jenny A, Dherani M, Acevedo R, Arana B. "Reduction in Child Pneumonia due to Randomized Introduction of a Chimney Stove in Woodburning Households: Results from RESPIRE." International Society for Environmental Epidemiology 2006, Paris, France.

Smith-Sivertsen T, Díaz E, Pope D, Arana B, McCracken J, Jenny A, Thompson L, Klein R, Smith KR, Bruce N. "RESPIRE-the Guatemala Randomised Intervention Trial: Impact of an improved stove on women's lung health in a rural wood-using community," International Society for Environmental Epidemiology 2006, Paris, France.

## Reducing Indoor Smoke and Illness for Women and Children: A Model Project in Peru

Kitchens in the Peruvian Andes share several common characteristics: they are built solidly of adobe bricks baked in the sun; they have few to no windows in order to keep out the high-altitude chill and seasonal winds; and, most strikingly, they are coated from floor to ceiling with a layer of soot and creosote so thick that shiny black drips form among the cobwebs across the ceiling. A minority of families have opened a hole in the roof which permits some of the smoke to escape, though with no chimneys and minimal air flow, this is a partial solution at best. This is the dark, enclosed and smoky environment where most women of this poverty stricken region spend an unhealthy portion of their day, cooking for their families with collected wood or dung over open fires, accompanied by their infants and young children.

It thus comes as little surprise that acute lower respiratory infections (ALRI) are prevalent in these communities, especially among indigenous children under 5 years old, for whom the death rate is well over twice the national average. And yet, awareness of the risks of pneumonia among infants and COPD among women associated with daily exposure to high concentrations of smoke remains almost nonexistent among the cooks themselves. When interviewed, women readily acknowledge the discomfort of smoke in their eyes, the persistence of a cough, or the exhaustion, time burden and back pain associated with the gathering of fuel. But without access to more complete information on the extent of the health risks, and virtually no access to alternatives, they have little ability to change their cooking practices.



***Cooking over an open fire leads to indoor air pollution and soot (creosote) inside a typical Inkawasi home.***

## Creating awareness, introducing alternatives, promoting change

The poverty and remoteness of these high-Andean communities make access to LPG, electricity or other cleaner and more efficient fuel alternatives infeasible. The most viable option is to introduce improved designs of biomass cook stoves that have higher efficiencies and better exhaust systems. But to achieve an appropriate and sustainable solution, it must be comprehensive, integrating local ingenuity into stove design, and complementing the technology with awareness raising and innovative approaches to local finance such that access for the poor is self-driven, ongoing and expanded.

In response to this challenge, the offices of health and energy of USAID are jointly implementing an integrated "Healthy Kitchen" project model to minimize exposure to IAP from cooking in the district of Inkawasi, Peru. This strategy combines locally-adapted technology with micro financing, micro enterprises, behavior change and community engagement into a comprehensive approach. By approaching the problem from different angles, USAID seeks to demonstrate a sustainable model with strong potential for replication and scale-up.

The technology being promoted, the "Inkawasina" stove, was adapted from a Honduran stove design, which in turn incorporated both lab-tested efficiency principles and low-tech construction techniques based on locally-available materials. This adaptation was led by an indigenous engineering student from Inkawasi, who compared 5 stove designs and consulted with local women before determining the most appropriate characteristics. The current project is transferring skills to local artisans to make the combustion chambers and build the stoves; these entrepreneurs in turn sell—or exchange—their services to families who desire the stoves.

The greatest challenge has been the lack of a cash economy in Inkawasi: how will families afford the stove? In addition to the adobe bricks the families are responsible for contributing, the stoves require a ceramic "elbow" (combustion chamber, to be purchased from one of the trained potters). A system needed to be devised to work in harmony with the local barter system.

The result is essentially a micro-loan based on animal husbandry, wherein families receive a set of animals (ducks, chickens or guinea pigs), which they reproduce enough to pay for the stove—including the loan principal and interest. In this way, the animals themselves become the basis of a revolving loan fund—some are sold to pay the fund manager and stove producers, and some are passed along to the next family awaiting a loan.

To motivate families to enroll in the Healthy Kitchen project, the awareness program of the project aims to change perceptions of indoor air pollution risks and to adopt practices that help minimize those risks. The program utilizes local radio ads, posters, and paints simple messages on prominent community walls.

The core of awareness-building lies, however, in the hard work of a network of local volunteer promoters, who educate and motivate the community about IAP and solutions at hand. Women have been particularly responsive to healthy kitchen "competitions" conducted by promoters as a technique to motivate improvements in the cleanliness and organization of kitchens.

**Results and impacts to date**

***The smoke and creosote-free interior of a home using an Inkawasina stove.***

Families from over 30 villages in the Inkawasi district have participated in the project. Over 430 families have received the animal module "micro-loans", and a third have already completed repayment. Several families have recently opted to pay outright for the stoves—a positive indication of the perceived value of this technology. Twenty one (21) stove makers have been trained and have installed over 300 stoves, prompting a growing interest among neighbors as they see the stoves in operation.

To verify that the Healthy Kitchen intervention model is yielding measurable reductions in indoor air pollution, USAID has supported pre- and post-intervention monitoring of respirable particulate matter ($PM_4$) and carbon monoxide in a sample of 48 households. Pre-intervention monitoring revealed severe IAP levels: average PM4 concentration was 680 mg/m3, over 10 times Peru's recommended ambient level for PM2.5 (a valid value for comparison).

Preliminary results following the post-intervention monitoring show that significant reductions have been achieved in over 70% of the households, with the reduction in these households averaging 84%.

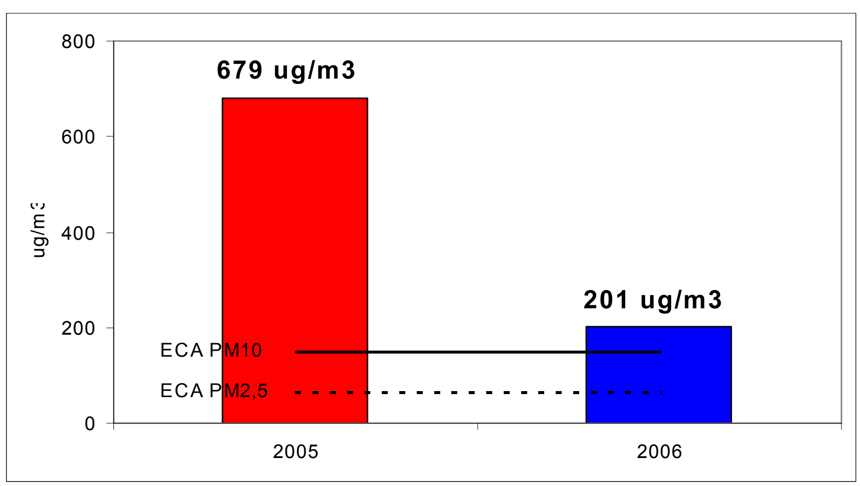
Fuelwood use has also been monitored pre- and post-intervention. Preliminary results indicate that the use of the new Inkawasina stove has reduced fuelwood consumption by 32% compared to the traditional open fire. This reduction has positive impacts not just on the area's natural resources but also on the lives of the families. Women spend less time collecting firewood, and the Inkawasina stove also uses smaller diameter firewood than the traditional fire, enabling families to collect smaller, lighter pieces of wood. This reduces the physical burden of carrying firewood for long distances.

**Increased visibility and nationwide commitment**

Winrock has collaborated with the Pan-American Health Organization (PAHO) in Lima, as well as a number of government programs, NGOs, universities and private sector entities to raise visibility of indoor air pollution in Peru and viable solutions.

In December, 2006, PAHO and USAID contractor Winrock International co-organized a seminar on the topic, for which the First Lady of Peru, Pilar Nores de Garcia, gave the inaugural address. The Inkawasi project was presented in-depth, raising interest among the participating NGOs, universities, government and international agencies in the efficient and appropriate Inkawasina stove model, as well as the animal-based micro-loan.

**Reduced Household Exposure to Particulates**




*Average reduction in 24-hour $PM_4$ concentrations across the 42 households was greater than 70%.*

A working group on IAP in Peru has formed as a result of the seminar, and the First Lady is considering using the Inkawasina stove as the model for the ambitious stove program she is promoting. These developments bode well for further replication and potential scale-up of USAID's integrated approach to reducing women and children's exposure to indoor air pollution.

For more information, contact Pam Baldinger, (pbaldinger@usaid.gov), USAID/EGAT/I&E/Energy Team, John Borrazzo (jborrazzo@usaid.gov), USAID/Bureau for Global Health, Lisa Buttner (lbuttner@winrock.org) and Rogerio Miranda (rmiranda@winrock.org), Winrock International.

## The Health Effects of Fuel and Vehicle Emissions in Developing Countries

Air pollution in many cities in the developing world is reaching crisis proportions. The WHO in a recent release of their updated air quality guidelines, stated that ambient air pollution in cities causes two million premature deaths every year, with more than half the deaths in developing countries (see reference 1). Air pollution causes asthma, chronic obstructive pulmonary disease, cardiovascular disease, and lung cancer.

Motor vehicles account for a significant portion of urban air pollution in developing countries, in some cases contributing over half of the overall pollution. In mega-cities (e.g., Delhi, Beijing and Manila), the proportion may be much higher, and the skyrocketing growth in urban travel in the developing world will further exacerbate this problem. Vehicular pollution can lead to premature mortality and a variety of respiratory illnesses (e.g., chronic bronchitis, acute bronchitis in children, and asthma).

Children are at particular risk from air pollution, as their bodies are still growing and their organs are still developing. Lead from gasoline, for example, interferes with brain development and other organs and systems in young children. Respiratory infections from air pollution were the fourth-largest cause of death in children under five in South Africa in 2000, according to UNICEF - more than 6,000 deaths per year (see reference 2). New data increasingly links particulate matter (PM) to respiratory illness and heart disease. According to WHO, reducing PM levels can yield dramatic health benefits. Since PM emissions are directly linked to sulfur levels in vehicle fuels, particularly diesel, introducing lower sulfur fuels can have direct health benefits. In many countries, new vehicles, along with new emission control technologies, are entering the market. These new vehicles bring with them the possibility of significantly lowering emissions. However, before the benefits of these new technologies can be realized, the quality of the fuel must be improved, particularly the levels of sulfur in both gasoline and diesel.

The USEPA, with support from USAID, has been working on-the-ground in developing countries to reduce air pollution associated with vehicles and fuels. These programs were reinforced in 2002, when The Partnership for Clean Fuels and Vehicles (PCFV) was launched at the World Summit on Sustainable Development in 2002. For more information on the Partnership, see the web site: www.unep.org/PCFV.

USEPA and USAID's programs to reduce vehicle emissions reach across the developing world, and include:

***Saying Goodbye to leaded Gasoline***: USEPA and USAID are working with the PCFV to eliminate lead from gasoline worldwide by 2008. In 2006, a major milestone was reached: all 49 countries of Sub-Saharan Africa switched to unleaded gasoline, reducing the exposure of over 700 million people to the harmful effects of lead. Indonesia, the 4th most populous country in the world, has also recently made the decision to remove lead from gasoline.

***Reducing Sulfur in fuels***: USEPA and USAID are co-sponsoring a series of projects, all designed to demonstrate the benefits of moving to ultra-low sulfur diesel fuel, with sulfur content of 15 parts per million or less. These include:

- Mexico City Diesel Retrofit Project, which evaluated the emissions reductions from retrofitting existing city transit buses in Mexico City with advanced emissions control technology, combined with ultra-low sulfur diesel fuel. The results showed that these technologies can reduce particulate emissions by almost 90%. For more information, please visit www.usaid.gov/our_work/economic_growth_and_trade/energy/publications/projects/cleanfuelandvehicles.pdf.
- Central America Fuels and Vehicles Harmonization: this project is providing technical assistance and support to harmonize fuel and vehicle requirements in the 7 Central American countries, which would include introducing ultra low- sulfur diesel fuel and putting in place vehicle standards.

For more information, contact Pam Baldinger, (pbaldinger@usaid.gov), USAID/EGAT/Energy Team, and Jane Metcalfe (Metcalfe.jane@epa.gov), USEPA.

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2. "South Africa Energy and Environmental Issues", U.S. Department of Energy Information Agency (EIA), November, 2004. To download this, visit http://www.eia.doe.gov/cabs/safrenv.html


## Understanding Air Pollution Levels in Accra and the Links to Health

Sub-Saharan Africa is urbanizing at the highest rate of any region of the world and Ghana is no exception, with an urban growth rate of approximately 4.2 percent per annum (World Bank estimate, January 2002). As in most African cities, the average age of vehicles on the road in Accra is between 8 to 14 years of age. In most cases the catalytic converter on these aging vehicles has either been destroyed due to the use of leaded gasoline or has simply been removed from the vehicle, resulting in increasing levels of air pollution. Anecdotal evidence suggests this pollution is taking a toll on people's health, particularly vulnerable populations such as children, the elderly and the poor.

In December 2003, Ghana took the first step in addressing air pollution issues by phasing the lead out of gasoline. The next crucial steps are to quantify the reductions in ambient lead concentrations as well as to understand the current levels of other priority pollutants in the air. These data will be used to develop strategies that reduce exposure to air pollution and in turn improve public health. In July 2004, USAID, USEPA and the United Nations Environment Programme (UNEP) approached Ghana EPA to initiate an air quality monitoring program. Details on this program can be found in the April-May 2005 issue of Energy and Development at www.usaid.gov/our_work/economic_growth_and_trade/energy/publications/newsletters/2005-2_eu_apr-may.pdf.

***Many people in Ghana live or work beside major roads, which exposes them to potentially harmful levels of pollutants.***

Particulate matter (especially PM10) is the principal air pollutant measured in the monitoring program. This is due in part to the predominance of PM10 emission sources (such as vehicle exhaust, road dust, open burning of waste, and domestic cooking) and the health impacts attributable to PM10 exposure (such as damaged lung tissue, decreased lung function and aggravated asthma).

As of July 2006, each PM10 sample taken at residential, commercial and industrial sites was within both WHO and US standards. However, approximately 40 percent of the PM10 samples taken at roadside sites exceeded these norms. On the positive side, roadside tests also show a significant reduction in particulate lead levels (from 80 to 99 percent) since the phase-out and the levels are now well below the health-protective quarterly average US ambient standard of 1.5 ug/m3.

Armed with the air quality data, the Ghana Health Service (GHS) has recognized the need to make the case to decision-makers and the public that air pollution needs to be addressed to protect the health of Ghana's population.

To that end, the GHS is initiating a study to explore the linkages between respiratory diseases in children and the levels of particulate matter found in the air. Also, as an outcome of the monitoring program, Ghana EPA is leading the effort to adopt enforceable standards with respect to ambient air quality that are health protective.

These efforts will provide information on which Ghana can base actions toward reducing air pollution and improving people's health. Likely future steps by Ghana EPA and its supporters include requiring the use of functioning catalytic converters in vehicles, reinstating a ban on the importation of older vehicles without functioning emissions controls, and improving fuel quality, primarily by reducing the level of sulfur in fuels (currently at 3,000 ppm) to 50 ppm.

For more information, contact Pam Baldinger, (pbaldinger@usaid.gov), USAID/EGAT/Energy Team, and Cristina Mercurio (mercurio.cristina@epa.gov), USEPA.

# NOTES FROM THE FIELD

## Monrovia Lights Up: A First Step in Liberia's Stabilization

Upon Liberian President Johnson Sirleaf's inauguration in January last year, electricity services in that country were virtually non-existent. After 14 years of devastating civil war, the entire power grid was broken. Except for diesel generators owned by a handful of individuals, all power supplies were gone. The Liberia Electricity Corporation (LEC) was moribund – no infrastructure, no customers. Liberia was in darkness, literally and figuratively.

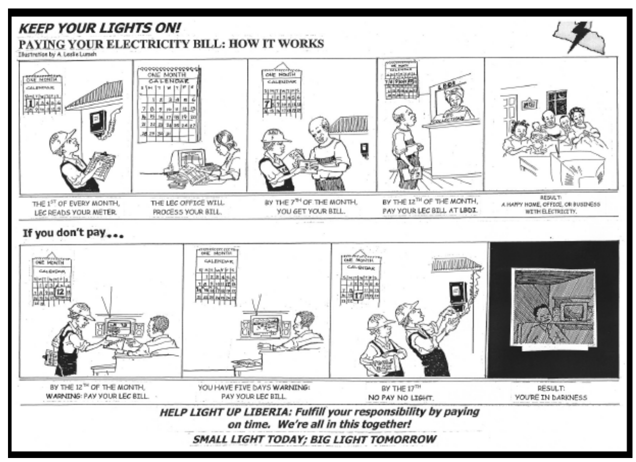
Consequently, the President promised on taking office that she would launch an emergency power program in Monrovia to provide electricity to parts of that city. She set her own deadline of 150 days.

The unique coalition of international donors that she turned to for funding and implementation - including the US Government, the European Commission, and the Government of Ghana –were able in four months to bring grid-delivered electricity to neighborhoods, hospitals and other public buildings for the first time in more than a decade. With the active participation of the Government of Liberia and LEC, they imported generators, rebuilt distribution networks, installed new streetlights and began commercial service. The US Government, working through the US Agency for International Development, provided funding for the initial fuel supply for the first several months of operation as well as technical and financial support to LEC to re-commercialize, i.e. to start metering, billing and collecting from customers again, so that the utility's operations were partially self-financed.

On July 26, as promised, President Johnson Sirleaf pressed a ceremonial button and turned on power in parts of Monrovia. Electric lights shone again on a major Monrovia thoroughfare, Tubman Avenue.

"The switching on of these lights today symbolizes our journey from darkness to illumination," the President told assembled dignitaries and residents, including US Charge D'Affaires Lou Mazel and USAID Mission Director Wilbur Thomas.

"Small light today, big light tomorrow," she said.


The Emergency Power Program was designed to restore electricity to selected parts of Monrovia while rebuilding LEC's operations in a financially and operationally sound manner that can serve as a sustainable model for providing future services throughout Liberia. The commercialization goal was very specific: to make LEC self-sufficient, i.e. revenue collected each month would be sufficient to pay for that month's fuel, plus Operations and Maintenance. The electricity tariff has been set at a level to cover operating costs, including streetlights. Since it is operating on a cost-recovery basis, all customers are required to pre-pay a month's estimated electricity usage in advance, and delinquent customers are disconnected.

By the end of 2006, LEC was serving about 300 customers, mostly small businesses and institutions like hospitals and schools. And LEC has achieved operational self-sufficiency.

A second phase of the EPP, with an additional donor – the Government of Norway – will expand generation and LEC's customer base five-fold in the next 18 months and extend street lights all the way from Bushrod Island through downtown to Paynesville. At completion, 70% of Monrovia's population will have electricity service in their neighborhood. A second complementary USAID project kicked off in November, and is focusing on pilot projects for delivery of electricity to urban and rural poor, in addition to legal, policy and investment promotion assistance.

"Energy is fundamental to creating economic growth opportunities in post-conflict societies and both stabilizing and delivering obvious benefits to the population.  A self-sustaining electricity supply is critical to Liberia's future. EPP is a significant first step," said Mission Director Wilbur Thomas.

For more information, contact Wilbur Thomas (withomas@usaid.gov), USAID/Liberia, and Joan Ablett, International Resources Group, jablett@irgltd.com

**Lessons Learned**

***Electrification can be a cornerstone of early post-conflict stabilization.*** Affordable, accessible energy is a natural building block of any economic reconstruction. More importantly, a visible demonstration to the average citizen that a government is functioning.

***Capacity development is more important than technical development***. Establishing LEC's ability to operate their business is making the expansion of power possible in Monrovia, not the other way around

**Commercialize early and often**: It is a convincing argument to the international financial community that further investment in Liberia's energy sector has an acceptable risk/return ratio.

**Top-level government support is critical**: Re-electrification is a priority for President Sirleaf Johnson who has repeatedly demanded that her ministers and other government members support it.