

PARTNERSHIP FOR CLEAN INDOOR AIR

Household Energy, Indoor Air Pollution and Health: Overview of Experiences and Lessons in Guatemala



Prepared by



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The Partnership for Clean Indoor Air was launched at the World Summit on Sustainable Development in Johannesburg in September 2002 to address the increased environmental health risk faced by more than two billion people who burn traditional biomass fuels indoors for cooking and heating. The Partnership is led by the U.S. Environmental Protection Agency with support from the U.S. Agency for International Development. The mission of the Partnership is to improve health, livelihood and quality of life by reducing exposure to air pollution, primarily among women and children, from household energy use.

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ABBREVIATIONS AND ACRONYMS

µg/m³	micrograms per cubic meter
ALRI	acute lower respiratory infection
ARI	acute respiratory infection
AT	appropriate technology
CEMAT	Centro Mesoamericano de Estudios sobre Tecnología Apropriada
CO	carbon monoxide
COPD	chronic obstructive pulmonary disease
ENCOVI	2000 Survey on Living Conditions
EPA	Environmental Protection Agency
ESMAP	Energy Sector Management Assistance Programme
FIS	<i>Fondo de Inversión Social</i> (Social Investment Fund)
GDP	gross domestic product
GENES	Mesoamerican Gender in Sustainable Energy
GOG	Government of Guatemala
GVEP	Global Village Energy Partnership
HEH	household energy and health
IAP	indoor air pollution
ICS	improved cookstoves
IGSS	<i>Instituto Guatemalteco de Seguridad Social</i> (Guatemalan Social Security Institute)
LPG	liquefied petroleum gas
LSMS	Living Standards Measurement Survey
MDG	Millennium Development Goal
MEM	<i>Ministerio de Energía y Minas</i> (Ministry of Energy and Mines)
MSPAS	<i>Ministerio de Salud Pública y Asistencia Social</i> (Ministry of Public Health and Social Assistance)
NGO	nongovernmental organization
PM	particulate matter
PM₁₀	particles with an aerodynamic diameter less than 10 microns
PM_{2.5}	particles with an aerodynamic diameter less than 2.5 microns
ppm	parts per million
SAIS	<i>Sistema Integral de Atención de Salud</i>
SCT	standardized cooking test
TSP	total suspended particles
TWP	Trees, Water & People
UCB	University of California, Berkeley
UNDP	United Nations Development Programme
UVG	Universidad del Valle
WBT	water boiling test

I. REPORT HIGHLIGHTS

Overview of Household Energy and Health

- Pneumonia is the single largest cause of infant death in Guatemala, accounting for 36% of all registered deaths among infants in the country. Guatemala has an infant (<1yr) mortality rate of 43 per 1,000 live births.
- Acute lower respiratory infections (ALRI), such as pneumonia and bronchitis are the chief cause of morbidity in children 5 years and under. Mortality from ARLI in Guatemalan children under 5 is 1,215 per 100,000 live births.¹
- Studies have identified chronic obstructive pulmonary disease in women who have cooked over open fires for many years.
- More than half of Guatemala's population of over 14.2 billion uses firewood for cooking; in rural areas more than 86% use firewood for cooking. LPG is used by over 11%. While 85% of Guatemalan households have electricity,² only 2.7% of the population cooks with electricity.
- Rural highlands include indigenous populations in which both infant mortality rates and acute respiratory infection rates are among the highest in the world. More than half of Guatemala's population is below the poverty line, of which nearly 75% are indigenous.
- About a dozen studies in Guatemala have established correlations between biofuel use and reduced birth weight; between high cough and phlegm prevalence and open fire usage; and between smoke exposure and respiratory infections.
- Many other studies have demonstrated significant reductions in indoor air pollution (IAP) (carbon monoxide, total suspended particles, particulate matter) through the use of improved stoves.
- The first ever randomized intervention trial is now underway in Guatemala, which will provide evidence on the impact of reduced IAP on ALRI incidence among young children.
- According to a recent UNDP/ESMAP study,³ eliminating IAP could reduce annual Guatemalan highland cases of ALRI by 16,000, and deaths by about 700, resulting in a 50% reduction in the annual cases of ALRI in the 400,000 children under 4 living in households where open fires are used for cooking.

Key Entities Working in the Field of Household Energy and Health

Government agencies

- The Ministry of Energy and Mines (MEM)
- Social Investment Fund (Fondo de Inversión Social: FIS)
- The Ministry of Public Health (MSPAS)

¹ Pan American Health Organization, 1994: <http://165.158.1.110/english/sha/be954acu.htm#current>

² *Comisión Nacional de Energía Eléctrica* 2002 (<http://www.eia.doe.gov/emeu/cabs/centam.html>)

³ United Nations Development Programme/World Bank Energy Sector Management Assistance Programme (ESMAP), Health Impacts of Traditional Fuel Use in Guatemala, June 2003.

NGOs

- Fundación Solar
- HELPS, International
- Trees, Water & People (TWP)
- Intervida
- PLAN International
- Centro Mesoamericano de Estudios sobre Tecnología Apropiada (CEMAT)

Private stove manufacturers and contractors

- Taller San Mateo
- Construferro
- Mr.Manuel Tay

Multi-lateral and bi-lateral agencies

- World Bank/ESMAP
- United Nations Development Programme (UNDP)

Academia

- University of California, Berkeley (UCB)
- Universidad del Valle (UVG)

Key Household Energy and Health Programs

- In the early 80's, the Ministry of Energy and Mines (MEM) sponsored a short-lived National Group for Improved Stoves, comprised of 27 public and private institutions involved in the dissemination of the popular Lorena ("mud and sand") cookstoves, for exchanging ideas and experiences regarding improved cookstoves (ICS) in Guatemala. The Lorena stove, developed in Guatemala as an appropriate technology (AT) following the widely destructive earthquake of 1976, was spread throughout the region and even to Asia and Africa through the AT movement.
- In 1994-5 the MEM sponsored the training of about 70 "plancha" stove builders, including manufacturing of the plancha griddle. These trained professionals today support the dissemination of plancha stoves throughout the country. The plancha is considered an improvement over the Lorena, having greater efficiency, hotter griddle and more standardized design.
- FIS began an aggressive improved cookstove (ICS) dissemination program in 1996, installing on average 15,000 plancha stoves per year, and has installed over 100,000 units to date. The program is subsidized, but each community must contribute labor, local materials and provide lodging for masons.
- In 2000, HELPS International developed a "Rocket stove" design-based portable cement molded stove with a chimney, similar in dimension to the plancha stove, and has disseminated 2500 units in the past year, totaling 3000 units throughout the country. They are currently negotiating a contract for 2400 more. The "Rocket" stove, developed by Aprovecho Research Center, utilizes design principles that aim to maximize efficiency; these design principles can be incorporated into many stove models. HELPS also produces and promotes a portable, chimneyless "Nixtamal" stove, designed to accommodate a

single, large pot for cooking maize, and will be incorporating hayboxes into their stove promotion programs. HELPS is currently implementing a pilot project funded by Shell Foundation involving mass production of its stoves.

- Trees, Water & People (TWP) has been promoting “Justa” stoves along Guatemala’s southern coast since 1999, collaborating with rural women to build 400 Justa stoves in 12 communities, in addition to the 150 stoves they installed prior to this project. The Justa stove incorporates efficient Rocket design principles into a fixed stove model that is built in the home. TWP combines its stove promotion with a reforestation requirement.
- From 1998 to 2002, Intervida implemented a plancha stove project of over 9000 units in which the ~\$82 capital cost of the stove provided by Intervida is a loan, which must be paid back within one year to a local community fund used to finance income generating activities. The Tezulutla’n project implemented 4129 improved stoves in Baja Verapaz, northern Guatemala from 1997 to 2002. With the help of local women, the project improved the design of the plancha stove to best fit local needs, using alternate locally-available materials, and improving the combustion chamber to increase efficiency.
- With technical assistance from Tezulutla’n, PLAN International has built 1703 stoves from 1998 to 2002 within their assisted communities.
- The Mesoamerican Center for Appropriate Technology Studies (CEMAT) developed a market survey in 1990 for woodstoves within Guatemala City. They now work in training and stove construction and maintenance.
- Through University of California, Berkeley (UCB), an international, interdisciplinary research team led by Professor Kirk Smith has been researching household energy and health issues for over 14 years. The team is currently carrying out a \$2 million, four-year study (2002-06) among 20 Mayan communities, which will provide robust evidence on the impact of reduced IAP on ALRI incidence among young children in the highlands of San Marcos, western Guatemala.⁴
- In 2001-2003, UNDP/ESMAP undertook a study to quantify health impacts of traditional fuel use and outline strategies and policies for mitigating health risks, giving particular emphasis to policy recommendations to enhance the impact of existing improved stove programs.

Synthesis of Lessons Learned

- **Market development**—The cost of common improved stoves in Guatemala is too high for most poor households, necessitating subsidies in most improved cookstove programs, as micro-finance options are rare. Subsidies work best when beneficiaries provide some amount of capital, local materials and/or labor. Recent approaches in which beneficiaries are required to buy commercially-available components themselves establishes expenditure expectations, strengthening the market for new stoves and replacement parts, and better assuring broken parts will be replaced.

⁴ The primary source of funding for this research is the National Institutes of Health. Complementary funding for UCB research in Guatemala has come from WHO, IDRC, Emory University, Fulbright Foundation, Latin American Studies Program at UCB, Kresge Foundation, National Research Council of Norway, Healthy Housing Foundation, Maxwell Endowed Chair at the UCB School of Public Health, and the AC Griffin Family Trust, among others.

- Technology standardization—While technology standardization through the popular plancha stove has enhanced stove model replicability, and in turn has facilitated dissemination, there is a lack of standardization of main stove components, and some components are difficult to replace in some parts of the country. Further, recent improvements in efficiency through the HELPS and TWP stove models have introduced new considerations for standardization. Guatemala lacks a coordinating institution for improved stoves R&D to enhance and support technological innovation.
- Health Impact Monitoring—Most Guatemalans are not aware of the relationship between IAP and health. The continuing research by academia to directly establish this link will provide incentives for decision-makers and policy-makers to take action.
- Social and Cultural Barriers—Stove programs that more successfully address social and cultural barriers 1) include participation of families-- especially women-- in the design and construction of the stove; 2) incorporate local trainers with social and cultural background and language fluency; 3) create local expertise to lower project dependence; and 4) include an established maintenance program. Behavior change techniques are underutilized in the IAP sector in Guatemala, but may be adapted from promotions in the health sector, and be incorporated into ongoing preventive health and environmental health programs.

II. INTRODUCTION

Overview

For over three decades, development practitioners, government programs and researchers have promoted the use of improved stoves in Guatemala, initially spurred by concerns over fuelwood savings and more recently with a greater concern over the health impacts of indoor air pollution. Guatemala is one of the few countries in the world where extensive epidemiological research has been conducted with the objective of linking specific disease impacts with reductions in indoor air pollution from a specific stove intervention. From this research, government agencies and international donors have gained greater awareness about the tremendous burdens that household energy in general, and indoor air pollution in particular, represent for millions of people—especially women and young children—in Guatemala, and around the world. In recent years, several efforts have emerged through the NGO community, research institutions, government interest, and multi-lateral initiative that demonstrate great potential for innovative and comprehensive approaches to reducing the health impacts of household energy in Guatemala.

Figure 1 Map of Guatemala, with its Neighboring Countries in Central America and Mexico.



Guatemala's principal energy source has historically been firewood. It is estimated that in 2003, 67% of Guatemala's 1.6 million families used firewood as their main fuel source for cooking.⁵ Of these, a great majority still use traditional three stone open fires. Mayan communities in the highlands are especially likely to use fuelwood in open fires, to the detriment of their health and the environment. Due to the fact that women are heavily involved in meal preparation, their exposure to indoor air pollution is especially high, posing serious health risks.

The original Lorena stove was developed in Guatemala in the 1970's, starting the movement in Central America for improved stoves. Technology advancements have continued in Guatemala to this day, with significant efforts in efficiency improvements, involvement of women in stove development, and mass production undertaken in the last five years. Guatemala has hosted key studies on exposure measurements and links between smoke and health, supporting evidence of the impact of indoor air pollution (IAP) on acute respiratory infections (ARI) that has emerged in recent years.

Guatemala is a lower-middle income country by world standards, but the incidence and intensity of poverty in Guatemala is comparable to that of the very lowest income countries.⁶ Guatemala has a high percentage of indigenous minorities (43%), most of whom live in the country's highlands where infrastructure, education and health care services reach far smaller percentages than are reflected in national averages. According to the Government of Guatemala's poverty reduction strategy, poverty levels are 71% for rural populations and 75% for indigenous populations,⁷ far higher than the nation-

⁵ Informe de Desarrollo Humano, Guatemala: el rostro rural del desarrollo humano. PNUD, Edición 1999.

⁶ Elements of a Poverty Reduction Strategy for Guatemala, USAID, 2000.

⁷ SEGEPLAN Estrategia de reducción de la pobreza, 2004 – 2015. Gobierno de Guatemala, Octubre 2003.

wide level of 57%, as determined by the National Survey of Living Conditions.⁸ Rural areas lack roads and general infrastructure, and have the lowest electrification indexes in the country. In the Departments of Alta Verapaz, Huehuetenango, Quiché, and San Marcos, poverty rates range from 76% to 87%, and electrification rates range from only 22% to 53%.⁹ While overall electrification rates for the country are higher, Guatemala's rural electrification program, *Programa de Electrificación Rural*, does not yet reach many of these communities.

Guatemalan infant mortality and under-five mortality rates are higher than average for Latin America and Caribbean countries (37 and 49 per thousand live births, respectively),¹⁰ with higher rates among indigenous populations. Child mortality is 44 per 1,000 live births nation-wide, and nearly double at 79 for indigenous populations.¹¹ Similarly, maternal mortality is 113 deaths per 100,000 births country-wide, with rates up to 267 in the highlands, reflecting the lack of medical assistance in rural areas where ethnic minorities live, which affects women most.¹²

The mounting data of severe levels of indoor air pollution and associated health impacts in the highlands of Guatemala, combined with advances in technology development in the region, have led various government agencies to refocus on household energy issues in Guatemala, with support from multi-lateral agencies and collaboration with NGOs active in pursuing solutions. Of particular note has been support from the Energy Sector Management Assistance Program (ESMAP),¹³ which has undertaken a series of studies and country consultations to identify needs and opportunities for developing a comprehensive national household energy program.

At the same time, Guatemala is a Global Village Energy Partnership (GVEP) pilot program country, with a high-level multi-sector team working together on a national action plan to address rural energy needs. Country Action Programs provide a vehicle for implementation of energy related activities developed in national and/or local poverty reduction strategies and development plans, and as such are a potential vehicle for collaboration and implementation of household energy and health activities.

The Guatemalan delegation includes representatives from the Ministries of Energy and Mines, Health, Agriculture, Planning, Economy, Education, Environment and Natural Resources, Guatemalan Association of Nontraditional Exports, and the private sector. The delegation is working with Fundación Solar (funded by United Nations Environment Programme), Advanced Engineering Associates International (funded by USAID) and local experts to develop a Guatemalan Action Plan, which will include selection of a small number of communities for initial pilot projects. Household energy and health issues have been discussed, and are likely to be addressed as part of a comprehensive approach to rural energy needs through these pilots.

Population

While fertility rates are decreasing in Guatemala, population growth is still high. Rural and indigenous populations have the highest fertility rates (lifetime births of 6.2 and 6.8 per woman) respectively. According to the census of 1994, 40% of Guatemalans are indigenous, and 70% live in

⁸ Encuesta Nacional de Condiciones de Vida (ENCOVI) 2000.

⁹ SEGEPLAN Estrategia de reducción de la pobreza, 2004 – 2015, Gobierno de Guatemala, October, 2003.

¹⁰ Sources for paragraph: CIA Factbook and

http://pooh.undp.org/maindiv/hdr_dvpt/statistics/data/indic/indic_85_3_1.html

¹¹ <http://www.pnudguatemala.org/documents/pdfs/milenio/MORTAL~1.PDF>

¹² MSPAS, 2000. Línea basal de mortalidad infantil (Infant Mortality Baseline).

¹³ Program of the World Bank/United Nations Development Program.

small rural communities. Some 40% of the population is under 15 years old, characterizing the population as very young.¹⁴ The portion of the population 15 years and under is higher in rural communities. Family size in Guatemala averages 5.1 people per household, with the average for urban households lower, at 4.7, than for rural areas, which averages 5.5. The following table reflects these trends.

Table 1 Population Trends, Projected to 2015¹⁵

Total Population			Annual rate of population growth		Urban Population			Population under 15		Population above 65		Fertility Rate	
(millions)			(%)		(% of total)			(% of total)		(% of total)		(per woman)	
1975	2001	2015	1975-2001	2001-2015	1975	2001	2015	2001	2015	2001	2015	1970-1975	2000-2015
6.0	11.7	16.2	2.6	2.3	36.7	40.0	46.2	43.3	37.4	3.6	3.9	6.5	4.4

Many rural Guatemalans migrate to the city in search of new opportunities and work, while others immigrate illegally to the United States. Several million Guatemalans live in the United States and send money home to their families—the transfer of monies from the U.S. is becoming one of the main sources of foreign exchange in Guatemala. This phenomenon may lead to some disposable income among rural populations (which suffer disproportionately from IAP-related illnesses) where early adopters of improved stoves and associated behavior changes may facilitate awareness and demand for such changes. There is no evidence, however, demonstrating the extent to which such transfers really do reach the rural poor, as opposed to urban middle class families, for example.

Poverty Rates

The incidence of poverty and extreme poverty is concentrated in the rural areas and among indigenous populations. ENCOVI, the 2000 Survey on Living Conditions,¹⁶ determined that 57% of the total population is below the poverty line, defined as an inability to meet minimum costs for food and non-food items,¹⁷ of which 74% are indigenous. These are families that cook mainly with firewood, and in a vast majority of cases, over open fires. Of note, 82% of Guatemalans live in rural areas.¹⁸

The World Bank conducted a Poverty Assessment Report for Guatemala, published in 2003, targeted at governmental decision makers. Although household energy and health issues were not directly addressed, report recommendations include that preventive health measures be emphasized, targeted particularly to the vulnerable groups that also happen to be the groups most affected by IAP: poor and malnourished children, poor women and girls, poor indigenous households, and the rural poor (World Bank 2003).

¹⁴ III Informe del Presidente al Congreso de la República, enero 2003

¹⁵ World Bank, 2004, www.worldbank.org

¹⁶ ENCOVI: Encuesta de Condiciones de Vida 2000

¹⁷ Of note, reported poverty rates for Guatemala vary. The CIA World Factbook, for example, estimates in 2002 that 75% of the population is below the poverty line in Guatemala.

¹⁸ ENCOVI: Encuesta de Condiciones de Vida 2000

Monthly Income Rates

Income in urban households is almost double that of their rural counterparts. In Guatemala, higher incomes correlate with diversified fuel use for cooking: firewood is complemented with liquid petroleum gas (LPG) and eventually (at high income levels) substituted.

Table 2 Household Income

MONTHLY INCOME AND MONTHLY EXPENSES					
<i>Total Country</i>		<i>Urban</i>		<i>Rural</i>	
Homes	Average	Homes	Average	Homes	Average
TOTAL HOUSEHOLD INCOME (US\$)					
1,997,537	402.61	866,067	590.42	1,131,470	258.85
TOTAL HOUSEHOLD EXPENSES (US\$)					
1,997,537	282.10	866,067	402.90	1,131,470	189.75

Survey 1998/99

Mortality Rates and Acute Respiratory Infections

Official statistics¹⁹ show that there has been a 27% reduction in national child mortality from 1990 to 2002, falling from 82 deaths per 1000 births to 60, largely due to wider health system coverage. It is important to note, however, that some isolated indigenous communities are not included in national statistics; births and deaths, for example, are not always reported. The statistics represent populations with at least some access to national health care systems. Consequently, marginalized populations with no access to health care (often the most at risk) are unreported, so official statistics are likely to underreport average child mortality.

Available Pan American Health Organization estimates²⁰ indicate that mortality from acute respiratory infections (ARI, including pneumonia, influenza, bronchitis, and bronchiolitis) in children under 5 in Guatemala is 1,215 per 100,000 live births.

Table 3 Child Mortality and Mothers' Health²¹

Mortality rate in children under 5 (per 1000)		Infant (0-12 months) mortality rate (per 1000 live births)		Mothers childbirth mortality rate (per 100,000 live births)	Births attended by specialized personnel - %
1990	2002	1990	2002	1995	1995-2001
82	49	60	36	270	41

The Ministry of Health's (Ministerio de Salud Pública y Asistencia Social, MSPAS) mother-child programs only reach a small portion of rural areas. They estimate that the coverage reaches about 28% of the population, and only 41% of children under 5 are tracked on growth and development.²² MSPAS does not have any statistics that directly relate ARIs with IAP, and the Health and

¹⁹ UNICEF, 2004: www.childinfo.org/cmr/revis/db2.htm

²⁰ Pan American Health Organization, 1994: <http://165.158.1.110/english/sha/be954acu.htm#current>

²¹ UNICEF, 2004: www.childinfo.org/cmr/revis/db2.htm

²² Primera Comunicación Nacional sobre Cambio Climático, MARN 2001

Environment division (*Salud y Ambiente*) does not directly address household energy, indoor air pollution and health. However, Recent MSPAS statistics cite pneumonia as the single greatest cause of infant death in Guatemala in 2000, accounting for 36% of all registered deaths among infants in the country.²³ Ministry representatives have attended several meetings and seminars that report on findings and correlations on ARI and IAP, but as yet the Ministry has not created a unit to address this issue.

Household Energy and Health Activities

Guatemala has been involved in improved cookstove initiatives since the 70's, starting with the Lorena stove, followed by plancha stoves, in various designs and adaptations. Several stove models have been technologically successful, and accepted by both the rural and urban communities. These efforts have been supported by multiple donors, NGOs, research organizations and universities.

In the 1980's, the Ministry of Energy and Mines was a key stakeholder in the dissemination of improved stoves, as well as a participant and local counterpart to stove and household energy programs. The FIS, Fondo de Inversión Social, has had the country's largest improved stove program in recent years (see p.22). It has installed more than 90,000 stoves in the country as part of its environmental program, and has an office in each Department²⁴ of Guatemala. These fully subsidized stoves are installed in response to requests by poor communities primarily in the Central-Western part of the country, largely inhabited by indigenous communities.²⁵

The following table provides a brief overview of the different phases of stove promotion and trainings that have occurred in Guatemala. A short history of studies and stove interventions follows in a separate table.

23 Health Impacts of Traditional Fuel Use in Guatemala, ESMAP 2003

24 Guatemala has 22 administrative subdivisions (Departments) administered by governors appointed by the president.

25 For instance, during the 2001-2002 years, from a total of Q\$ 43.812.156,00 invested in ICS project by FIS, 50% was allocated within the Central-Western Departments of Baja Verapaz, Chimaltenango, Huehuetenango, Quetzaltenango, Quiché, Sacatepéquez, San Marcos, Sololá and Totonicapán. 34% was spent in the southern Departments of Chiquimula, Jalapá, Jutiapa, Suchitepéquez and Zacapa, and the remaining 16% in the eastern Departments of Izabal and Alta Verapaz. (Source FIS).

Table 4 Overview of Stove Promotion and Trainings in Guatemala

Stove promotions and training	Experiences	Lessons learned
Lorena stove promotion 1970's-1980's	Used less wood, extracted smoke from the household. First design that dealt with the problem.	Not very efficient, and had maintenance and quality problems. Chimney to vent smoke from home is important, but requires maintenance and periodic replacement.
In 1987, CEMAT convened with the Foundation for Woodstoves Dissemination.	Experts from around the world gathered in Guatemala to evaluate stove dissemination issues, focusing on the Lorena stove.	World experts gathered in Guatemala to evaluate stove dissemination issues. A 1990 CEMAT market survey in Guatemala City found a lack of demand and models with unresolved technological problems.
FIS Plancha stove promotion 1990's	New design with a <i>plancha</i> , a metal top griddle with fire built in enclosed cinder block body, with chimney	Multiple designs, higher efficiency, good acceptance, effective venting of smoke with chimney.
1994-5 Ministry of Energy and Mines implementation of specific <i>school workshop</i> for training programs	Training metal workshops for <i>plancha</i> fabrication	The training produced artisans, who later proved to be key personnel to technically support the dissemination of the <i>plancha</i> stove.
2001 Mesoamerican Exchange on Efficient Cooking Techniques and Improved Stoves, conducted by Fundación Solar and Winrock International with funding from ESMAP.	Regional exchange of experiences with "new generation" of improved stoves among cooks, stove builders, researchers, NGOs, government agencies, and donors from Mexico to Panama.	Significant increases in efficiency and reduction in emissions can be achieved while maintaining culturally-accepted designs. Exchanges of this type are invaluable for advancing awareness of experiences with effective approaches to technology development and dissemination.

Guatemala has been a prime study area for indoor air pollution and health due to various conditions, including severe IAP (particularly in the highlands) and widespread adoption of the locally-improved *plancha* stove. A short history highlighting some of these studies and stove interventions is presented in the table below, with a brief summary of lessons learned. Throughout the 90's, dozens more studies on health-related impacts of IAP and IAP and exposure measurements were undertaken by numerous research institutions and NGOs in Guatemala ultimately leading to funding for the Maternal and Child Health intervention presented below.²⁶ A more comprehensive summary of the highlighted studies is presented in section VI (Household Energy, Indoor Air Pollution and Health in Guatemala). For more information on many of the studies not included below, please reference the Smith/McCracken Household Energy and Health in Guatemala Annotated Bibliography.²⁷

²⁶ A substantial portion of the support for this research has come from the U.S. National Institutes of Health. Additional support has come from WHO, IDRC, Emory University, Fulbright Foundation, Latin American Studies Program at UCB, Kresge Foundation, National Research Council of Norway, Healthy Housing Foundation, Maxwell Endowed Chair at the UC Berkeley School of Public Health, and the AC Griffin Family Trust, among others.

²⁷ http://ehs.sph.berkeley.edu/guat/publications/01_mccracken_1.pdf

Table 5 Overview of Studies Conducted

Study	Importance
Dary, Pioneda and Belizian. Study on CO contamination (1981)	Determined linkages between CO contamination and health in poor areas of Guatemala.
Boy, Rivera, and Delgado. Study of Risk Factors for Low Birth Weight in Quetzaltenango. (Institute of Nutrition of Central America and Panama, Guatemala).. (1992)	First study relating slow growth of fetus due to hypoxemia caused by inhalation of CO in rural women cooking in open fires. Found that babies born to mothers using wood fuels weighed less than those whose mothers cooked with gas or electricity.
Smith, Liu and Rivera. Indoor air quality and child exposures study (1993)	First documented studies on indoor air quality and child exposure in the highlands of Guatemala, showed correlation between respiratory diseases and smoke inhalation.
Multiple conducted field investigations led by UC-Berkeley/Liverpool/Guatemala/WHO teams (with support from various other institutions) mainly in the San Juan Ostancalco, Quetzaltenango area from 1992 to 2000, when the focus shifted to the San Lorenzo, San Marcos area.	Important research on air pollution and exposure measurements, fuelwood consumption and improved stoves through pilot studies, which laid the foundation for the intervention trial below.
University of California-Berkeley Maternal and Child Health Study in Highland Guatemala, and various associated studies in the San Lorenzo, San Marcos area. (2000-present)	First ever randomized intervention trial undertaken to increase confidence in ALRI risk estimates; characterize the exposure-response curve for particulate matter (PM) at higher levels than has been done within a single population; determine the benefit of stove intervention on mother's respiratory health; determine the impact of the high smoke exposures on heart disease risks among older women; examine the relationship between various environmental risks, including smoke, and childhood asthma; and improve long-term health conditions in the study area.
UNDP/ESMAP Health Impacts of Traditional Fuel Use in Guatemala (2003)	Major secondary source review of health impacts of traditional fuel use, outlining strategies and policies for IAP mitigation.
Fundación Solar. Evaluation of Improved Stoves Programs in Guatemala. Case Study Final Report : Tezulutl'an Project, FIS Project, and INTERVIDA Project (2002)	Evaluation of improved stove programs in Guatemala, with case studies on three large stove projects, conclusions and lessons learned from the three experiences. ²⁸
Schei, Hessen, Smith, Bruce, McCracken, Lopez. Study on Childhood Asthma and Indoor Woodsmoke from Cooking in Guatemala (2004)	Estimated the prevalence and severity of asthma, and the association with cooking on open wood fires, related to the Maternal and Child Health intervention study above. One of the first systematic studies of asthma and indoor wood-smoke pollution and the first asthma study in a purely indigeneous population in Latin America to authors' knowledge.

III. OVERVIEW OF HEALTH IN GUATEMALA

The main causes for morbidity and mortality in Guatemala are sicknesses related to diarrhea and ARI, both associated with poor environmental conditions and low socio-economic status. Recent Health Ministry statistics cite pneumonia as the single greatest cause of infant death in Guatemala in 2000, accounting for 36% of all registered deaths among infants in the country.²⁹

²⁸ Contracted as part of UNDP/ESMAP-funded World Bank study.

²⁹ Health Impacts of Traditional Fuel Use in Guatemala. ESMAP 2003

Infant Mortality and Under-5 Mortality

The official Guatemalan infant mortality rate and under-five mortality rate are below world averages, but higher than average for Latin American and Caribbean countries (see the two tables below). Guatemala's indigenous population has the highest mortality and infant mortality rates in the country. Life expectancy in Guatemala is 65 years.³⁰

Table 6 Comparison of Guatemalan Infant Mortality Rate with Other Regions

Infant Mortality Rate (per 1,000 live births)						
	1960	1970	1980	1990	1995	2000
<i>Guatemala</i>	<i>136</i>	<i>115</i>	<i>97</i>	<i>60</i>	<i>49</i>	<i>44</i>
Sub-Saharan Africa	153	136	119	111	110	108
Middle East and North Africa	157	127	92	58	54	49
South Asia	148	129	115	88	78	72
East Asia and Pacific	140	86	55	43	39	34
Latin America and Caribbean	102	86	62	43	36	30
CEE/CIS and Baltic States	78	59	45	36	34	30
Industrialized countries	31	20	12	8	6	6
Developing countries	141	108	88	70	66	63
Least developed countries	170	150	130	114	108	102
World	126	96	79	64	60	57

Table 7 Comparison of Guatemalan Under Five Mortality Rate with Other Regions

Under-five Mortality Rate (per 1,000 live births)							
	1960	1970	1980	1990	1995	2000	2001
<i>Guatemala</i>	<i>202</i>	<i>168</i>	<i>139</i>	<i>82</i>	<i>64</i>	<i>59</i>	<i>58</i>
Sub-Saharan Africa	253	223	194	180	177	174	173
Middle East and North Africa	250	196	132	81	71	62	61
South Asia	244	206	176	128	110	100	98
East Asia and Pacific	212	125	77	58	52	44	43
Latin America and Caribbean	153	123	84	54	43	36	34
CEE/CIS and Baltic States	103	76	58	44	42	38	37
Industrialized countries	37	26	14	9	8	7	7
Developing countries	223	166	132	103	96	90	89
Least developed countries	278	244	208	180	170	159	157
World	197	147	117	93	87	82	82

According to UNDP, Guatemala has a medium human development index score, based on three basic indicators: life expectancy, educational level and income per capita. In 2000, Guatemala ranked 129 of 173 total countries evaluated (173 being the worst).

³⁰ Informe de Labores al Congreso de la República 2003

Access to Health Services

Like in many Latin American countries, Guatemala's health services in rural areas are less accessible and comprehensive than those in urban areas, where population concentration is higher, and public services are more available (light, potable water, basic education, etc). Rural communities in Guatemala are highly dispersed, consisting of groups of homes separated by several hundred meters, rather than clustered in small villages, making service provision difficult. Rural electrification is very expensive and electricity consumption very low. Small villages often have health centers that provide basic services (e.g. vaccination), and to which doctors make periodic visits. In villages that do not have roads and/or are far away from clinics, health services are much more difficult to provide.

Table 8 Access to Health Services and Resources³¹

% Population with access to adequate sanitation services	% Population with dependable access to clean water	% Population with dependable access to essential medicine	% of 1-yr-olds immunized		Rate of oral rehydration use (%)	Rate of contraceptive use (%)	% Births attended by trained practitioners	Doctors per 100,000 inhabitants	Health expenditures		
			TB	Measles					Public (% of GNP)	Private (% of GNP)	Per capita
<i>2000</i>	<i>2000</i>	<i>1999</i>	<i>2001</i>	<i>2001</i>	<i>1994-2000</i>	<i>1995-2001</i>	<i>1995-2001</i>	<i>1990-2002</i>	<i>2000</i>	<i>2000</i>	<i>2000</i>
81.0	92	50-79	92	90	15	38	41	90	2.3	205	US\$ 192

Health and Gender

Guatemala shows no exception to the economic disparities between men and women common to the region: fewer women participate in the job market (35%) than men (67%), and when women do work in formal markets, their salary is lower, on average, than that of their male counterparts. In 1999, for example, the average income for women was 53% lower. Of the highest 10% of income-earners, 74% are men, while women comprise 75% of the lowest 10% of income-earners, true even when adjusting for education levels and positions.³² Further, women in Guatemala spend more time than men working in informal markets and working within the home, often logging more total work hours than their male counterparts. These gender-based economic disparities reflect cycles of poverty and inequality for women, and limit women's access to cleaner fuels and technologies. While women are the primary users of household energy, and often place a higher value on their children's health than men, it is often the men who are in charge of making household expenditure decisions for the family. Poverty also limits access to information, particularly for women. Basic information, such as the fact that smoke can kill infants, can enable mothers to make simple cooking and child-tending adjustments to improve their family's health.

³¹ UNFPA, 2004: <http://www.unfpa.org/swp/english/indicators/index.htm>

³² Slowing, 2001: 9

Table 9 Gender, Workload and Time Employed

Work Load			Daily Time Allocation (%)					
Total time of work (minutes per day)		Women as % of men	Total time of work		Time employed by women		Time employed by men	
Women	Men	(%)	Market Activities	Activities outside of market	Market Activities	Activities outside of market	Market Activities	Activities outside of market
678	579	117	59	41	37	63	84	16

Women still face high inequality in access to education. According to the Guatemalan Ministry of Education, girl drop-out rates reach 82% in rural areas and 50% in urban areas. Just 17% of girls finish grade school in rural areas, and 66% drop out by third grade. Though there is little data available on the time that girls spend gathering fuelwood in Guatemala, anecdotally it is among the more physically taxing and time consuming chores that girls participate in, thus often competing with class time and homework.

Health Care Programs

National health interventions in Guatemala are carried out by the Ministry of Health, mainly through its Integrated System for Health Attention (SIAS, Sistema Integral de Atención a la Salud), which primarily responds to outbreaks of infectious diseases, including seasonal illnesses. The SIAS supports trained personnel at health clinics to provide guidance to local communities on how to avoid illness, including through informational brochures, awareness campaigns, and vaccination campaigns.

Health expenditures in Guatemala have remained around 8% of total social expenditures, and roughly 1% of GNP, with no significant changes in the last several years.³³ According to a January 2003 Guatemalan Congressional report, national expenditures increased from Q1,178 million (1998USD \$185 million) in 1998 to Q1,939 million (2002USD \$257 million) in 2002—still insufficient to address all national health concerns, especially for reaching the poorer sectors of society.

Preventive campaigns undertaken in Guatemala include the April 2004 “Vaccination of the Americas Week,” sponsored by the PAHO, which included vaccination of children 1-6 years for measles, polio, rubella and infant flu and tetanus vaccines. Guatemalan government-run health centers also stock these vaccines, which are available year-round. AIDS awareness campaigns are coordinated by the Department of the National Program Against AIDS within the Ministry of Health.

The private sector has also been involved in preventative health campaigns, including anti-cholera and food disinfection campaigns via television and radio by bleach manufacturers, which include instructions on food disinfection and hand washing.

³³ Informe de Labores al Congreso de la República de Guatemala, January 2003

IV. HOUSEHOLD ENERGY, INDOOR AIR POLLUTION AND HEALTH IN GUATEMALA

In Guatemala, although only a few studies have been conducted to establish relationships between smoke inhalation and health within the country, a number of studies have measured indoor air pollution. At present, however, the largest and most comprehensive study of health and indoor pollution in the world is being conducted in the Guatemalan highlands, with results expected in 2006. Through studies in other countries, the high correlation between smoke inhalation and acute respiratory diseases has become better understood, but this understanding has only begun to result in action by government authorities and international organizations in Guatemala in recent years. More such action may be triggered by results coming from Guatemala itself. In Guatemala, the main governmental actors in household energy and health have been the Ministry of Energy and Mines (MEM) and the Social Investment Fund (FIS).

Indoor Air Pollution Exposure Evaluations

Many studies have been carried out in Guatemala over the past several years to better define the relationships among fuel type, stove use, and IAP. To a lesser extent, symptoms of ill-health have also been evaluated.³⁴

Dary, Pioneda and Belizian, 1981 pioneered a study on carbon monoxide (CO) contamination, determining linkages between CO contamination and health in poor areas of Guatemala.

Bruce et al, 1998 examined 340 women between the ages of 15 to 45 in a poor village in the western highlands of Guatemala. Results included high cough and phlegm prevalence among women exposed to open fires, and identification of confounding factors such as dirty floors, present in 82% of open fire-using home, as opposed to 16% of plancha stove users. As dirty floors can affect the level of suspended particles within a household, it interferes with observational studies. Consequently, the authors suggest intervention studies to determine the level of influence of this confounding factor in IAP and its effect on health.

To understand the impact of IAP on larger numbers of people, *Naeher et al, 2000*, monitored both outdoor air pollution and IAP generated by various stoves types (open fires, Lorena, plancha and LPG), sampling for 2-3 minutes at breakfast, lunch and dinner in 98 homes distributed among three villages with high population density and four with low population density. The findings were consistent with other studies; open fires had the highest emission of carbon monoxide (CO) and PM_{2.5}-- 22.9 ppm and 5.31 mg/m³ respectively, the Lorena stove 15.4 ppm and 6.03 mg/m³, the plancha stove 10.3 ppm and 1.91 mg/m³, and LPG stoves 3.5 ppm and 0.13 mg/m³.

The study found significantly higher levels of outdoor CO and PM_{2.5} pollutants in high-density villages than in low-density villages, indicating that high concentrations of higher emission stoves do affect outdoor as well as indoor air quality.

³⁴ Funders have included: the U.S. National Institutes of Health, WHO, IDRC, Emory University, Fulbright Foundation, Latin American Studies Program at UCB, Kresge Foundation, National Research Council of Norway, Healthy Housing Foundation, Maxwell Endowed Chair at the UC Berkeley School of Public Health, and the AC Griffin Family Trust, among others.

For a more comprehensive picture of the various pollutants generated by different stoves, *Naeher, Leaderer and Smith, 2000*, evaluated CO, total suspended particulates (TSP), PM₁₀ and PM_{2.5}, following four different cooking scenarios, with 22-hour average samples in three test homes in the rural Guatemalan highlands.

Table 10 Comprehensive Picture of Various Pollutants Generated by Different Stoves

	<u>Background (no fire)</u>	<u>open fire</u>	<u>plancha</u>	<u>LPG stove</u>
CO (ppm)	0.2	5.9	1.4	1.2
TSP (mg/m ³)	174	836	276	218
PM ₁₀ (mg/m ³)	173	717	210	186
PM _{2.5} (mg/m ³)	56	528	96	57

Through extended measurements within a small sample of representative kitchens, this study demonstrated that improved plancha stoves with chimneys and LPG stoves reduce exposure to 10 to 20% of that found in kitchens using open fires. Comparisons with other studies in the area indicate that exposure reductions achieved by improved wood-burning stoves diminish with stove age without proper maintenance. For instance, a cross-sectional study of 43 households by Naeher et al, 1996, found out that the mean kitchen PM_{2.5} level for 26 plancha stoves (with ages varying from several months to over a year old) was 152 mg/m³, in contrast with only 88 mg/m³ for 3 new plancha stoves evaluated by the study. As reported by Miranda, 2003, it is not uncommon for older plancha stove griddles and mason bodies to crack. In addition, many stove users lose some of their early training skills over time, which leads to poor maintenance and consequently bad performance of the stove, such as lower energy efficiency, higher emissions, clogged chimneys and indoor smoke leaks.



Typical households in western highland in Guatemala using open fires.

Photos by Kirk Smith and Nigel Bruce.



**Typical households in western highland using a plancha stove (left) and open fire (right).
Photos by Kirk Smith and Nigel Bruce.**

In order to evaluate existing stove options in the region, *Albalak et al, 2001*, undertook 24-hour monitoring of particulate matter under 3.5 microns ($PM_{3.5}$) concentrations over 8 months for traditional open fires, improved plancha stoves, and a combination of LPG/open fire stoves. The results indicated concentrations of $1560 \mu\text{g}/\text{m}^3$ for the open fire, $280 \mu\text{g}/\text{m}^3$ for the plancha stove, and $850 \mu\text{g}/\text{m}^3$ for the LPG/open fire combination, representing a 45% reduction in $PM_{3.5}$ concentrations for the LPG/open fire combination over open fire, and an 85% reduction in $PM_{3.5}$ concentrations with plancha stoves.

One important outcome of the study was to highlight concentrations generated by combined use of LPG stoves and open fires, as households often supplement gas stove use with open fires for space heating and more energy-intensive cooking. Families with gas stoves often use them for quick-cooking tasks such as frying eggs, heating water for coffee, and heating leftovers. The authors found that older women often felt uncomfortable with the new technology.

Boy, Bruce and Delgado, 2002, undertook the first study on the association between biofuel use and reduced birth weight. Results indicated that children born to mothers who routinely cook over open fires had the lowest mean birth weight (of 2.819kg), while those whose mothers used a plancha stove had an intermediate mean (of 2.863kg), and those whose mothers used the cleanest fuels (electricity or gas) had the highest mean (2.948kg). Some 19.9% of babies born in homes using open fires had low birth weights (<500g), compared with 16.8% for plancha stove users and 16.0% for users of electricity/gas. After adjusting for confounding factors associated with fuel type, fuelwood users still had a lower average birth weight by 63g.

Efficiency Evaluations

McCracken and Smith, 1998 used a water boiling test (WBT) to compare thermal efficiencies for open fires and planchas stoves, finding efficiencies of 14.8% for the open fire and 13.7% for the plancha stove, not statistically significant differences. The plancha stove took 32.2 minutes to

accomplish the WBT, versus. 25.4 minutes for the open fire. Simultaneous measurements of indoor emissions, however, showed that the plancha emitted 87% less PM_{2.5} and 91% less CO than the open fire per kJ of useful heat delivered. In a standardized cooking test (SCT), in which beans and tortillas were cooked according to local custom, the plancha stove emitted 99% less TSP and 96% less CO. The authors concluded that since a strong correlation was found between average kitchen concentration of CO and PM_{2.5}, CO can be used as inexpensive and accurate way to estimate PM_{2.5} kitchen concentration.

Boy et al, 2000, in a study in San Juan Ostuncalco, measured the thermal efficiency of the plancha stove (9.33%) compared with that of the open fire (11.08%) during a high power phase (HPP).³⁵ The study found no significant difference in thermal efficiency for the low power phase (LPP)³⁶ (15.94% vs. 16.05%, respectively). The combined efficiency, which includes both the high and low power phases, showed that the open fire was significantly more thermally efficient (12.54%) than the plancha stove (10.35%).

The inclusion of a baffle within the plancha combustion chamber to force hot gases upward toward the pots significantly increased the stove's efficiency during the HPP (by 40%) but significantly decreased the efficiency during the LPP (by 32%). The modification increased overall plancha thermal efficiency to 12.43%, bringing it up to the level of the open fire.

An important observation in this study was that a high proportion of plancha stoves (67%) had to be excluded from the initial sample because of structural defects and poor maintenance, observed in other studies as well.

Naeher, et al, 2001 also found CO to be a good proxy for PM_{2.5} in homes using open fires or planchas, but not under gas stove use conditions, due to changing ratios of PM/CO. The study also determined that mother personal CO exposure is a good proxy for child (<2yr) personal CO, and that area CO measurements are not strongly representative of personal CO exposure measurements. This is primarily due to the fact that mothers and children do not stay in the kitchen all the time, and that the time they do spend there does not always coincide with times of higher emissions (which also vary greatly within the same burning cycle depending on fuel feeding dynamics).

Kuwabara 2003 also evaluated the thermal efficiency of open fires versus. plancha stoves using the water boiling test, finding 15% efficiency for open fire and 6.6% for plancha stoves.

While plancha stoves rate less thermally efficient than open fires in performing water boiling tests, their efficiencies increase when cooking for longer periods of time, due to better fuel management options and as a result of the stove body warming up over time.

V. HOUSEHOLD ENERGY IN GUATEMALA

While Guatemala has long depended upon fuelwood, a move toward LPG has been observed in recent decades, primarily in urban areas. The following table of census data for household cooking fuels used in Guatemala shows an increase in LPG use of 65% for urban areas, while only 11% for rural areas. Meanwhile, fuelwood use has increased 29% in urban areas, in contrast to 86% for rural areas.

³⁵ The high power phase (HPP) test consists of bringing a fixed amount of water from ambient temperature to boiling temperature and keeping it at boiling temperature for 15 minutes.

³⁶ The low power phase (LPP) test consists of maintaining the boiling temperature ($\pm 1-2^{\circ}\text{C}$) for an additional 60 minutes.

Table 11 Household Cooking Fuels Used in Guatemala

Household cooking fuels used in Guatemala according to the 1981, 1994 and 2002 national census.										
Household fuel	Census 1981		Census 1994		Census 2002					
	Total	%	Total	%	Urban areas	%	Rural areas	%	Total	%
Total	1,151,872	100.0	1,591,823	100.0	1,104,994	100.0	1,095,614	100.0	2,200,608	100.0
Electricity	14,957	1.3	24,604	1.5	45,808	4.2	12,842	1.2	58,650	2.7
LPG	164,789	14.3	483,034	30.3	722,007	65.3	121,700	11.1	843,707	38.3
Kerosene	57,041	5.0	8,239	0.5	7,350	0.7	8,494	0.8	15,844	0.7
Fuelwood	889,899	77.3	1,059,214	66.5	317,845	28.8	944,107	86.1	1,261,952	57.3
Charcoal	6,587	0.6	3,201	0.2	1,566	0.1	2,072	0.2	3,638	0.2
No cooking	18,599	1.6	13,531	0.9	10,418	0.9	6,399	0.6	16,817	0.6

It is important to note that when lower-income households and those in rural areas adopt LPG stoves, they tend to still use fuelwood either as the main cooking fuel, or as a secondary fuel for the cooking of energy-intensive foods such as beans and corn. In addition, many families with improved stoves still use open fires to prepare large amounts of food (i.e. for celebrations) and to warm homes in colder climates. When the weather is cold and wet, open fires are used to dry clothes. Open fires are also used for complementary illumination, primarily in rural homes.

The 2000 Living Standards Measurement Survey (LSMS) confirms that fuelwood is still the main fuel of Guatemala, with 73.6% of the households relying on it, as broken down in the following table:

Table 12 Fuels Used in Guatemala

Fuels Used	Urban	Rural	Region (%)								Total
			Metrop.	North	North East	South East	Central	South West	North West	Petén	
Fuelwood	45.2	95.4	32.0	94.0	77.9	89.7	79.8	87.9	95.3	92.1	73.6
Kerosene	1.4	8.4	0.8	7.3	8.9	6.2	5.6	7.4	2.9	18.3	5.4
LPG	78.0	20.3	82.9	15.4	45.9	31.9	49.2	35.8	13.9	22.3	45.3
Charcoal	24.6	3.4	31.0	1.6	11.1	5.8	12.4	5.7	3.3	2.4	12.6
Electricity	4.8	0.8	4.1	1.0	4.9	1.8	2.6	1.7	1.9	0.7	2.5
Other	3.1	11.5	2.7	2.5	8.2	5.3	2.1	15.1	16.1	1.4	7.9

The survey results above demonstrate a clear overlap of fuels. Living Standards Measurement Survey data below provides the breakdown.

Table 13 Fuel Use Patterns in Guatemala

Fuel Option	% of households using the fuel	
	Rural	Urban
LPG only	4%	52%
Fuel wood only	42%	17%
Multiple fuel use	55%	31%

Source: LSMS 2000

More recent studies have found that in urban areas 37-49% of the households use fuelwood plus another cleaner option, mostly LPG and/or charcoal. Some 69% of rural households use fuelwood exclusively, while just 3% rely solely on LPG.³⁷ Guatemala's high dependence on fuelwood, especially in rural areas, has important IAP implications. Chimneys are uncommon, and the traditional style of cooking in rural areas is over open fires, which takes longer, and produces higher emissions than an improved stove or when cleaner fuels are used.

It is estimated that Guatemala loses an estimated equivalent of 2,460 hectares of biomass annually due to firewood consumption,³⁸ out of an overall annual deforestation rate of approximately 90,000 hectares per year, the major causes of which are shifting agriculture and new pasture land.³⁹ Multiple isolated efforts have been made by the Government, NGOs and international aid in the last thirty years to make firewood use more efficient.

³⁷ Health Impacts of Traditional Fuel Use in Guatemala, ESMAP, 2003

³⁸ FAO, 1997

³⁹ Kaimowitz D. 1996. *Livestock and Deforestation Central America in the 1980's and 1990's: A Policy Perspective*. Center for International Forestry Research. Indonesia.

VI. KEY ACTORS AND STAKEHOLDERS IN HOUSEHOLD ENERGY AND HEALTH IN GUATEMALA

Government

Ministry of Public Health and Social Assistance (MSPAS)

The Ministry of Health and Social Assistance (MSPAS) is the national entity responsible for ensuring national access to health services. MSPAS has a center in each department, called *Jefaturas de Area*, and health district that supervise the health posts. The MSPAS network covers the country through one of three mechanisms: health posts and community centers; health centers; and the hospital centers.

In an effort to expand health coverage in rural areas, and due to difficulty among the rural indigenous population in accessing the national health services (due to geography and language barriers, poverty, lack of roads and communications), some health services are outsourced and provided at a community level through the *Sistema Integral de Atención de Salud* (SAIS), or Integrated System for Health Attention. The SAIS network currently has about 2121 health centers throughout the country, supported by MSPAS through agreements with NGOs to provide coverage to specific populations,⁴⁰ benefiting 3.2 million people. This extension was achieved through 154 agreements with 95 NGOs, administrators and service providers. Some 280 basic health care teams, totaling 35,526 people, have participated in this effort, 99% of which are local community members.⁴¹ The SAIS network could be an excellent delivery system for household energy and health-related education in rural areas.

In addition to MSPAS coverage, the Instituto Guatemalteco de Seguridad Social (IGSS, the Guatemalan Social Security Institute) provides health coverage for public and private sector employees. IGSS users generally have a better-than-average economic position and only a small percentage rely exclusively on firewood for cooking. According to Government statistics, these forms of health coverage together reach 92% of the population.

Table 14 Government Health Coverage, 2002

Institution	Total Population	Percentage
Total	10.9	92
MSPAS	8.9	75
IGSS	2	17

Source: MSPAS and IGSS, Institutional Reports 2002

Complementing the above-mentioned organizations, there is widespread use of traditional medicines, practiced mainly by the rural indigenous population. Additionally, there is a private health care system in Guatemala, used by the high-income sector of the population.

Although the Health Ministry has a unit addressing ARI⁴² and has been invited to participate in household energy and health programs and informed by the Ministry of Energy and Mines, ESMAP, Social Investment Fund (FIS) and NGOs such as Fundación Solar, they have not yet been involved in any household energy or IAP initiatives, nor has any formal unit been established within the Ministry to address household energy and health (HEH). Guatemala's new government administration is in

⁴⁰ Informe de Labores al Congreso de la Republica, enero 2003

⁴¹ III Informe del Presidente al Congreso de la República, enero 2003

⁴² ARI Director: Dr. Enrique Molina, Telephone: 4750914/17

the process of reorganizing work programs, and HEH may be then brought into the Health Ministry's agenda.

Ministry of Energy and Mines (MEM)

The Ministry of Energy and Mines (MEM) is part of the General Direction of Energy. This Ministry's mission is to contribute to sustainable energy development in Guatemala, promoting supply, renewable energy, nuclear energy, and efficient use and economic competitiveness of electricity, to contribute to the sustainable economical, social and environmental development of the country.⁴³

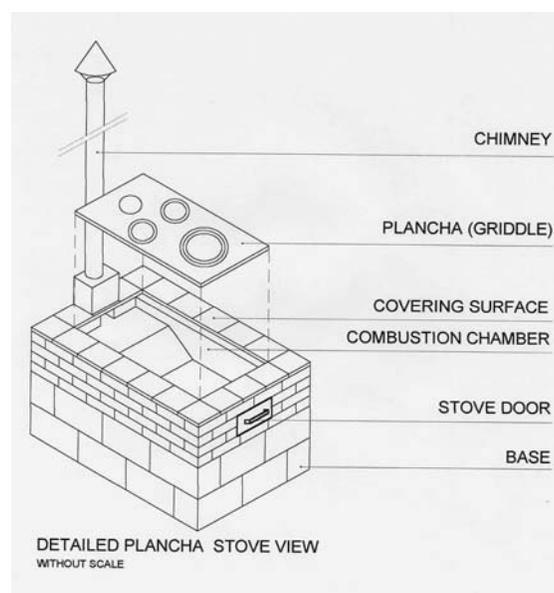
From 1982 to 1986, the MEM sponsored the creation of the National Group for Improved Stoves, comprised of 27 public and private institutions involved in the dissemination of the popular Lorena cookstoves. This group was a forum for exchanging ideas and experiences regarding improved cookstoves (ICS) in Guatemala. Key results included the formulation of a national program to develop ICS, an interinstitutional information exchange system, workshops on ICS construction and maintenance, a directory of ICS institutions, and a national survey on ICS. With changes in government administration, however, this group dissolved after 1986. A partial group participant list is available in the attached annex.

The Ministry of Energy and Mines first became involved in stove dissemination in 1983, working with a steel-reinforced portable cement "CETA stove," developed by the Engineering Research Center of Guatemala's San Carlos University. The MEM further developed this stove model, producing and disseminating over 2000 units, and provided training on its production to interested parties. The MEM also evaluated the "Finlandia stove," disseminated in the early 1990's along the borders of Guatemala, Honduras and El Salvador by the Organization of American States Trifinio project.

The MEM again was involved with ICS after the development of the Plancha stove by Manuel Tay in the early 1990's. Given a lack of commercial success with stoves in Guatemala, the MEM joined in partnership in early 90's with several NGOs (PRODEFOR, FUNDAP and Proyecto Cuchumatanes) to further develop the Plancha stove, a basic version of which was being used by communities in northwest Guatemala, and parts for which could be found in local hardware stores. The team standardized the combustion chamber size, and added a chimney, dampers and stove doors. In 1994-95 the MEM sponsored the training of about 70 plancha stove builders, including manufacturing of the plancha griddle. These trained professionals today support the dissemination of plancha stoves throughout the country.

To promote the improved technology, the MEM built demonstration stoves in rural regions, set up a demonstration metal workshop for Plancha production-- to supply stove demand generated by NGOs

Figure 2 FIS Standard Plancha Stove Model



Source: Guatemalan plancha stove cost study. ESMAP/WB, 02/2003, unpublished.

⁴³ <http://www.mem.gob.gt/energia/index.htm>

and projects-- and trained people interested in setting up their own Plancha production business. This shop facilitated wide and rapid commercialization and dissemination in western Guatemala. Community demand for the improved Plancha continues to grow, and several other development agencies have incorporated the technology into their portfolios of projects.

While MEM's initial ICS objective was to increase efficient use of firewood, after working with Fundación Solar and the World Bank, MEM now includes in its programs information on smoke inhalation and ARIs. The MEM participated in the Mesoamerican Exchange on Efficient Cooking Practices and Improved Stoves in 2001, (see section on Fundación Solar) and more recently in the World Bank study on HEH in Guatemala. The MEM has recently reinitiated ICS dissemination activities in Alta Verapaz, with over 100 stoves installed or in process this year. The MEM aims to install 1000 stoves in 2004. In current MEM initiatives, users provide construction materials and the MEM provides the *plancha*.

Social Investment Fund (Fondo de Inversión Social FIS)

The Social Investment Fund (Fondo de Inversión Social: FIS) is a temporary decentralized national entity (from 1993 to 2006), independent from the presidential administration in resources and functions. Its objective is to improve quality of life for rural Guatemalans, through initiatives related to water and sanitation, education, health and nutrition, environment, and income generation.

Since 1996, through its environmental unit, FIS began an aggressive ICS dissemination program, installing on average 15,000 plancha stoves per year, and has installed over 100,000 units to date. The stove program's objective is to reduce fuelwood collection time, reduce pressure on forests and improve indoor air quality. Until recently, the FIS ICS program had become the predominant ICS program in Guatemala, but is now on hold (see more detail below).

The FIS program responds to community requests to be involved in the stove program. FIS technicians recommend project approval based on a site evaluation. Stove builders are then contracted through competitive bidding to build the stoves. FIS standardized the plancha stove design beginning in 1998 for quality assurance.

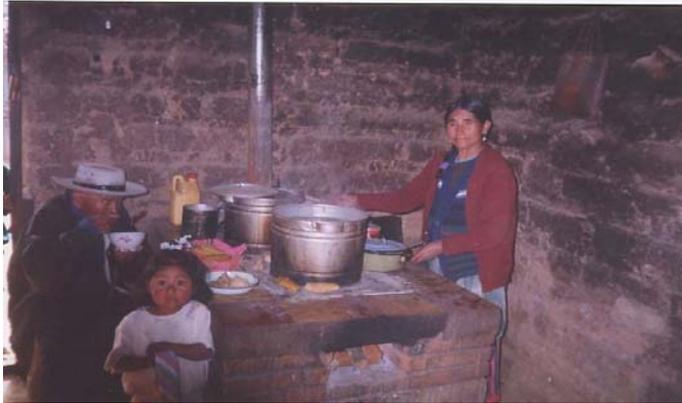
The estimated cost of each stove ranges between US\$100-145, depending on the community location. While the program is subsidized, each community must contribute (unskilled) labor, local materials (including mud, molasses and sand) and provide lodging for the contractor's specialized improved cookstove mason. The selected contractor must deliver a complete stove and guarantee its performance for at least one year; another contractor is responsible for the training of the beneficiaries regarding the plancha stove operation and maintenance.

In the first few months of the Berger administration, this program was halted due to lack of new funds and an internal audit of the previous FIS administration. Recently, with US\$563,000 in new funding from Central American Bank for Economic Integration (BCIE), the program is being restarted to benefit at least 3700 households with plancha stoves within the next 3 years. Further funds, which likely will include a stoves component, are currently being negotiated with The World Bank. FIS is now performing an evaluation of its programs (including the ICS program), with results expected by late September 2004.

The FIS ICS program has widely disseminate the plancha stove model, created a job market for several stove contractors and many plancha manufacturers, and may have induced other NGOs and government agencies to pursue ICS projects, and some users to acquire a plancha stove.

An assessment of the costs and performance of FIS plancha stoves by ESMAP (Miranda, 2003), concluded that FIS overall stove costs are on average 36% higher than the expected real value of the

stoves in terms of materials, mostly due the fact that FIS uses private contractors to built the stoves. These stoves are good quality in general, with an average lifespan of above five years, but for adequate performance, the stoves need proper maintenance and repair by the stove owners (not often performed). The most common problems are related to the chimney (incomplete installation, broken or clogged), missing stove doors, stove body cracking, and eventual warping of the griddle. These malfunctions result in higher than expected emissions and lower energy efficiencies.



**Typical plancha stove promoted by FIS.
Photo by Rogério Carneiro de Miranda.**



**Plancha stove installed
with Fundación Solar support**

NGOs

*Fundación Solar*⁴⁴

Fundación Solar is a Guatemalan non-governmental organization that has been working in the field of water, renewable energy and rural development since 1993, founded with collective support from Winrock International, USAID, Sandia National Laboratories and NRECA (National Rural Electric Cooperative Association). Fundación Solar (FunSolar) has been involved in household energy studies, project implementation and policy development, through its gender and energy units. With ESMAP support, FunSolar recently developed case studies on improved stoves in Guatemala,⁴⁵ including the FIS program. With support from CARE and USAID, FunSolar installed over 800 improved stoves in 19 poor rural communities in Cahabón in 2000-2001. These activities were part of a post-Hurricane Mitch project integrating the provision of rural energy services (including solar household systems and improved wood-burning “plancha” style stoves) with the adoption of soil conservation techniques and diversified production to improve land management in order to reverse damage caused by soil misuse, and minimize the effects of future natural disasters. As an emergency project, it required rapid execution by nature. As a result, Fundación Solar was unable to complete usual project planning with users (male and female), nor were they able to perform a needs assessment based on user input. Consequently, not all users adapted well to the PV systems and stoves—some are now in disuse, or disrepair. Lessons learned include:

⁴⁴ <http://swtdi.nmsu.edu/funsolar/index.shtml>

⁴⁵ Evaluación de Programas de Estufas Mejoradas en Guatemala. Informe de estudios de caso. Banco Mundial/ESMAP, Agosto de 2002.

- Women are the principal energy consumers in the household, therefore it is important to include a gender approach to energy related projects. Effectiveness requires more time involved in training and in monitoring gender progress.
- For a large project to help many people, it must have a strong social component support and a large follow-up team to monitor sustainability.
- It is important to establish coordination at the field level between private sector vendor/installers of equipment, promoters of development organizations involved in the area and community representatives, in order facilitate technical audits of the systems installed. This allows for prompt repair for any malfunction or technical failure, avoiding negative perceptions of end-users on the reliability of their equipments. Furthermore, this encourages users to pay their organization and maintenance fees on time.

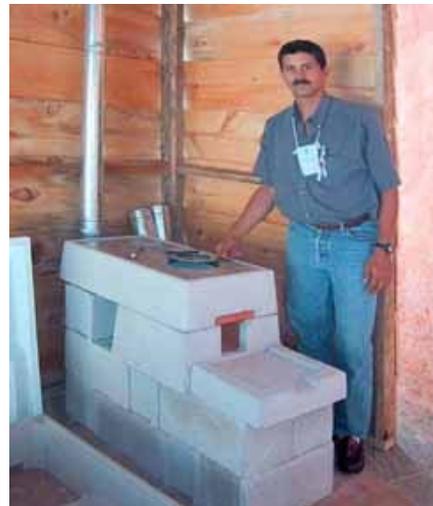
In 2001, Fundación Solar and Winrock International jointly coordinated a regional workshop on efficient cooking techniques and improved stoves with funding support from the World Bank's Energy Sector Management Assistance Program (ESMAP) in support of the Mesoamerican Gender in Sustainable Energy (GENES) network. The purpose of the workshop was to catalyze the sharing of experiences with the "new generation" of cooking techniques and technologies being developed around the region since the late '90's.

Over 70 women and men from throughout the region participated, including policy-makers, stove designers, project implementers, development practitioners, health researchers, stove users and local entrepreneurs. The three-day workshop included cooking demonstrations of various models of efficient woodstoves, as well as solar, LPG and coal stoves, and placed an emphasis on the multi-level, cross-sectoral nature of household energy, including participatory design processes, efficient design principles, health and safety issues, emissions exposure monitoring, materials, economics, commercialization models, and enabling policy environments. This workshop represented the first opportunity to share experiences on a regional level in nearly a decade, and the first time that cooking smoke and associated health impacts were explicitly addressed.

*HELPS International*⁴⁶

Helps International was organized in 1984 as a US nonprofit organization that works in partnership with rural Guatemalans to improve water, medical care, education, housing, agricultural and economic development.

Since 1999 HELPS has been promoting an improved cookstove with a rocket stove principle-based design. HELPS first got involved with household energy when US volunteer medical teams noticed a significant number of locals burned by cooking over open fires. With the assistance of Aprovecho Research Center, HELPS developed a portable cement molded stove, very similar to the plancha stove, but with a smaller two-pot hole griddle, and a rocket stove combustion chamber for high efficiency.



Richard Grinnell with the portable cement molded stove.

⁴⁶ <http://www.helpsinternational.org>

Currently, HELPS has a production facility in Rio Bravo, Suchitepequez with capacity of 500 units per month. With a grant from the Shell Foundation, HELPS has disseminated 2500 units in the past year, totaling 3000 units throughout the country. The sales price of the stove is Q\$570 (~US\$69), and over 80% of HELPS' sales have been to NGOs and development projects, including Plan International, CARE, World Vision, and Save the Children. Furthermore, according to stove project manager Richard Grinnell, HELPS is negotiating a contract for another 2400 units with the Guatemalan office of the First Lady, which has received a US\$200,000 donation from the government of Taiwan.

In addition to the portable cement molded stove, HELPS also produces and promotes a Nixtamal stove, which is basically a half barrel stove with a rocket stove burner. This stove accommodates larger pots, and is especially well suited to cook corn for tortillas, and is sold at Q\$120 (~US\$15).

For both stoves, HELPS provides a ½ day training to the stove users, usually through local stove promoters.

HELPS has recently received a USEPA grant to manufacture and promote retained heat cookers (“hay boxes”) along with its stove, to further decrease energy requirements for cooking. This project will use locally available insulation materials so that the hay boxes may be built in the communities. By using hay boxes, HELPS anticipate an additional 15% saving in firewood in homes already using improved cook stoves.

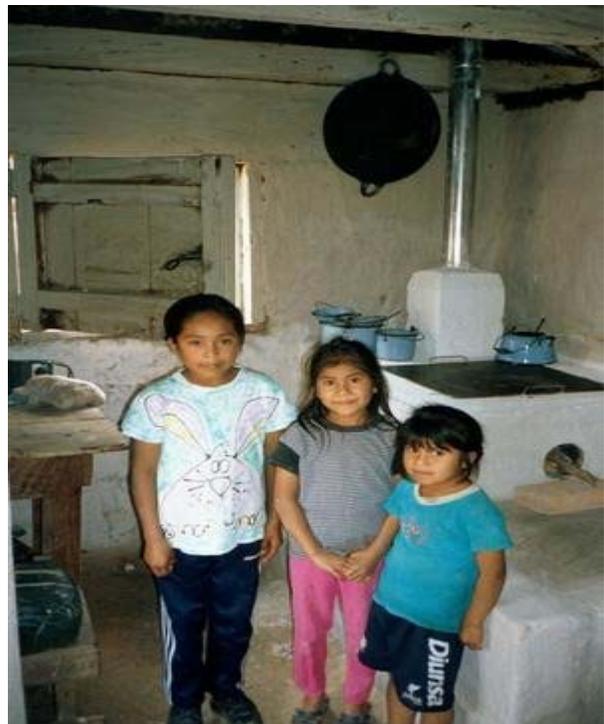


Guatemalan women preparing corn in a Helps nixtamal stove. Photo by Helps International

*Trees, Water and People (TWP)*⁴⁷

TWP is a U.S.-based NGO with field operations in Guatemala, and partnerships with other NGOs in Central America and Brazil. TWP's mission is to help local people to sustainably manage watersheds in order to protect their forests and natural resources.

In addition to its reforestation efforts, TWP has been promoting Justa stoves in Central America, including along Guatemala's southern coast since 1999. The Justa stove is a rocket stove-based vented fixed stove model, built at the home of each customer/beneficiary with a brick frame insulated by wood ash, and has a square or rectangular solid metal griddle. In addition to high efficiency provided by the rocket design, the Justa stove



Typical TWP Justa Stove in Guatemala. 26
Photo by Trees, Water and People

⁴⁷ www.treeswaterpeople.org

dramatically reduces IAP, as the stove body, griddle and the chimney are sealed.

TWP's activities on Guatemala's southern coast involve collaborating with rural women to build 400 Justa stoves. TWP field personnel and female community promoters are promoting the stoves in 12 communities between the town of Tiquisate and the coast. TWP works with community leaders and local community organizations, holding promotional workshops to introduce the stoves to community members. Interested families must build the base for the stove and provide some of the materials (sand, clay and wood ash for insulation) in addition to US\$5 to pay the stove builder. Rotary Club funds the remaining \$50 per stove, which includes \$40 for materials and \$10 to cover transportation, training and other costs.

Prior to this project, TWP funded the construction of 150 Justa stoves in Guatemala; 100 on the southern coast and 50 in cooperation with indigenous women in the highlands.

*Fundación Intervida*⁴⁸

Fundación Intervida is a Spanish NGO that has supported community development in the western highlands of Guatemala since 1996. Intervida's work is based on child sponsorship by Spanish citizens, and its program areas include community organization, education, infrastructure, cultural events, young people, health, nutrition and environment.

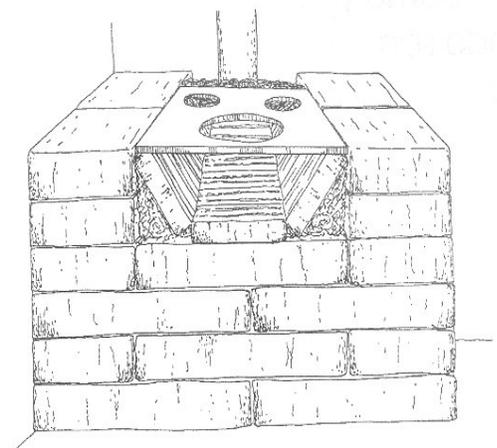
From 1998 to 2002 Intervida implemented a plancha stove project of over 9000 units. Project goals included watershed protection and improved housing conditions. Intervida's methodology is similar to that of FIS, consisting of hiring a contractor to build the stoves, but the \$82 capital cost of the stove provided by Intervida is a loan, which must be paid back to a local community fund within one year. This fund is later used to finance income generating activities. Woodstoves were also implemented in some rural schools.

This stove project is scheduled to run through 2010 as part of Intervida's watershed management strategy. Through this project Intervida staff has learned that stoves projects require a strong community assistance effort.



**Typical plancha stove promoted by INTERVIDA.
Photo by Rogério Carneiro de Miranda**

Figure 3 TEZULUTLA'N stove model



⁴⁸ www.intervida.org

Plan International

Plan International is an international development NGO that also uses a sponsored child approach. The goal of Plan International's work is to improve the educational and living conditions of the sponsored child and his/her family.

PLAN's stove project was based on early Tezulutla'n work; a rural development project jointly financed by the European Union and Guatemalan government from 1997 to 2002, and implemented in the department of Baja Verapaz, northern Guatemala. The goal of the stoves component of the project was to improve working conditions in the home for women and children, especially health and hygiene.



**Typical Plan International plancha stove.
Photo by Rogério Carneiro de Miranda**

At the time, Tezulutla'n, with the help of local women, improved the design of the plancha stove to best fit the needs of their communities. One difference between this model and the standard plancha stove promoted by FIS is that the base of the stove is made of local materials such as adobe or a mud and cow manure mix. Furthermore, the side bricks of the combustion chamber are at a 30-degree diagonal instead of vertical (see figure above), to reduce the size of the chamber and force the heat upward, increasing efficiency.⁴⁹ Other differences include a support base for the fuelwood at the stove door, and the use of cement or ceramic tubes for the chimney.

During its existence, the Tezulutla'n project disseminated 4129 stoves in partnership with two other local NGOs.

With technical assistance from Tezulutla'n, Plan has built 1703 stoves from 1998 to 2002 within their assisted communities. Plan financed the cost of the chimney, stove door, metal griddle (plancha), ceramic bricks for the combustion chamber, molasses, transportation and skilled labor (a mason contracted through local NGO APADRODESH).

Beneficiary families contribute the concrete blocks for the stove base, cement, lime, sand, mud and unskilled labor to assist the mason. The approximate cost for this stove is ~US\$80.

Centro Mesoamericano de Estudios sobre Tecnología Apropriada (CEMAT)

CEMAT is a Guatemalan NGO formed in response to the 1976 earthquake, to help reconstruction efforts and specifically to provide new appropriate technologies. In the early 1980s, CEMAT became the Latin American node for the Foundation for Woodstove Dissemination (FWD), an international networking organization with headquarters at that time in Holland and funded by the Dutch foreign aid agency. In 1987, CEMAT hosted the Second FWD International Conference in Antigua, which was funded by a group of donors including the International Development Research Centre (IDRC) of Canada. At the meeting, experts from around the world gathered in Guatemala to evaluate stoves dissemination issues. Many of the papers given at this conference were published in

⁴⁹ Informe Técnico de Estufas Modelo TEZULUTLA'N. Mayo del 2002. Proyecto TEZULUTLA'N, ALA 94/88.

Caceres, R., J. Ramakrishna, & K.R. Smith, eds., Stoves for People, Intermediate Technology Pubs, London, 1989.

In 1990 CEMAT developed a market survey for woodstoves within Guatemala City. The survey found that although there were many stove models and producers at the time, consumers were unenthusiastic about buying woodstoves, and models had many technological problems not yet resolved.

CEMAT currently works in training and stove construction and maintenance (primarily for metal plancha stoves), incorporating complementary activities, such as using wood ash as fertilizer. CEMAT's technical training courses include workshops on stoves and latrines.

Private Sector

Stove Manufacturers

There are at least three private improved woodstove manufacturers in Guatemala, all producing a portable plancha stove, which performs as well as a fixed plancha stove, and can be quickly assembled on site in under an hour. The stoves range from US\$65-80 for a small stove, and US\$115-155 for a larger stove. The small model has a 18x24 in² plancha⁵⁰ with two or three pot holes, while the larger model has a 18x36 in² plancha with two, three or four pot holes. Both models are assembled within a metal frame, which accommodates about 38 ceramic bricks for the combustion chamber, the plancha and the chimney (See photos on the next page). Of note, the small stove has no protective edge around the planchas, which could increase potential for burns.

The three manufacturers in Guatemala are:

1. Taller San Mateo, Mr. Remijio Ixcot, Phone: 768 6040 and 694 3304, San Mateo, Quetzaltenango.
2. Construferro, Mr. Isman Manzanares, Phone 767 5690, San Mateo, Quetzaltenango.
3. Mr. Manoel Tay, Phones: 515 1504 and 434 1018, Chimaltenango, Chimaltenango.

The third listed manufacturer, Manuel Tay, is a well know specialist in the ICS field. He led the development of the plancha stove while working at the MEM in the 1990s, and organized the 1994-5 plancha construction workshop at MEM.



**Portable plancha stoves manufactured by Taller San Mateo, including small model at the back without protective edge.
Photo by Rogério Carneiro de Miranda.**



**Portable plancha stove manufactured by Manuel Tay in operation, with two pot holes and an edge.
Photo by Rogério Carneiro de Miranda**

⁵⁰ For reference, the size of the FIS project plancha is 20x37 in².

Stove manufactures also sell plancha griddles and chimneys to local hardware stores, for purchase by individuals. The market for these parts is primarily families who are not beneficiaries of FIS or other stove programs, who take the initiative to buy the griddles and chimneys themselves and have the stoves constructed in their homes.

According to Remijio Ixcot of Taller San Mateo, he currently produces about 80 planchas griddles and 50 chimney sets (3 tubes and the lid) per month, which are bought by various hardware stores in the region of Quetzaltenango. Isman Mazariegos reports producing about 200 plancha griddles and chimneys sets per month, all directed to NGOs and governmental institutions. Mazariegos says that after the griddle price increased in the past six months (due to international metal price increases based on high steel demand from China), most hardware stores stopped buying from him, opting instead for lower price and lower quality planchas from other manufacturers. Manuel Tay reports a monthly production of about 50 planchas, recently delivering 80 portable stoves to a local NGO.

While the plancha market in Guatemala is clearly functional, there is no reported estimation for the country's overall demand. Some manufacturers are not legally registered as business, and there is no manufacturers' association or nationwide inventory of plancha production. However, Manuel Tay roughly estimates that one year ago during the FIS plancha stoves dissemination boom and lower metal prices, the overall nationwide production average was around 2000 planchas per month, while today it might be around just 300 units.

An LPG stove manufacturer, Turbo Mac⁵¹ produces tortilla stoves popular among small tortilla businesses. These stoves primarily replace traditional fuelwood stoves used for commercial tortilla-making.

Private Stove Contractors

Private stove contractors in Guatemala-- private individuals or companies that construct mason stoves in customers' homes-- are usually contracted by FIS or NGOs, and deliver stoves according to the client specifications. Some of the many private stove contractors in Guatemala include:

- Diconsi, Oscar Sierra, Guatemala City p: 255 5995
- Rony Ralac, Quetzaltenango, Quetzaltenango, p: 761 4477
- Juan Jose Gomez, Guatemala City, p: 331 4365
- Cesar Spell, Guatemala City, p: 333 6332
- Cornelio Díaz, Guatemala City, p: 473 5482

FIS maintains a larger registry of Guatemalan private stove contractors, which can be obtained through the environmental project unit.⁵²



Griddle for plancha for stoves manufactured by Construferro sold at their hardware store in San Mateo, Quetzaltenango. Photo by Rogério Carneiro de Miranda

⁵¹ Turbo Mac phones are (502) 511-1108, 232-2426 and 253-4597.

⁵² Olga Camey de Noak, Manager of the Environmental Projects Unit (502) 367 2884

Academia

Universidad del Valle

The Universidad del Valle's Medical Entomology Research and Training Unit (MERTU), is associated with the U.S. Centers for Disease Control in Atlanta and has close ties to the Guatemalan Ministry of Health. Among its extensive research portfolio, the MERTU conducts community-level epidemiological studies to gauge the causes and effectiveness of interventions for vector-borne and environmentally mediated diseases, such as Chagas disease and diarrhea. It is also the Guatemalan partner organization responsible for managing the field station for the randomized stove intervention trial on acute respiratory infections and other health effects in the San Marcos highlands. (see below)

University of California, Berkeley

Through the School of Public Health/Environmental Science Division of University of California, Berkeley (UCB), and under the leadership of Professor Kirk Smith, an international, interdisciplinary research team⁵³ is carrying out a four-year study (2002-06) called Stove Intervention Study In the Guatemalan Highlands.⁵⁴ The study will provide robust evidence on the impact of reduced indoor air pollution on acute lower respiratory infection (ALRI) incidence among young children in the highlands of San Marcos, western Guatemala, one of the poorest regions in the country, where both infant mortality rates and acute respiratory infection rates are among the highest in the world. The importance of this research is underscored by the fact that pneumonia, one common ALRI, is the most prevalent serious disease among children under five globally, and the main cause of death for children in developing countries. Roughly two-thirds of children in developing countries today live in households that depend upon on fuelwood or other biomass fuels for cooking and heating on open fire stoves.

Major goals of the project are to:

- Conduct the first ever randomized intervention trial, which will increase confidence in ALRI risk estimates;
- Characterize the exposure-response curve for particulate matter (PM) at higher levels than has ever been done within a single population, thus assisting efforts to understand the physiological mechanisms;
- Determine the benefit of the stove intervention on mother's respiratory health;
- Determine the impact of the high smoke exposures on heart disease risks among older women;
- Examine the relationship between various environmental risks, including smoke, and childhood chronic respiratory disease such as asthma; and



Indigenous MAM family in San Marcos, Guatemala which is participating in the study, with new plancha woodstove.

Photo taken from:

<http://ehs.sph.berkeley.edu/guat/about/details.htm>

⁵³ Researchers also from Liverpool University (UK), Universidad del Valle (Guatemala), Harvard University (USA), University of Bergen (Norway), MERTU/CDC, and the World Health Organization.

⁵⁴ For further study details, contact Kirk R. Smith at krksmith@berkeley.edu or, the study coordinator, Alisa Jenny at ajenny@berkeley.edu, 510-643-4808 or visit the project website: <http://ehs.sph.berkeley.edu>

- Improve long term health conditions in the study area by working to establish sustainable health services.

Consequently, in addition to weekly health surveillance of each of the 500 children and air pollution monitoring, this project is also monitoring other important risk factors for ALRI,⁵⁵ the incidence of asthma and allergy-related indicators, low birth weight, women's respiratory and cardiac health, as well as recording time-activity patterns of participants and quality of life indicators.

Most of the studies and associated publications on air pollution and stoves discussed above were done as pilot studies in preparation for writing the proposal to fund this intervention trial. Major funding is provided by the US National Institutes of Health, with contributions by The Norwegian Research Council, the World Health Organization, UC-Berkeley, and the Kresge Foundation.

Multilateral Institutions

World Bank

The World Bank's environmental strategy for the energy sector identifies mitigation of biomass-generated IAP as a high priority. As such, the Bank's Energy and Environmental units, in coordination with the Health unit and UNDP/ESMAP⁵⁶ undertook a study⁵⁷ from 2001 to 2003 to quantify health impacts of traditional fuel use and outline strategies and policies for mitigating health risks, giving particular emphasis to policy recommendations to enhance the impact of existing improved stove programs.

The study aimed to provide the Government of Guatemala, and specifically the Ministry of Energy and Mines, with a better understanding of IAP in Guatemala and corresponding mitigation options, including strategies for achieving the fourth and fifth Millennium Development Goals (MDG) of reducing child mortality and improving maternal health, given the close linkages between IAP and women's and children's health. The timing of the study allowed overlap with complementary activities underway in Guatemala, including the World Bank Poverty Assessment and the UC-Berkeley comprehensive exposure monitoring study. The World Bank, among others, was also providing support to FIS with poverty reduction projects, including its improved stove program, at the time.

The study included a literature review on IAP and health (both globally and in Guatemala), estimates of the health implications of not addressing the problem, reviews of major Guatemalan demographic health and living standards surveys, an evaluation of improved stoves programs in Guatemala, two dissemination workshops, and a study of the LPG industry and market in Guatemala.

As a result of this study, the new GOG administration, in conjunction with WB staff, is now developing a new environmental health project, with strong promotional component of preventive health, and IAP to be included among traditional environmental health topics of water and sanitation, and solid waste management.

⁵⁵ Diarrhea episodes, nutritional status, scalds/burns, and infant/child growth and development.

⁵⁶ United Nations Development Programme, World Bank Energy Sector Management Assistance Programme

⁵⁷ Health Impacts of Traditional Fuel Use in Guatemala (ESMAP)

VII. INDOOR AIR POLLUTION AND/OR HOUSEHOLD ENERGY PROGRAMS AND PROJECTS IN GUATEMALA

Household energy activities in Guatemala have benefited from more technological development and financial and institutional support over the past three decades than anywhere else in Latin America. The progression has included the development of Lorena stoves in the 1970s, the creation of a national improved cookstoves (ICS) group, an international workshop on ICS dissemination, the development of the plancha stove, training of plancha stove manufactures, large-scale plancha dissemination by FIS and other NGOs, various indoor air pollution and health studies, and recent developments of more efficient and safe stove models. What started as a focus on appropriate technology and fuel efficiency has grown to incorporate an increasing concern of health impacts from IAP exposure, along with a greater focus on participatory technology development, cost-sharing and design standardization.

The Government of Guatemala (GOG) has made a substantial contribution to these efforts, first through the Ministry of Energy and Mine's (MEM) past efforts to organize the stoves community and to build private sector technical skills, and later through Social Investment Fund's (FIS) financing of improved stoves throughout the country, both implementing and helping to create demand. However, while household energy activities in Guatemala have produced positive results, their development has not been consistently supported and coordinated.

The following discussion addresses Guatemala's experience with household energy and health in light of the four key factors recognized by EPA and the broader community as critical to sustainable adoption of cleaner cooking practices.

Market Development

Today's improved cookstove (ICS) market in Guatemala is challenged by the low purchasing power of consumers most in need, and the relatively high price of the most common ICS model, the plancha stove. The majority of ICS dissemination initiatives in Guatemala involve some level of subsidy, sometimes providing all external materials and labor, while beneficiaries provide locally available materials and local labor. In other cases agencies provide the non-commercially available materials, such as the stove body and specialized labor, and require beneficiaries to buy the metal griddles and chimneys available in the market. In addition, the Shell Foundation grant to HELPS International is helping to establish mass production of standardized stoves, enabling a reduction of manufacturing and distribution costs.

The ICS market largely consists of sales by private stove builders to NGOs and GOG agencies such as FIS, which subsidize the stoves to the poorest populations. These subsidies have varied from 50-90% of total stove cost, which ranges from US\$60-150, depending on stove quality and location. Subsidies have not typically been directed toward the development of more affordable stove models, or toward increasing commercialization and micro-finance mechanisms, which is not widely available for ICS purchases.

Key events contributing to the establishment of Guatemala's ICS market include the development of the plancha stove model in 1993, the plancha manufacturing training workshop by MEM in 1994-95, and FIS' large scale plancha stove dissemination beginning in 1996. Many NGOs have also contributed to significant plancha stove dissemination; Manuel Tay estimates that approximately 200,000 plancha stoves have been constructed within the past 10 years. Stove demand, through the FIS program, NGO initiatives or direct sales, keeps many plancha and chimney manufactures, and

several plancha stove contractors busy, as well as myriad hardware stores that carry parts for individual buyers.

The individual sale of planchas and parts is a growing business, supported by customers not reached by any subsidized stove project, those who once received a subsidized stove requiring replacement parts, and users who received only the masonry part of the stove as a subsidy from an NGO and must purchase the plancha and chimney themselves. Interestingly, a plancha stove accessory is now appearing in hardware stores: water heater adapters for hot showers.

Efforts to promote ICS in Guatemala have helped to increase market penetration. The plancha stove has demonstrated strong acceptance around the country, indicating that consumers value its benefits. Widespread promotion, combined with improvements in quality and efficiency over the last decade, have contributed to greater awareness and desirability of improved stoves. However, the price for most stove models remains too high for poor families to purchase directly. An estimated 1 million homes in Guatemala with an identified need do not have improved stoves. The challenge for the ICS community is to reach these people in the near term. With a growing variety of models entering the arena, including the HELPs molded stove and Nixtamal stove, the TWP Justa stove, and the portable Plancha, consumers will gradually have more choices. To the extent that some of these models are promoted on a true commercial basis (incorporating micro-finance as appropriate), competition may have a price-reducing effect.

Technology Standardization

The MEM training workshop on plancha stove manufacturing was the initial contributor to standardization of improved stove production in Guatemala. FIS' one model stove guideline, which has spread to the hardware store market, has been another key contributor. FIS and most implementing NGOs require—or themselves provide—stove operation and maintenance training sessions to users, and require that contractors enforce stove construction quality control. Warranties are also typically required; FIS requires one year.

Through experience, stove quality has continued to increase in Guatemala. The original lower-quality cast iron plancha (griddle) is now made with steel. Increased efficiency in griddle manufacturing has enabled cost reductions; as metal cutting was originally done manually, manufacturers could produce only 20 griddles per week. Today individual manufacturers can produce 150 griddles/week, using an oxcart, which diminishes the time- and labor-intensiveness of the work. On the other hand, griddle prices in Guatemala have risen by as much as 90% in the past several months due to increases in international steel prices.

Several of the improved stoves on the market in Guatemala approximate the overall dimensions of the plancha stove. Varying options of griddle and chimney sizes exist, as manufactures respond to consumer preferences; however, basic combustion chamber and stove size dimensions and proportions are fairly standardized. It should be noted that there are exceptions to this trend, such as the Nixtamal stove designed specifically to accommodate the large pots used for cooking maize for tortillas and for large gatherings; and a coal briquette stove for use with imported Chinese coal.⁵⁸ Neither have griddles or chimneys.

⁵⁸ Note: There was a formal effort in 2000-2001 to introduce the coal stove technology to Guatemala. This effort faced technical problems with the equipment for making the coal briquettes (which broke easily) and a lack of technical support from China. Due to toxic gas emissions from the stoves, and the technical problems, a decision was made not to pursue the effort—some stoves are still in use, but the model is not actively promoted.

Despite this general trend toward technology standardization, stove performance parameters such as efficiency and emissions have not been closely evaluated. There is no regulatory agency in the country to set standards by which manufacturers and contractors must abide. Data is currently available and forthcoming in Guatemala on IAP emissions by the plancha stoves which could be used to guide the establishment of such standards. The new portable cement-cast griddle-style stove model manufactured by HELPS International strives to meet higher technological standards for energy efficiency and smoke emissions, is price competitive with the traditional masonry plancha stove, and provides an opportunity for accelerated dissemination of ICS in Guatemala.

The “haybox” or retained heat cooker was promoted during the Mesoamerican Exchange on Efficient Cooking Techniques and Improved Stoves in 2001 as a complementary cooking device that can further reduce fuel consumption and time spent tending the food and the fire. HELPS is currently working with EPA grant funding to develop a standardized model of insulated cookers that will work well at high altitudes, including Guatemala’s highlands. The potential time and fuel savings from use of hayboxes for cooking simmer-intensive foods such as beans—a staple in Guatemala—has led HELPS to pursue this technology for promotion in conjunction with its stoves.

Health Impact Monitoring

Dozens of studies on indoor air pollution from solid fuels have been conducted in Guatemala, including significant research sponsored by WHO and IDRC in the western highlands of Guatemala (Bruce et al., 1998; McCracken and Smith, 1998; Neufeld, 1995; and Smith et al., 1993). All of the studies and interventions were technology-focused, and had no behavior modification or improved ventilation components. Plancha and LPG stoves were evaluated alone and LPG in combination with traditional open fires, as is common practice. Albalak et al. (2001) reported an 85% reduction in PM_{3.5} concentrations when replacing an open fire with a plancha, and a mere 45% reduction for open fire and LPG stove combinations, highlighting the missed IAP-reducing potential of LPG when used as a complementary fuel with open fire.

Some dose response studies (i.e. linking the direct effect on health of concentrations of pollutants emitted by different stove types, as in Bruce et al., 1998) have established a reasonable case for a causal association of respiratory infections and the use of open fires. The authors have pointed out that confounding presents a substantial problem for observational studies relating IAP and health, suggesting that controlled intervention studies would be required to demonstrate stronger evidence. This conclusion has led to the current study being implemented by Dr. Kirk Smith and colleagues (see UC-Berkeley section) on the relationship between IAP from biomass stoves and the incidence of ALRI in children. The study aims to achieve direct proof of the effects on health of an accepted and practical intervention in the area, and will be the most comprehensive study of its sort conducted to date.

As with many government agencies, Guatemala’s Ministry of Health is eager to obtain data on specific health impacts of common interventions in order to prioritize funding to combat major health risks. The UC Berkeley-led study will provide valuable new data that will increase confidence in the value of household energy interventions. At the same time, epidemiological studies cannot be conducted for every intervention. There is now general consensus that IAP exposure monitoring can be used as a proxy for health, made possible by the linkages established through the Berkeley-led study. The Shell Foundation will be working with its pilot project grantees, including HELPS in Guatemala, to monitor reductions in IAP exposure of the pilot interventions.

Social and Cultural Barriers

Household energy initiatives carried out in Guatemala to date have focused largely on stove design and health monitoring. Social barriers addressed have primarily been socio-economic in nature, wherein ongoing programs have utilized subsidies to address the lack of capital among most vulnerable populations to acquire stoves.

Cultural barriers to adoption of cleaner cooking technologies are present in Guatemala, where there is a long tradition of open fires for cooking and space heating. Significant changes in behavior are often required, from adapting cooking methods to conducting regular stove maintenance. Space heating has received less attention than cooking; due to the insulation of combustion chambers to achieve fuel efficiency gains, most improved stoves provide little space heating. For particularly cold climates, such as in Guatemala's highlands, the reduced heating capacity of improved stoves can result in some resistance to adoption.

Most household energy initiatives in Guatemala recognize the importance of addressing cultural barriers, and have designed approaches to engage women and men in the design and promotion of stove models that fit their needs, and provide training in effective stove use and maintenance. The Tezulutla'n project incorporated recommendations from a pre-implementation in-depth consultation with users aimed at adapting the proposed ICS model to users' culture and needs. Modifications included the use of a larger ceramic or cement chimney to avoid burning and reduce the frequency of cleaning requirements; and adjusting stove height for individual users. In addition, the stove door was removed when consultations indicated users did not use it; while designed to improve efficiency, if not used it only increased costs. Those initiatives that involve in-house stove construction, as with TWP and the Justa stove, often find labor and/or materials contributions as a requirement for installation to be an effective means for reducing cultural barriers and maximizing user commitment to maintaining the technology.

An additional obstacle to reducing IAP in Guatemala is the fact that poor households often do not perceive IAP to pose short or long-term health risks. This lack of association between smoke and specific disease outcomes eliminates what might otherwise be an important incentive for adopting new technologies, methods and behaviors to minimize IAP. No household energy projects or programs in Guatemala to date have focused on behavior modification or structural changes in poor households to minimize IAP exposure. The World Bank health team is working with the new GOG to design a new preventive environmental health project in which an IAP campaign will be included to educate people about the dangers and suggest mitigation actions.

VIII. LESSONS LEARNED AND RECOMMENDATIONS FROM HOUSEHOLD ENERGY INTERVENTIONS IN GUATEMALA

While experience with household energy in Guatemala has been extensive over the past 30 years, it has lacked coordinated action among stakeholders and appropriate policies. Despite this fact, NGOs and government agencies have consistently promoted ICS dissemination, resulting in an estimated 200,000 plancha stoves installed in the past decade, and a cadre of skilled private sector ICS manufacturers and contractors developed to sustain continued stove dissemination. Most of the 60-70 plancha stove manufacturers trained in 1994-5 are still either manufacturing stove parts and/or installing stoves.

It is expected that these results could be multiplied with a stronger, more integrated and organized household energy and health community, including a coordinating and support unit, to share

experiences, define guidelines, policies, and strengthen the capacity of the community to create a more enabling policy environment. A number of lessons are summarized here, according to the four focal areas outlined in the previous section.

Market Development

Subsidies for improved stoves have been instrumental in supporting the initial phases of the commercial market in Guatemala. Even with significant price reductions, a large portion of the rural poor will be unable to access stoves through commercial channels in the foreseeable future.

Fundación Solar made the following market-related observations in its evaluation of the Tezulutla'n project, and projects by FIS and Intervida, described earlier:

- Projects tend to compete bids for stoves or component purchase to private companies. As such, stoves are designed for the implementing agency, rather than the final user, which thus becomes an 'interested party' rather than a consumer. Marketing often takes place only between the project implementers and the producers of stoves or their parts.
- High subsidies by implementing organizations create distortions in the market. The dependency of the stove makers on projects creates a barrier to the promotion of their goods and services; reduces incentives for innovative design improvements; and creates a dependency of users on implementing agencies, thereby inhibiting project sustainability. In the three projects Fundación Solar analyzed, subsidies ranged from 55% to 90%.
- Subsidies may, however, be necessary, given the economic and social context of the majority of users (71-86% at a poverty level). In such cases, users should bear some portion of the cost of the stove. Subsidies have indeed made it possible for many homes to acquire improved stoves.

At the same time, approaches taken by NGOs and agencies to require certain stove components such as chimneys and griddles to be purchased by the users demonstrate some ability and willingness to pay and assume stove ownership. Such approaches establish in users an expectation that stove parts must be purchased, which helps to strengthen the market for new stoves and replacement parts, improving long-term stove performance. The fact that individual stove parts are available in many hardware stores is creating a base for increasing commercialization.

Space heating stoves and cleaner fuels such as LPG have not been the focus of subsidies, and thus the lessons are less direct. Although space heating stoves are not yet widely used in Guatemala, extending subsidies to space heating stoves could play an important role in further minimizing IAP, since many households with improved cookstoves still rely on open fires for space heating.

Dissemination of LPG stoves is currently dependent on the private sector. LPG gas remains expensive and is sold in large cylinders (25kg) which are less convenient to transport and require higher capital investment by users than smaller cylinders. According to ESMAP's recent study,⁵⁹ LPG was "available" to 98% of urban households and 55% of rural households in 2001. Prices dropped 50% from January 2001 to May 2002, due to strong competition between two major LPG distributors.⁶⁰ However, despite its availability, and relative affordability, LPG has penetrated only

⁵⁹ Data extracted from Health Impacts of Traditional Fuel Use in Guatemala, ESMAP 2003. Chapter 5: The Role of LPG

⁶⁰ Prices dropped in Guatemala to US\$0.75/gallon, at a time when LPG prices were at US\$1/gallon in the U.S. and US\$1.15/gallon in Chile

about 77% of urban households and only 18% of rural households. Rural areas experience higher delivery prices, in turn fueled by lower consumption rate, as LPG is used to complement rather than substitute fuelwood in rural areas. Rural incomes are also much lower, making the purchase of LPG (which is not distributed in cylinders smaller than 25 lbs.) even less attractive to rural consumers.

Equally daunting is the capital cost of US\$50-60 for a simple LPG stove. The fuel itself is expensive compared to “free” fuelwood collection, and safety concerns (poisoning and fires) may also be a factor, heightened by press coverage of LPG accidents involving faulty valves or misuse. Although these accidents are fairly infrequent, publicity leads to perceptions by many Guatemalans that LPG is unsafe. Cylinders are owned by consumers, rather than companies, reducing incentives to companies to maximize cylinder safety.

There is also a potential risk in Guatemala of future LPG price increases, as the market is dominated by only two companies. There are indications that some households in Guatemala pay as much or more for LPG as they do for fuelwood or kerosene, but do not use LPG exclusively and thus their total expenditures may rise considerably as they add LPG to the mix. These barriers to LPG access, price stability and appropriateness of LPG stoves need to be better understood in order to overcome them and promote LPG further in Guatemala.

Technology Standardization

While the *plancha*-style stove has had over 10 years of experience in Guatemala, a similar model has been widely used and recognized in Brazil for several decades. Experience has shown that improved *plancha* stoves enjoy higher efficiency and lower emissions than open fires. However, the extent to which they do so depends on the quality of materials used for its construction, key design characteristics, user training and stove maintenance. Attention to each of these factors is critical to long-term stove performance and user satisfaction. New stove models, such as the one currently being promoted by HELPS, bring to market innovations that improve efficiency, reduce emissions, provide portability for easy dissemination and relocation, and reduce costs. The long-term effectiveness of such innovations, however, has yet to be evaluated. Better exchange of information among Latin American countries would allow for the sharing of important technological advances and lessons learned in the region.

Fundación Solar’s above-mentioned analysis of three stove projects included the following additional observations on technology standardization:

- While creating local expertise through participation in stove construction and maintenance creates local ownership of the technology and supports future replicability, monitoring is needed to ensure quality of the product. Use of local materials lowers stove costs and allows for further user participation and responsibility.
- Ergonomic and safety design features, such as placement of bricks to prevent burning logs from falling out of the combustion chamber, increased user acceptance of stoves.
- Despite the general convergence of *plancha*-style stove characteristics, there is a lack of standardization of key stove components (combustion chamber, administration valve, and chimney). Quality control is often limited to observations or complaints from the users.
- Even though the *plancha* stove is the most common model in Guatemala, some components are difficult to replace due to a lack of market structures in some parts of the country.
- Guatemala lacks a coordinating institution for improved stoves R&D to enhance and support technological innovation.

The technical stoves unit recommended by the UNDP/ESMAP-funded World Bank study could provide important incentives for technological improvement in the ICS market. By way of example, in the early 1980's, the USEPA imposed emissions regulations on U.S. woodstove manufacturers, which stimulated great improvements in the sector in stoves quality and efficiency.

Health Impact Monitoring

One of the most significant lessons learned in Guatemala is that people are not generally aware of the relationship between IAP and specific disease consequences for women and young children. The continuing research by academia to establish this link will provide incentives for decision-makers and policy-makers to take action and support information campaigns. At the same time, IAP monitoring of interventions like the Shell Foundation-funded pilots will help establish exposure data under field conditions involving different stove types, kitchen improvements and behavior changes that can inform future interventions.

An additional lesson to emerge from the research conducted to date is that adoption of LPG does not guarantee dramatic reductions in IAP exposure, due to the fact that women often use LPG in complement to open fires. Targeted promotion of LPG and other clean fuels will need to take account of the preferences and constraints that inhibit complete fuel substitution.

Social and Cultural Barriers

Understanding what motivates changes in cooking practices and adoption of improved stoves requires learning about what women and men value in relation to traditional cooking practices versus "improved" technologies and methods. The better these barriers are understood, the more likely interventions are to address and overcome them.

Practitioners have found that women currently lack adequate information about the health risks associated with IAP. Given that health risks often motivate changes in behavior, particularly among women, awareness raising of those most at risk is important for effectively minimizing IAP exposure. Behavior change techniques are underutilized in Guatemala for communicating the impacts of IAP on health, and associated benefits of improved cooking techniques and behaviors.

Fundación Solar's evaluation of the Tezulutla'n, FIS and Intervida projects resulted in several observations of additional barriers faced and addressed by the projects:

- Firewood savings is often perceived by users as the most important stove benefit, independent of cost or availability. Data provided by users for these projects indicate actual savings of 50-67%. Fuelwood savings equates with time savings, as well as financial savings for families that purchase firewood. Additionally, families with plancha-style stoves can use them to cook tortillas, and as such don't need to buy *comales*.
- Community participation was a common element in the three projects evaluated. The fact that interest in having an improved stove initiated from the families was especially important for projects in which stoves were donated or heavily subsidized. Participatory diagnosis to understand user needs and preferences allowed for design modifications to improve stove desirability, and translated into a shared responsibility in project execution.
- All three projects incorporated local personnel into their work teams. In this way, facilitators, field technicians, trainers and administrative personnel involved in project implementation knew the customs, traditions, geography, access and language of given project areas. This practice enhanced community support, and allowed for fluent communication and effective training.

- The participation of women in the decision-making process of improved stove construction improved status and social position in the community.
- As there are several ethnic groups and languages in Guatemala, focusing interventions in areas with a common language and cultural background helped to make implementation easier and to optimize resources.

Recommendations

While there have been many household energy and health initiatives in Guatemala, there is a need to integrate the issues and lessons learned to date, and to consolidate efforts through a focal point for coordination and coverage. Better results could be achieved with a stronger, more integrated and organized household energy and health community, including a coordinating and support unit, to share experiences, define guidelines and policies, and strengthen the capacity of the community to create a more enabling policy environment. Such a unit should coordinate programs, information campaigns, and inter-Ministerial cooperation (health, energy, environment, education, agriculture) toward the goals of reducing physical stress and opportunity costs from time and effort spent collecting fuelwood; health risks from indoor air pollution (IAP); and pressure on forest resources.

Given the importance of IAP to the health and livelihoods of Guatemala's most vulnerable populations, it is advisable that the GOG follow recommendations resulting from a workshop organized by ESMAP in April 2003, and take a leading role in creating a national IAP program backed by appropriate policies, technical units, and commitment from the ministries of energy and health, and supported by NGOs, the private sector, academia and international cooperation.

The UNDP/ESMAP study on traditional fuel use, and strategies and policies for mitigating health risks emphasizes that short-term action is needed, consistent with steps necessary for achieving child mortality and maternal health Millennium Development Goals, and recommendations of the WB Guatemala Poverty Report with regard to preventive health and vulnerable populations.

The four broad types of interventions recommended by ESMAP are:

1. **Monitoring the problem and improving understanding of the links between health and poverty.** The ESMAP study recognizes that while there is a growing body of evidence, conclusive links between IAP and health are still lacking. The UC Berkeley study is expected to help fill this gap.
2. **Greater Inter-institutional Coordination,** including within governmental Ministries, particularly with respect to financial and technical coordination; among stakeholders, including government, the private sector, NGOs, households (especially cooks) and academia; and throughout the region, including joint monitoring and information exchange with Mexico. The Partnership for Clean Indoor Air can help achieve this.
3. **Making people aware of the problem in order to promote behavioral change,** as the lack of knowledge about IAP and health is one of the main causes for the severity of the problem—the study found that women are not aware of the link between health and smoke. This understanding provides an important incentive on the part of the user, and governmental agencies, to enact change. Such awareness-raising could be implemented through women's groups and NGOs, GOG training and health outreach programs and media campaigns for cleaner cooking options, including promoting awareness of links between IAP and health for users.

4. **Implementing technical options**, especially improved stoves and LPG stoves, focusing on coordinated design and implementation (emphasizing both fuel efficiency and health), supported by IAP-reduction related national policies, and the establishment of an intersectoral coordination group and within the MEM a technical stoves unit for improved stove design and certification. FIS and other similar activities should incorporate more than one design, increasing options for consumers, and introducing competition in implementation. FIS subsidies offered as a fixed amount for any certified improved stove (or LPG stove) would allow for greater consumer choice according to ability and willingness to pay.

Greater coordination among government agencies would reinforce the complementary roles that NGOs, women's groups and the private sector play. In complement to the ESMAP report's many recommendations, the authors of the present report offer the following recommendations for these implementers and stakeholders:

- Secure at least partial user investment in the stoves and other technologies, such as through requirements that users purchase the commercially-available griddles and chimneys. This approach establishes in users an expectation that stove parts must be purchased, which both increases the incentive for maintenance, and helps to strengthen the market for new stoves and replacement parts, improving long-term stove performance. Consider innovative means such as community revolving funds or micro-credit to facilitate greater purchasing power.
- Offer a mix of stove options to best meet households' needs, ability and willingness to pay, and complement technology interventions with structural and behavioral changes to increase ventilation and reduce exposure.
- Borrow from promotions in the health sector, and collaborate with ongoing preventive health and environmental health programs to employ behavior change communications within technology interventions, and to educate health specialists about technology, ventilation and behavior approaches to reducing indoor air pollution. In Guatemala's health care system, there are three main complementary delivery possibilities for expansion of household energy and health (HEH) initiatives:
 1. Including HEH in the national health program;
 2. Including HEH in the Guatemalan Social Security Institute's (IGSS) education program for their affiliates, and conducting seminars for selected target groups;
 3. As part of the Integrated System for Health Attention (SIAS) network, through which the Ministry of Public Health and Social Assistance (MSPAS) contracts NGOs to cover specific populations not reached by MSPAS, concentrating in remote areas.
- For LPG providers to reach a broader market, including remote poor populations, introduce smaller cylinder sizes for convenient transportation and lower capital costs, expand distribution channels, and improve safety.
- Better exchange of household energy and health information among Latin American countries (e.g. through periodic workshops, communications among national-level bioenergy networks and regional-level gender and energy networks, etc.) would foster the sharing of important advances and lessons learned in the region. Facilitation of such regional exchange could be one role of the Partnership for Clean Indoor Air.

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ANNEX A

Contact list for Key Agencies, Organizations and Individuals

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