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Energy and Environmental Health: A Literature Review and Recommendations

March 2004

JOINT UNDP / WORLD BANK

ENERGY SECTOR MANAGEMENT ASSISTANCE PROGRAMME (ESMAP)

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The Joint UNDP/World Bank Energy Sector Management Assistance Program (ESMAP) is a special global technical assistance partnership sponsored by the UNDP, the World Bank and bi-lateral official donors. Established with the support of UNDP and bilateral official donors in 1983, ESMAP is managed by the World Bank. ESMAP's mission is to promote the role of energy in poverty reduction and economic growth in an environmentally responsible manner. Its work applies to low-income, emerging, and transition economies and contributes to the achievement of internationally agreed development goals. ESMAP interventions are knowledge products including free technical assistance, specific studies, advisory services, pilot projects, knowledge generation and dissemination, trainings, workshops and seminars, conferences and roundtables, and publications. ESMAP work is focused on three priority areas: access to modern energy for the poorest, the development of sustainable energy markets, and the promotion of environmentally sustainable energy practices.

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Energy and Environmental Health
A Literature Review and Recommendations

March 2004

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Executive Summary

1. ***Objectives and Audience:*** This literature review is an initial step in a broader inquiry looking into linkages among energy, health, and the environment. A closer look at the energy sector is part of a broader initiative at the World Bank on environmental health, which is striving to find solutions to health problems in developing countries through interventions outside the health care system. Thus far, work has concentrated on preventive interventions in the infrastructure and environment sectors, such as water, sanitation, waste management, transportation, urban development and pollution management, together with their policy and economic dimensions. Thus, the review has two main audiences: first, decision-makers in the energy sector; and second, other practitioners of economic development from a wide array of professions and sectors.

2. *This literature review aims to (1) identify and prioritize energy-related health problems, especially "hot spots," and (2) assess the Africa Energy Strategy for its health repercussions and make recommendations.* (See Annex I for details.) In analyzing the literature, this report also aims to (1) determine whether neglected health issues are important to energy operations and economic analysis, and (2) explore whether powerful lessons from water/waste infrastructure are applicable to the energy sector, that is, whether enormous potential health benefits remain untapped.

3. Respiratory and diarrheal diseases are two of the top causes of disability and death in developing countries. Improvements in safe water supply, sanitation services, waste management, and the drainage infrastructure have provided enormous strides in addressing diarrheal diseases. By comparison, the energy sector has tremendous potential to address respiratory diseases through improved air quality management. Benefits attributable to electricity production can also offset other health costs, including those for diarrheal diseases by facilitating access to water for drinking and hygiene.

4. The literature review focuses on Sub-Saharan Africa (SSA) and concentrates on household fuels, mainly biomass, since these appear to have both the greatest health burden and the greatest potential to improve the health of the poor through the energy sector. The report also looks at coal, electricity and transport fuels, but to a lesser extent.

5. ***Conclusions of the Literature Review***: In order to make the topic manageable, the review focused on air pollution (rather than environmental health), because of the clear links with the energy sector and with respiratory disease. Thus, the review is representative of a major issue, rather than comprehensive. Overall, the literature was very helpful in highlighting the importance of indoor air pollution, but (1) it was not very helpful in identifying solutions for health improvement in energy-sector projects, and (2) shows the cutting edge nature of work addressing energy-related health problems, especially at the household level. The review also highlights the difficulty of addressing topics pertinent to developing countries through computerized searches, because much key information is available in the "gray literature," or is not classified in

abstracts so as to be picked up in searches, especially in specialized journals. For example, a critique of a draft of this paper identified a few articles on occupational hazards of coal mining in Nigeria, which were not identified in any of the literature searches. By the numbers, the literature (about 75,000 titles) concentrates on developed countries, emphasizing outdoor (ambient) air pollution from vehicular and industrial sources, particularly health damages and their costs, measurement techniques, and the particle size of pollutants.[1] This "preponderance of evidence" on many issues allows decision-making without additional research. While much less information exists on indoor air pollution (6,000 titles), it is reasonable to speak of "the literature on indoor air pollution." Many other topics with high health impacts have limited coverage (1–50 titles), making it difficult to draw conclusions. For example, only one study compared exposures to smoke from indoor and outdoor cooking, common in SSA: exposure to the latter was about one-third, but still hazardous. Only three studies examined households' priority rating for the reduction of indoor air pollution (IAP), showing it to have a low priority. Out of all the developing counties, China and India receive considerable attention.

6. By content, the literature confirms that promoting better quality fuels to reduce IAP is on the right track. Other issues may be important, but do not yet have a strong literature base; these include:

- Injuries from gathering and using biomass fuels, from burns to miscarriages (by carrying heavy loads);
- Vector-related diseases from energy production (hydropower and village-level dams), mainly malaria and schistosomiasis (current literature deals mostly with irrigation);
- A better understanding of behavioral change to reduce exposures at the household level;
- Better economic valuation of health benefits (because the literature focuses on costs); and
- Diseases and conditions besides acute respiratory infections (ARI), e.g., chronic respiratory infections, tuberculosis, asthma, cancers, and cataracts (from exposure of the eyes to smoke), that can be simultaneously targeted with the same measures to reduce ARI.

7. From an environmental health perspective, indoor air pollution in developing countries is more important than outdoor. However, the understanding of linkages between energy and health, with a history of about 20 years, lags behind that of linkages between water/waste management and health, which has a history of about 50 years. As a result, it appears that Bank energy operations as well are about a decade behind infrastructure operations. In Bank operations, outdoor air pollution has received the most attention in the environmental, infrastructure (urban) and energy sectors. Health has not been integrated systematically into energy projects, except for improving: (1) electricity for health facilities, and (2) stove efficiency and household fuels. IAP, however, is being discussed in several parts of the Bank, for ESMAP and other funding.

[1] The smaller the size, the deeper they can penetrate into the lungs, i.e., particles under 10 microns. Particles under 2.5 microns can penetrate to the point where oxygenation of blood occurs.

The water/sanitation sector could provide lessons on how to identify and quantify linkages, estimate their health and economic effects, and integrate remedial measures into projects, especially those at the community and household levels.

8. ***The Challenge of Uncharted Areas:*** Given that energy-environment-health linkages span several sectors, how can the energy sector determine its appropriate role in integrating preventive measures into the generation, storage, distribution, and use of energy in operations and policy? This poses a challenge because areas of straightforward energy intervention, mainly providing energy to health services and managing pollution, do not necessarily address the greatest energy-based health problems. While the energy sector contributes directly to outdoor air pollution through production (SO_2 emissions of power plants), health solutions may lie more with transportation and industry, because the major health damage comes from fuel *use*, not *generation*. The more important health problems come from indoor exposures to biomass fuels, where energy can play a major role by promoting the use of clean fuels, but gaps exists in tapping potential energy sector interventions. However, in some of the economically advanced countries (South Africa, Botswana, and Namibia), problems revolve around coal use, which might be easier to address by using market forces.

9. Preliminary figures calculated for this literature review show that environmental health components in infrastructure and energy projects may be able to reduce many diseases by the same order of magnitude (measured in DALY[2]) as health interventions per se, i.e., by 15–22 percent for each. In addition, untapped infrastructure and energy health benefits collectively may be equivalent to 6 percent of GDP for SSA (1998). The challenge for the energy sector is to acknowledge the links among poverty, biomass fuels, and environmental health risks. Four challenges lie in uncharted areas:

1) Quantification of the full burden of respiratory diseases from IAP, and of other health effects from dependence on biomass fuels. IAP-related diseases and conditions are underestimated. There is a need to better quantify household fuel-related health effects, especially for women and children (and the elderly, who are not addressed in the literature). Preliminary calculations on attributable risk show that, by looking beyond acute respiratory infections (ARI) which account for 82 million DALYs, an additional 87 million DALYs from other respiratory diseases could be targeted simultaneously. Other conditions, such as injuries and burns linked to biomass use, or vector-related diseases due to dams, could also be targeted, but were not apportioned.

   Whereas researchers consider many literature gaps as key problems, e.g., dose response curves for individual pollutants, there is sufficient evidence to proceed with reducing indoor air pollution and to promote cleaner fuels. The Bank has no advantage in direct involvement with such scientific research, but can make a considerable contribution in re-calculating the burden of disease by preventive measures outside the health sector (HNP) especially because of the resources already invested in promoting the

[2] Disability-Adjusted Life Years (DALY) measures the burden of disease and expresses (1) years of life lost to premature death (mortality), and (2) years lived with a disability. **One DALY is one lost year of healthy life.**

DALY concept and in working closely with the World Health Organization (WHO) in developing health statistics.

2) ***Economic valuation of the full burden of disease and the benefit of improved energy***. IAP-related diseases and conditions are undervalued. Better valuation of benefits is partly contingent upon better quantification, and better costing of the alternative cost-effective interventions is needed to determine policy choices. For example, how much of the additional 87 million DALYs from lung diseases besides ARI would respond to improved household fuels? And how many other benefits would accrue beyond those to the respiratory system, e.g., reduced injuries or improved nutrition (from more thoroughly cooked meals)? A segmentation of intervention options by cost-effectiveness, differentiated for urban and rural areas, is warranted.

3) ***Better understanding of socioeconomic underpinnings and behavioral change***. Many factors have been neglected because of a stress on technology. These cover a wide array, from cooking procedures that consume less energy (e.g., soaking beans overnight) to consumer preferences (cooking, heating, lighting, entertainment, refrigeration, water heating, etc.). A handful of studies discuss household responses to energy shortages, but little exists on promotion of behavioral change. (Health education was considered a major lesson from the water/sanitation sector, which had initially focused on water quality, and later on water quantity to allow for better hygiene.) However, reducing indoor air pollution appears not to be a high priority, despite its importance.

4) ***Policy response***. *A paradigm shift?* Reducing the energy-related burden of disease may call for a paradigm shift. Policy response, which could then be justified on health grounds, would require better quantification and valuation of biomass-associated health risks, beyond ARI. This policy response requires gauging (1) the willingness to pay by the poor, as well as determining a possible introduction of subsidies for investment, operations, and maintenance; and (2) synergies through key coordination with other sectors and partners. The main hindrance appears related to willingness to pay for health benefits, which may or may not be perceived at the household and projects levels. Of the three uncharted areas above, the Bank has a comparative advantage in dealing with economic analyses. Even more important, it may be possible for the Bank to move forward *without* much additional research, because current knowledge would probably point to scaling up improved household energy.

10. ***Recommendations***: Based on the literature analysis and the four uncharted areas, ten recommendations are suggested to target the poor:

I. Operations

– Define indoor air pollution (IAP) in "operational" terms. Then devise policy responses and prioritize interventions, e.g., TORs, data collection and analysis, proxy measures, etc.

- Devise “entry points” for collaboration, e.g., water, forestry, rural development.
- Tap synergies through partnerships, e.g., rural electrification, water supply, others as appropriate.
- Prepare case studies on energy-related health opportunities, with an initial focus on Poverty Reduction Strategy Programs (PRSPs) and Community-Driven Development Programs (CDDs).
- Estimate effect of exacerbating mosquito-borne diseases through reduction of indoor air pollution.

II. Operations Research

- Explore how a health awareness campaign to change behavior can be integrated into operations.
- Explore linkages with child health.
- Explore linkages with gender issues.
- Determine health effects related to small and medium-size enterprises (SMEs).

III. Economics and Policy

- Develop better economic valuation and monitoring techniques.

1

Environmental Health and Poverty

Rationale for Literature Review

1.1 This literature review is an initial step in a broader inquiry looking into linkages among energy, health, and environment. The review aims to identify energy-related health problems, especially "hot spots," to determine actual and untapped health benefits, and evaluate the Africa Energy Strategy for health repercussions (see Annex I for details). Respiratory and diarrheal diseases are the top two causes of illness, disability, and death in developing countries. Energy and other infrastructure projects have a major role to play in reducing the burden of disease from these causes through preventive environmental health measures; this is at least as influential as that of the health care system, if not more so. In Sub-Saharan Africa (SSA), malaria and AIDS would be added to make it a list of the top four cause of disease, disability, and death; here, the role of energy and infrastructure are less influential, but nonetheless important. Work completed on environmental health in infrastructure projects (water supply, sanitation, waste management, transportation, housing, and urban development)[3] contains important lessons that may be applicable to the energy sector:

- *Considerable health benefits remain untapped in Bank projects because environmental health factors, particularly preventive measures, are not systematically included in projects.*
- *Preventive health components can reduce about 20 percent of the burden of diseases— roughly equal to the success of health projects—for a fraction of the cost, because infrastructure projects are justified on other grounds; collectively, these benefits may equal 6 percent or more of GDP for SSA (1998).*
- *Improved infrastructure has been recognized as laying the framework during the nineteenth century in the United States and Europe for today's high health standards in the developed countries.*

1.2 This paper consists first of a literature review to help identify the main issues from an *environmental health perspective* (see figure 1). Following analysis from various perspectives, the identified issues will be prioritized for their potential incorporation into operations and in filling key research gaps. The literature review is based on the following premises:

[3] Under the Africa Region's Urban Environment Management Program, funded by Norwegian, Swedish and Swiss trust funds; the current work is being funded by ESMAP.

- *The links between energy and environmental health are significant, with untapped resources capable of substantially increasing potential health benefits from the energy sector.*
- *Preliminary calculations show that it may possible to double current estimates of potential health benefits attributable to the energy sector by looking beyond acute respiratory infections (ARI,) the current focal point of energy-health analysis.*
- *From an environmental health standpoint, targeting indoor air pollution (IAP) abatement may be more cost-effective than outdoor air pollution abatement (in SSA, for example, about 85 percent of the burden of disease related to air pollution stems from IAP and only 15 percent from outdoor); this needs to be explored further.*
- *Potential benefits of SSA energy operations are significant, since 70-85 percent of the people in SSA depend on biomass fuels (i.e., 80 percent firewood and 20 percent charcoal), which have with known deleterious health effects.*

Definitions

1.3 The main energy-health terms are defined below. For readers outside the Bank, a distinction needs to be made between the energy sector, which deals with the *production and transmission* of modern to traditional fuels, and the sectors such as transport, industry, and housing that *use* these fuels.. In addition, production of hydropower from large and small dams may also entail the agriculture, irrigation, environmental, and drinking water sectors because of the obvious linkages with water management and environmental issues. This distinction is key to understanding analyses and recommendations, since many solutions to health problems ranging from poor quality fuels to malaria lie outside the purview of the energy sector per se.

- *Biomass fuels* (wood, twigs, leaves, grasses, crop wastes, other vegetation, and dung). Renewable energy in the form of plant and animal matter that can be used as fuel. As a group, do not burn as cleanly as fossil fuels (see definition below), which include a range of clean and "dirty" fuels. Tend, therefore, to be more harmful to health, as incomplete combustion greatly contributes to indoor air pollution. Poor households tend to rely more on the cheaper biomass fuels.
- *Dust.* Suspended particulate matter. Receives less attention than chemical pollutants, but is virtually ubiquitous in rural areas. An important respiratory irritant that contributes to high rates of respiratory disease, one of the most important burdens of disease in developing countries. Ranges from large particles, which adhere to the surfaces of nose, mouth, and throat, to those small enough to penetrate deeply into the lungs. Chemical substances may adhere to or be incorporated into these particles.
- *Fossil fuels* (coal, oil, kerosene, natural gas, and liquefied petroleum gas [LPG]). Nonrenewable energy sources, basically fossilized remains of plants and animals with a high carbon and hydrogen content and varying levels of sulfur contamination. Sulfur reacts with air and other compounds to form air pollutants, for example, sulfuric acid and other acid aerosols,

which have varying impacts on agriculture, such as damage to the foliage of food crops, and human lungs. Vehicular and industrial sources generate the main ambient air pollutants from fossil fuels. Coal, kerosene, and oil are generally more hazardous to human health than natural gas and LPG (see *biomass fuels* above.)

– *Greenhouse gases.* Mainly carbon dioxide (CO_2), methane (CH_4), ozone (O_3), and chlorofluorocarbons (CFCs). Direct effects as irritants, causing respiratory disease, the most important direct health consequence. Indirect effects are considerable and can be wide-ranging, such as vector-borne diseases (malaria and schistosomiasis), which could spread as global warming extends vector breeding habitats.

– *Vector-borne, vector-related diseases.* Diseases transmitted by an intermediate animal host. Broadly includes pathogens transferred mechanically by flies or rats. Specifically involves development of a parasite within the intermediate host, such as mosquitoes or snails, which eventually infects humans. Key link to the energy sector comes from a shift in vector habitat due to climate change and global warming; change in breeding season, which can prolong or curtail human exposure, and expansion of habitat due to projects that entail water management for energy, agriculture/irrigation, or human settlements.

– *Environmental health*: "Environmental health comprises those aspects of human health, including quality of life, that are determined by physical, biological, social, and psychosocial factors in the environment. It also refers to the theory and practice of assessing, correcting, controlling, and preventing those factors in the environment that can potentially affect adversely the health of present and future generations."[4]

[4] World Health Organization, 1997, Health and Environment in Sustainable Development. Geneva.

The Energy-Environmental Health Context

1.4 Figure 1 summarizes the health issues addressed in the literature review in an energy context.

Figure 1: The Energy-Environment Health Context

The energy-environmental health context revolves around the three types of fuels that comprise the bulk of energy used in SSA: (a) household fuels, which have the greatest potential hazards and are the area where the energy sector role appears to be greatest; (b) electricity, which has the greatest potential benefits; and (c) transport fuels, which pose hazards in areas of intense automobile concentration, some of which may contribute to indoor air pollution (but are more appropriately handled by the transport sector).

Household Energy. Biomass (80 percent fuelwood; 20 percent charcoal and dung) accounts for more than 84 percent of total consumption (excluding South Africa). Biomass remains the traditional energy used at the household level for cooking and heating in rural areas (94 percent of rural consumption and 8 percent of their income quantified in terms of time-preference), where two-thirds of SSA's population lives. Of fuelwoods, 87 percent are used by households and 13 percent by industries and others. In urban areas, the consumption of biomass (86 percent among the poor and up to 20 percent of their income) is complemented by modern energy sources such as kerosene (also called paraffin), electricity, and LPG. The consequences of poor energy efficiency, coupled with archaic distribution chains, especially in rural areas, are borne by the consumer and are reflected in terms of incremental costs (distorted markets, especially for kerosene), imperfect markets (open access or "free" biomass fuels), time lost (fetching fuelwood), physical burden, especially on women (carrying fuelwood), increased pressure on natural resources (which, in extreme cases, can lead to erosion and flooding), and associated health risks (respiratory and eye diseases, burns, physical stress, diarrhea due to unboiled water, etc.). In addition, the absence of electricity in most neighborhoods in SSA turns into missed opportunities for the population at the social (cold chain for food and medicine, light to study, etc.) as well as economic (water pump, electric equipment, telecom, etc.) levels.

Electricity. Regrettably, electricity is not provided to more than 85 percent of the population in SSA and its absence deprives the population of many social and health benefits associated with use of clean fuels. On the production side, most of SSA's thermal power (80 percent from oil and mainly coal; 2.2 percent from gas) is generated in South Africa. Thermal power generation is a contributor to outdoor air pollution, and its health effects have been generally recognized and quantified. Renewable energy, which represents the remaining 17 percent of total electricity generation, includes mainly hydro; this is usually associated with vector-borne diseases, mainly malaria and schistosomiasis, but the health effects of hydro are rarely quantified. Other renewable energy sources such as eolic, solar, and gelfuel are being introduced or tested in SSA and do not constitute any major environmental health risk.

Transport fuels. Car, truck, and motorcycle density in SSA remains extremely low, with 73 persons per passenger car, 163 persons per truck, and roughly 217 persons per motorbike in 1996 (the most recent data). Only a few cities in SSA, with populations of more than a million, are prone to serious outdoor pollution from transport for the general population (see Table 3) and three of them contain nearly half of the vehicles in SSA (Lagos, Cape Town, and Johannesburg). However, the effect on the poor, or key urban areas, such as those close to congested roads or transport depots, and the risk of indoor air pollution from outdoor sources remain to be explored. (Clean Air Initiatives are being implemented in Dakar and Cotonou, and may address some of these issues.)

Conclusions of the Literature Review

1.5 This review analyzes the literature from two perspectives:

- "By the numbers," briefly looking at the numerical distribution of published books and articles to see the relative importance of energy-environmental health issues in developing countries, and
- "By content," analyzing the issues from three viewpoints, which are summarized below: i) general; ii) energy; and iii) uncharted areas.

By the Numbers

1.6 Given the importance of indoor air pollution to the energy sector, it was surprising to find less than 2 percent of the titles on developing countries related specifically to this subject (see Annex I, Objectives and Methodology, Tables 15-17). Some of this imbalance may be attributable to that fact that roughly 90 percent of the investment in health research addresses problems of 10 percent of the world's population. Although most of the literature on air pollution focused on outdoor sources in developed countries, sufficient literature exists to speak of "the literature on indoor air pollution in developing countries. This is not the case for other issues identified in this literature review, which are limited perhaps to twenty or so articles.

By Content

1.7 Table 1 indicates the main subjects treated in the literature (described below). While many *titles* are relevant, content is not necessarily pertinent to energy-environmental health issues and prioritizing them for SSA operations. For example, air pollution literature focuses on outdoor air emanating from industrial and vehicular sources, while indoor air tends to focus on issues like tobacco smoke and chemical pollutants and, for both, prime concerns are technical and measurement, neither of which is necessarily pertinent to energy operations. Thus, few pertinent energy-health issues are addressed by a preponderance of evidence; the published literature is only moderately helpful, underscoring the importance of single studies and the gray literature, as well as the cutting-edge work being done by the Bank and others on household energy in developing countries.

Table 1: Sample of Main Issues Discussed in the Literature

Current Energy-Environmental Health Emphasis
– Respiratory diseases due to outdoor air pollution from industrial and vehicular sources – Respiratory diseases linked to indoor air
Secondary and Neglected Issues
– Underestimation of full range of respiratory diseases linked to indoor air pollution – Other health effects linked to fuel inadequacy and use of biomass fuels – High-risk groups and issues pertinent to gender, children, and the elderly – Overall benefits of access of health facilities to electricity – Socioeconomic determinants of household energy use and the energy ladder – Health effects of climate change and global warming – Quantification of health *benefits* (current focus is on *costs*)

1.8 Detailed findings of the literature review have been divided, into three categories:

- Prior Work on Environmental Health and Energy in the Bank
- Updates of Prior Literature Reviews, Conferences, and Pertinent Work
- Developing Country Issues often Neglected in the Literature.

1.9 While the specific findings of the literature review will be presented in the following sections, seven overall observations emerge.

1. *Dominance of outdoor air pollution.* The literature tends to focus on pollution-related issues, with outdoor (or "ambient") air pollution overshadowing indoor air pollution, although the later is catching up (see observation number 2). Some of this imbalance may be due to:
   - The propensity to reflect the concerns of the developed and industrialized countries, namely industrial and vehicular pollution; even for climate change (with little attention paid to health for the latter); and
   - The tendency to focus studies on factors that can be measured, quantified, and monitored, with an emphasis on six "criteria pollutants"[5] which have been measured globally for decades.
2. *Indoor air pollution gaining attention.* The literature on indoor air pollution is about a decade behind that of outdoor air pollution; it retains an emphasis on developed countries, stressing chemical pollutants and tobacco smoke (see Annex I, Tables 15 and 17).
   - Developing country attention focuses on harmful exposures to cooking fuels. (The state of the art in addressing indoor air pollution is summarized below, "Consultation of Indoor Air Pollution").
   - Other pertinent health issues are seldom discussed, making it difficult to assess their relative importance; these include: i) injuries from fetching fuel, burns, etc.; and ii) the effects of biological pollutants (e.g., molds), which have been shown to be an increasing source of disease.
   - Once-familiar analyses of two important diseases in SSA, malaria and schistosomiasis, seem to have disappeared from the energy literature, but are still addressed in literature about irrigation (hydro projects expand the habitat of mosquitoes and snails that spread the diseases).
   - New research is helping clarify the mistaken notion that cooking outdoors or in well-ventilated houses does not pose a significant health ris. (health risks stem from evanescent but extremely high exposures from stoking the fire).

[5] Oxides of sulfur (SO_x), oxides of nitrogen (NO_x), carbon monoxide (CO), ozone (O_3), lead (Pb), and Total Suspended Particulates (TSP, or Particulate Matter, PM.)

- Regrettably, no equivalent criteria pollutants exist for indoor air, making it difficult to draw causal associations, despite literature documenting damages from exposure to poor household fuels.
- Health education to help take preventive measures against indoor air pollution and promote behavioral change to help anchor benefits of stoves and other interventions is not discussed.[6]
- Relative to cooking, health problems related to lighting and heating are neglected.

3. *Energy focus on improving access.* Bank energy sector documentation tends to stress improving access to modern energy with an emphasis on electrification and privatization, followed by improving household energy to the poor. Current energy health linkages focus on the benefits of providing power to health services, the cold chain (viz., the sequence of refrigeration necessary to transport and maintain medications), and improved stoves. Whereas environmental health is discussed, it has not been integrated into operations, nor are there existing provisions to do so. (According to the draft Energy Strategy, the same observation is applicable to poverty reduction as a whole.[7])
4. *Poverty, populations at risk, and gender.* Health data list age and sex, but not economic status, which hinders efforts to recommend remedial measures in energy projects. Health data often focus on the health care system, not on the root causes of diseases, such as deficiencies in basic infrastructure and energy. Much useful information comes from individual studies, but they are often too specific to allow generalizations (see Table 4). Gender issues have been established as a major concern within energy literature focusing on socioeconomic aspects; health generally gets passing reference, albeit a firm indication of its importance, but without detail. Children's issues tend also to be neglected, and the elderly appear to be absent.
5. *Economic analyses.* Discussion on economics tends to stress costs over benefits, and focuses on individual diseases, which has led to underestimated health issues on several counts:
   - Energy-health linkages go beyond IAP, and include, for example,., injuries, falls, and physical stress fetching wood (85 percent of which is done by women, on average); burns from cooking fires, etc., but children and elderly are seldom counted.
   - Benefits are often recognized for services provided by improved energy, but the energy itself is not necessarily recognized: e.g., reduced diarrheal diseases are attributed to clean water, but not necessarily attributed to the electricity that pumps clean water from boreholes.

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[6] By comparison, hygiene education proved to be a successful in water/sanitation sector projects to help reduce diarrheal diseases, a problem equal in importance to respiratory diseases, and now is a matter of course for rural water supply projects when appropriate.

[7] Audiovisual presentation: "Renewing our Energy Business: Draft Strategy for Discussion;" John Besant-Jones and Laszlo Lovei, Sept. 28, 2000.

- Calculations are based on individual diseases such as ARI, and do not estimate other diseases and conditions, such as cancers or blindness, that can be caused or exacerbated by indoor air pollution.
- Compared with calculations of water- and sanitation-related health benefits, energy is far behind.
- Health estimates, when calculated, are often lumped together as "health effects," without distinction.
- Cutting-edge hybrid solar-wind interventions in rural areas (such as the UNDP-funded Alizé Program in Mauritania) and new renewable energy (gelfuel) initiatives for cooking (RPTES) are not being looked at from an environmental health standpoint, to assess socio-economic benefits accruing to the poor.

6. *Institutional fragmentation of environmental health.* Institutional fragmentation makes it difficult to address many issues because of dispersed responsibilities, budgets, and critical mass of staff. The literature is also fragmented, making it difficult to substantiate multisectoral linkages and causalities. The literature also lacks systematic input from health specialists who can evaluate the relative importance of health issues in a public health or sectoral context. Fragmentation also means that much technical literature is not simplified for easy reading. A fragmented, disease-by-disease approach is also partly responsible for undervaluing the health effects of energy interventions (see Annex V, Recommendations, Table 31.)
7. Other Health Aspects:
   - *Indirect health effects.* Indirect health effects can sometimes be more important than direct ones, which receive more attention. For example, the indirect health effects of climate change and global warming surpass the direct effects, such as deaths from heat waves and flooding (see Table 10).
   - *AIDS prevention strategy.* The energy sector can promote the SSA AIDS strategy by facilitating outreach to high-risk groups such as work crews. While many large energy projects, such as those in Ethiopia and Tanzania, contain such components addressed under mitigating measures in social and environmental assessments, it is difficult to find them in Bank literature and hence draw lessons or make recommendations.

1.10 **The approach and its challenge:** This literature review casts a wide net in order to ensure that energy-specific issues are analyzed in a broader public health context. For example, when analyzing respiratory disease, an energy-specific approach might zero in on household fuels, but a public health approach would look at multiple sources, including tobacco smoke and biological and chemical pollutants, and *then* focus on household fuels to make recommendations for World Bank operations. This broad approach presents a challenge regarding how to operationalize solutions *feasible to the energy sector* when the problems may require interventions from other sectors. Table 12

summarizes the top ten recommendations derived from the literature review that are directly pertinent to energy sector operations.

1.11 Table 2, the main environmental health energy linkages, lists some of the interventions and their effects on reducing the burden of disease; these have generally been underestimated because current statistics focus on single diseases or single sectors (see also Annex V, Tables 31-35). The table is based on the top four health problems in SSA, viz., HIV/AIDS, malaria, respiratory diseases, and diarrheas (see table 18), plus potentially important health problems identified in the literature review, including stress, injuries, and accidents.

Table 2: Main Energy-Environment-Health Benefits and Pertinent Sectors

– *Health Problems that Can Be Reduced* – *High Risk Groups*	*Energy Sector*	*Secondary Sector*
Main Health Problems Globally		
– (a) Respiratory disease from indoor air pollution (which is established); plus (b) TB, cataracts, lung cancer, heart disease (evidence not yet confirmed) – Children at most risk of mortality; women, elderly, and men of morbidity	Improved stoves to reduce health risks; shift to less harmful fuels; health education	*Housing*: ventilation; *health:* health care; t*ransport/Solid Waste*: air pollution management for outdoor sources going indoors
– Diarrheal diseases from poor quality water and insufficient water for personal hygiene – Children at most risk of mortality; others at risk of morbidity	Energy to pump water; fuel to boil water	*Water*: water supply and waste management; *health*: health care
Plus Main Health Problems in SSA		
– HIV/AIDS: Implementation of SSA strategy to combat AIDS – Project workers, especially work crews away from home, are at greatest risk of contracting and spreading AIDS	Facilitate health sector efforts to reach high-risk groups, especially work crews	*Health:* outreach to key audiences to help energy companies with no in-house competence for prevention
– Vector-related diseases from production, distribution, and use of energy from dams – (a) *Malaria*: general population at risk; (b) *schistosomiasis*: occupational from fishing (mainly men), laundry (mainly women and girls), bathing (all), and recreational (mainly children and teens)	Dam and water management; health education	*Health*: preventive (spraying) and curative measures; *infrastructure*: water and drainage management; *agriculture*: dams, irrigation management
Plus Potential for Unknowns		
– (a) Physical stress, injuries, accidents from fetching biomass fuels; (b) burns from using them – (a) *Burns*: Children at greatest risk; (b) *injury*: women at greatest risk (including miscarriages), followed by men and children; (c) *malnutrition*: possible risk to children and elderly from absence of cooked meals	Improved access; better stoves; shift to non-biomass fuels; health education	*Health*: curative and preventive measures; *housing*: better stove construction, ventilation, and siting

1.12 **Hot Spots:** This report suggests hot spots where energy sector operations can have a positive health impact in SSA. Table 3 summarizes the hot spots determined by five selection criteria that use existing information that can be readily incorporated into Bank operations:

- Health conditions: because of difficulties with inaccurate health data, two criteria were used for identifying areas for possible environmental health activity in energy projects: (a) high levels of acute respiratory diseases based on survey results; and (b) concomitant high levels of diarrheal diseases based on the same survey results; these factors indicate poor quality of life. The countries most closely meeting these criteria are listed in (column 1.
- Existence of refineries; capability to phase out lead from gasoline: seven countries were selected as candidates for a workshop on lead phase-out. (The workshop, sponsored by ENV, USEPA, and the Environmental Health Center of the UN National Safety Council, was held in Senegal in June 2001.) The residential areas around the refineries were identified as hot spots (column 2).
- City size more than one million: for peri urban areas, and selected areas within cities, e.g., transportation depots; main thoroughfares that could pose problems for traffic workers; schools; hospitals; commercial, industrial, and public buildings; and residential areas along its route (column 3).
- High automobile density: for the three cities that contain nearly half the automobiles in SSA (two-stroke motorcycles not included) (see column 4).
- Existing Bank projects: for ease of piggybacking a component (see column 5).

1.13 The countries and cities of Table 3 will be reviewed before a list of potential projects is completed.

Table 3: Potential Energy-Energy-Environmental Health Hot Spots

By Health Conditions	*Countries with Refineries*	*City Size (More than one Million)*	*Automobile Density*	*Existing Bank Activities*
Benin, CAR, Comoros, Kenya, Madagascar, Malawi, Mali, Namibia, Togo, Uganda, Zimbabwe	Cote d'Ivoire, Ghana, Mauritania, Nigeria, Senegal, South Africa, (Zambia)	Abidjan, Accra, Addis Ababa, Capetown, Conakry, Dakar, Dar-es-Salaam, Johannesburg, Khartoum, Kinshasa, Lagos, Lusaka, Luanda, Maputo, Nairobi, Yaounde	Nigeria: Lagos South Africa: Capetown, Johannesburg	***Projects:*** Cape Verde, Chad, Madagascar, Mali, Mauritania, Senegal, Tanzania, Uganda ***Clean Air Initiative:*** Benin, Senegal

1.14 **Africa Energy Strategy:** The Africa energy strategy is derived from "Can Africa Claim the 21st Century" and follows the building blocks of the World Development Report 2001. (See Annex VII). The energy sector's poverty alleviation aims should be embedded in the development strategy of the country concerned and include the following goals and priorities: improve markets and services for energy

(quantity, quality, and prices); increase rural transformation (increased access to energy services; reduce environmental impact; and initiate a paradigm shift (private provision and better regulation). More specifically, interventions should be articulated around electricity (markets, tariffs, first access, renewable development markets, energy efficiency); rural transformation (commercially-oriented programs and decentralized energy services delivery); biomass and traditional fuels (sustainable supply and efficient use of biomass fuels and transition to modern fuels when possible); and hydrocarbons (sector reform and promotion of LPG). *From an environmental health perspective, health problems are recognized but indoor vs. outdoor abatement are not quantified or prioritized*.

Prior Work On Environmental Health And Energy In The Bank

1.15 This literature review builds upon and updates work on environmental health initiated more than ten years ago in the Bank. This prior work is important, since it gives an idea of the pace of change, and because some of its observations, conclusions, and recommendations are still pertinent. Prior Bank work that has been integrated most extensively into lending has come from infrastructure over the past 20 years, because of the importance of diarrheal diseases as one of the prime causes of morbidity and mortality in developing countries and because of the high toll of traffic fatalities. Other environmental health lending more recently has focused on respiratory disease linked to outdoor air pollution, mostly in the infrastructure (transportation and urban) and environmental sectors. The energy sector has been involved in indoor air pollution. Annex VII summarizes the main energy sector documents for their content and treatment of environmental health.

Parallel Lessons from the Water and Sanitation Sector

1.16 Lessons from eighteenth-century Europe and the United States show that overall economic development and sanitation were responsible for enormous health improvement— not necessarily development of health care services, but a collective progress on several fronts. In the United Kingdom, for example, death rates had already begun to decline prior to the discovery of antibiotics, which transformed modern medicine. Much of today's technology to combat diarrheal and vector diseases is based in World War II-era efforts to protect troops in the field from water- and sanitation-related diseases and malaria, followed by major efforts toward promoting appropriate technology and improved water sanitation services from the early 1970's, including an international "Decade". Although respiratory diseases are on a par with diarrheal diseases, there has not been a similar international effort dedicated to their reduction. For example, the first study linking ARI and woodsmoke in young children was published in 1982, and the only study to actually measure air pollution levels was published in 1990; both were from SSA.[8] No other Bank sector has had the same breadth and depth of work on integrating

[8] Gopalan, H.N.B.; and Sumeet Saksena, eds.; *Domestic Environment and Health of Women and Children*; Delhi: United Nations Environment Program and the Tata Energy Research Institute, 1999; pp. 99-100; Original studies are: (a) D. Kossove, "Smoke Filled Rooms and Lower Respiratory Disease in Infants;" South African Medical Journal; Vol. 62, No. 17; pp. 622-24; and (b) B.H.O. Azziz and R. L. Henry; "The Effects of Indoor Environmental Factors Respiratory Illness in Primary School Children in Kuala Lampur;" International Journal of Epidemiology; Vol. 20, No. 1; pp. 144-150.

health into their procedures, nor the concomitant change in thinking to incorporate behavioral factors.[9]

1.17 The most stunning lessons come from the International Drinking Water Supply and Sanitation Decade: first: *handwashing is as important as water quality*. This finding eventually changed the approach to health improvement, which had initially stressed water *quality* rather than *quantity*, because it facilitates personal hygiene. Energy interventions are still focusing on air *quality*.

1.18 A second lesson is that such improvements take time—10-20 years—to become engrained and self-sustaining in the activities of local populations. There does not seem to be a parallel of the same magnitude for the energy sector—either as an international movement to combat respiratory disease or of lessons learned and best practices.

1.19 And a third lesson, from vector control, suggests that many remedial strategies (for example, keeping drains clean to eliminate mosquito breeding) can be implemented even in advance of technical gaps for the research community (in this case, a wide range of breeding and biting habits), because the additional knowledge would not necessarily change the intervention.

1.20 A fourth lesson stems from the notion that better technologies may not be affordable to the poor, but can be designed as "upgradable" so households can make improvements at their own pace.

1.21 The water and sanitation sector could provide lessons for the energy sector on how to identify and quantify linkages, estimate their health and economic effects, and integrate remedial measures into projects, especially those at the community and household level.

Bridging Environmental Health Gaps

1.22 Generated under the SSA "Regional Study on Urban Waste Management: Examples and Best Practices in Africa" (1996),[10] this work concluded that the contributions of infrastructure projects toward poverty reduction and improvement in living conditions could be greatly enhanced by systematic consideration of opportunities for health improvement. The work contains a literature review of 2,000 titles, 300 Bank documents, and annotated bibliography. [11] (Excerpts on energy are in Annex V, "Review of Outside Literature on Energy Policy.") The work examined 203 SSA infrastructure projects (1984-94), 62 Project Completion Reports, 124 environmental reviews, and 25 National Environmental Action Plans. The analysis indicates that input from health specialists has been minimal (three consultants), and none of the 47 housing projects

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[9] For a detailed discussion, with particular emphasis on the International Drinking Water Supply and Sanitation, see: *Lessons Learned In Water Supply, Sanitation and Health --- Thirteen Years of Experience in Developing Countries;* Water and Sanitation For Health Project, USAID; Washington, D.C., 1993.

[10] Listorti, J., *Bridging Environmental Health Gaps: Volume I --- Lessons for Sub-Saharan Africa Infrastructure Projects; Volume II --- Cross-sectional Literature Review and Analysis, Volume III --- Recommendations for Sub-Saharan Africa and the Rest of the Bank;* AFTES Working Paper No. 22, May 1996; *Bridging* …is available on a Bank Webpage: http://afr.worldbank.org/aftie/ SECTOR/ WATER/UWM/HEALTH/V1INDEX.HTM

[11] The annotated bibliography and multi sectoral analyses of Volume 3 are available on the SSA infrastructure web page.

contained ventilation components. Two conclusions are especially pertinent to energy-health-environment linkages:

- Infrastructure-sector interventions conceivably have the potential to target as much as 44 percent of the burden of disease, compared with estimates for the health sector (public), which were estimated at about 32 percent. (This "targetable" figure has since been revised to an estimate of about 20 percent for both sectors; its methodology can be applied to energy; see tables 33 and 35)
- "Environmental health" tends to be equated with "pollution". This occurs because much literature and research emanates from industrialized countries, where infectious diseases associated with poverty have been replaced by "modern" diseases.

"The Environmental Health Dimensions of Climate Change and Ozone Depletion"

1.23 Funded by the Global Environment Facility (GEF), and based on the report of the Intergovernmental Panel on Climate Change,[12] this report (1997) concluded that:

- The indirect health effects of climate change and ozone depletion far outweigh the direct effects;
- The overall effects would be most severe on the developing countries; and
- The developing countries are least prepared to respond.[13]

Environment and Health—Bridging the Gaps

1.24 The work *of Bridging Environmental Health Gaps*, focusing on urban infrastructure, was continued for rural infrastructure and other sectors as well in *Environmental Health: Bridging the Gaps.*[14] This World Bank discussion paper aims to help fill a void in economic development thinking as well as provide procedures to address multisectoral problems. *Back-of-the-envelope calculations show that environmental health measures can target as much of the burden of disease as the health sector, roughly 20 percent, affecting the poorest of the poor, by dealing with several diseases simultaneously in remedial measures, such as reducing indoor air pollution, outside the health system.*. The work (part II) also contains multisectoral checklists showing environmental health linkages and proposing remedial measures for each of the Bank's sectors.

1.25 The paper (part III) also contains a methodology to find "entry points" in different sectors, based as much on institutional capability and compatibility as on the

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[12] IPCC, Intergovernmental Panel on Climate Change; WHO, WMO, UNEP; see: *Climate Change and Human Health: An Assessment Prepared by a Task Group on Behalf of the World Health Organization, the World Meteorological Organization, and the United Nations Environment Programme*: A.J. McMichael, A. Haines, R. Sloof, & S. Kovats, Eds.; Geneva: WHO; 1996.

[13] Listorti, J., "Environmental health dimensions of climate change and ozone depletion;" in *Partnerships for Ecosystem Management: Science, Economics and Law;" Proceedings and Reference Readings from the Fifth Annual World Bank Conference on Environmentally and Socially Sustainable Development - 1997*; Ismail Serageldin and Joan Martin-Brown, eds; Washington, D.C: The World Bank, 1997; pp.94-114.

[14] James A. Listorti and Fadi M. Doumani; *Environment and Health: Bridging the Gaps*; World Bank Discussion Paper No. XX; forthcoming, 2001.

seriousness of health problems, to facilitate collaboration on environmental health problems.

Background Paper on Environment and Health for the Bank's Environment Strategy

1.26 Overall, the environmental health burden as a percentage of the total disease burden is highest in regions with most of the world's poor (27 percent in SSA, 18 percent in Asia) and lowest in industrialized countries. Decline in this burden is clearly associated with reduction in exposure to traditional risks, such as polluted air and water. The impact of traditional environmental health hazards exceeds that of modern hazards by a factor of 10 in SSA, 5 in Asia (except China), and 2 1/2 in Latin America and Middle East. Within individual countries, the poor suffer disproportionately from unsafe environmental conditions at the household and community levels.[15] Inadequate water supply and sanitation (WSS) pose the largest threat to human health in Bank client-countries, except for China and the transition economies of Europe, where air pollution causes the most damage. Indoor air pollution is the greatest threat in Asia and SSA. Malaria has taken a heavy toll in SSA. Although malaria is not nearly as significant in other regions, it is the third-greatest environmental health threat globally. Indoor Air Pollution is well recognized as a traditional hazard, related to poverty with IAP-related Disability Adjusted Life Years (DALYs) in 1990 reaching 5.5, 6 and 5 percent in SSA, India, and Asia and the Pacific, respectively.

Updates of Prior Literature Reviews, Conferences, and Pertinent Work

The Impact of Development Policies on Health

1.27 This 1990 review,[16] contracted by the Bank with WHO, and Harvard University, concluded that:

- Health has generally not played an important role in policy outside the health sector—except where a high level of understanding about health linkages already exists, e.g., water pollution; and
- Macro policy decisions appeared to be based more on technical factors within a sector, than on their application in a broader context, e.g., on the manufacture and immediate use of chemicals rather than on their accumulation in watersheds.

1.28 These conclusions remain largely intact, except for pollution control, which has increased as a policy consideration in many sectors. *Impact* …, a good indicator of literature gaps, covered nearly 400 publications on macroeconomic planning, agriculture, industry, energy, and housing.[17]

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15 Background Paper on Environment and Health, Environment Strategy, The World Bank, August, 2000

16 Weil, D. E. Cooper, A. P. Alicbuson, J. F. Wilson, M. R. Reich, and D. J. Bradley; *The Impact of Development Policies on Health: A Literature Review*; Geneva: WHO; 1990.

17 Macroeconomic policy, 89; agricultural policy, 78; industrial policy, 93; energy policy, 72; housing policy, 60.

"A Review of Environmental Health Impacts in Developing Country Cities"

1.29 This 1992 review, conducted by the London School of Hygiene and Tropical Medicine and UNCHS/UNDP/IBRD Urban Management Program, covering more than 100 publications, was aimed at identifying emerging patterns and gaps in the field of environmental health.[18] It concluded that the literature on nutrition, water and sanitation, diarrheal diseases, children, and the technical aspects of tropical diseases has been extensive. *This observation from the early 1990s indicated that, at that time, understanding of energy-health linkages was not as advanced as it was for other areas.*

"Global Consultation on Indoor Air Pollution"

1.30 In May 2000, USAID and WHO sponsored a consultation of experts on indoor air pollution. Five background papers were prepared for the consultation, published collectively in *A Review of Environmental Health Impacts in Developing Country Cities:*[19]

1. The Burden of Disease from Indoor Air Pollution in Developing Countries: Comparison Estimates
2. The Health Effects of Indoor Air Pollution Exposure in Developing Countries
3. Household Energy Use, Health, and Environment
4. Review of Interventions to Reduce the Exposure of Women and Young Children to Indoor Air Pollution in Developing Countries
5. Household Benefits of Indoor Air Pollution Control in Developing Countries

1.31 Because of the wide array on new information on indoor air pollution from the consultation, few additional literature searches were conducted on the topic of indoor air pollution, apart from those to determine the proportion of literature devoted to indoor air pollution and developing countries (see tables 15 and 17). The main points of the consultation pertinent to this report are as follows:

- Resolving the problem of indoor air pollution in developing countries has focused on improving exhaust of household smoke through improved stoves.
- Although the focus on stoves is appropriate, many other important issues have not been dealt with.
- Improved stoves have been more successful in urban areas than in rural ones; in part this may be due to market forces because biomass fuels are sold in urban areas, but considered "free" in rural areas.
- Considerable research has been devoted to documenting exposure to smoke and its adverse health effects; however, understanding the types of fuels (including their chemical components) and their specific health

[18] Bradley, David J.; "A Review of Environmental Health Impacts in Developing Country Cities" (London School of Hygiene and Tropical Medicine, UNCHS/UNDP/IBRD Urban Management Program Series, World Bank, 1992

[19] 1) Smith, Kirk R. and Sumi Mehta; 2) Bruce, Nigel, and Rogelio Perez-Padilla; 3) von Schirnding, Yasmin and Nigel Bruce; 4) Ballard-Tremeer, Grant and Angela Mhee; and 5) Larson, Bruce, and Sydney Rosen.--- The complete report is available in hard copy and on CD Rom from the USAID's Environmental Health Project, 1161 N. Kent. St. (Suite 300); Arlington, Va. 22209-2111; 703-247-8730.

effects (especially dose-response) is still problematic, needing major research.

– While cooking outdoors or in well-ventilated houses poses less risk than it does in enclosed spaces, it still poses a significant health hazard.

– Considerable progress has been made in showing that other diseases besides acute respiratory disease are directly linked to indoor air pollution, summarized in table 4.

Table 4: Diseases Linked to Indoor Air Pollution

Disease	*Level of Evidence*	*Estimated Percent of BOD Attributable*
Acute respiratory infections (ARI)	Strong	84
Chronic respiratory disease	Strong	3
Lung cancer	Strong	<0
Blindness	Moderate	1
Tuberculosis	Moderate	8
Cardiovascular disease	Suggestive	4
Asthma	Suggestive	<0
Perinatal effects	Insufficient	---

Source: Kirk R. Smith and Sumi Mehta, "The Burden of Disease from Indoor Air Pollution in Developing Countries;" May 2000; pp. 12-13, and Annex E for percent Est. of BOD.

1.32 New work on attributing risk to specific sources of death and disability indicates that solid fuel use accounts for 4.7 percent deaths in developing countries and 4.3 percent of disability adjusted life years. Solid fuel ranks third after malnutrition, 14.9 percent and 18 percent respectively, and water supply, hygiene and sanitation, 6.7 percent and 7.6 percent (see table 14).

Air Pollution and Community Health: A Critical Review and Data Sourcebook

1.33 *Air Pollution and Community Health: A Critical Review and Data Sourcebook* (1994) [20] focuses on developed countries and establishes the key importance of methodology and measurement in the literature. It recounts the historical disasters of air pollution, and discusses case studies, effects on mortality, hospital stays, etc. An excellent sourcebook, it is not helpful in looking at developing countries or the broad context, which were not stated as objectives; it is, however, useful in setting the tone in understanding the current emphasis of the research and health communities—which remain the driving forces in dealing with environmental health—in the developed countries.

Developing-Country Issues Often Neglected in the Literature

1.34 Tables 5 and 6 show the main topics of the literature searches and the main observations of the literature review,, with a focus on SSA and other developing countries. In essence, the health risks from outdoor air pollution have been well established, and are discussed only in passing in this report, which concentrates on the issues for which the literature is less clear. Regrettably, but not unpredictably, the

[20] Frederick W. Lipfert; *Air Pollution and Community Health: A Critical Review and Data Sourcebook*; New York: Van Nostrand Reinhold; 1994.

literature is fragmented and directed at specialized audiences. Many issues are represented in the literature by only one or two articles, or often, merely passing references. Professional judgment tells us that many of these issues may be important. A selection of such issues is discussed below, with the implication that they merit further study to substantiate their presumed importance until a preponderance of evidence can be built up. After discussion of research bias toward developed countries and high-risk and vulnerable groups, the issues are discussed according to the main environmental health issues identified in this review (table 2):

- Diseases and conditions related to air pollution
- Injuries, stress and other conditions
- Vector-related diseases.

Table 5: Main Topics of Literature Searches

– Air pollution and health	– Indoor health effects of burning coal
– Air pollution policy analysis	– Indoor smoke and insects
– Cancer risks from power lines/EMFs	– Injuries to children, women, elderly
– Climate variation and health in SSA	– Interactions of tobacco smoke and air pollution
– Cooking fire injuries in developing countries	– Lung cancer and charcoal use
– Construction of power lines—spread of malaria	– Malaria and smoke or indoor air pollution
– Different health effects of diesel/gasoline fuels	– Mold/dampness as source of respiratory disease
– Food preservation as air pollution	– Ozone as indoor air pollutant
– Head/neck/back injuries; employee absenteeism	– Power lines and health effects
– Health effects of jet fuels	– Problems for local authorities created by AIDS
– Health risks and cooking oils	– Slash-and-burn agriculture as source of IAP
– Health risks of open air cooking	– Time spent fetching energy
– Indoor air pollution	– Women’s time expenditure/usage
– Indoor air pollution and eye problems	– Wood fuel demand/pressures on biodiversity

Table 6: Observations of Literature Review

Current Energy-Environmental Health Priorities
– Respiratory diseases and outdoor air pollution from industrial and vehicular sources in developed countries, especially lead-based motor vehicle fuels; measurement techniques – Respiratory diseases linked to indoor air pollution in developed countries, especially tobacco smoke and chemical pollutants
Secondary and Neglected Issues
– Diseases Related to Air Pollution – Underestimation of respiratory diseases linked to indoor air pollution and biomass burning – Health effects other than respiratory diseases linked to indoor air pollution, including biological contamination, and repelling mosquitoes – Health effects of different fuel types, and multiple sources of lead – The energy ladder and socioeconomic aspects – Health effects of cooking outdoors or in well-ventilated homes – Injuries, Stress, and Other Conditions – Injuries associated with gathering and using biomass fuel, mainly a gender/children issue, e.g., burns, negative nutritional consequences of fuel deficiency – Behavioral change in reducing exposure to smoke or deciding on household expenditure – Injuries from natural disasters like extreme weather events possibly due to climate change – Vector-Related Diseases – Relative health effects of dams for irrigation and power – Heath effects of climate change and global warming

Ninety Percent of Health Research to Ten Percent of World Population

1.35 Much general information about environmental health is based on conditions in developed countries, reflecting that the driving forces in research, development, and technology largely emanate from the industrialized world. About 90 percent of the US$56 billion currently invested in health research and development by the public and private health sectors goes to research concerning only 10 percent of the world's population.[21] This situation has introduced an inadvertent bias into many analyses of environmental health issues in developing countries, because students trained in industrialized countries hear only passing reference to vector-related diseases or cooking in smoke-filled rooms. Moreover, physicians receive little training in environmental health, except for diseases like asthma, which are extremely sensitive to pollution,[22] "sick building syndrome," or the latest term coined by EPA, "building related illnesses" (BRI).[23] Table 19 gives an indication of the unevenness in the literature coverage of air pollution (73,000 titles), in which developing countries were covered in about 1-2 percent of published articles (see Annex I, Objectives and Methodology).

High-Risk Groups and Gender Issues

1.36 In general, public health looks, at a minimum, of four potential high-risk groups: (1) children, (2) those exposed to risks occupationally, (3) the elderly, and the sick, plus and others depending upon the circumstances, and (4)women (see Table 9). These high-risk groups are pertinent to each of the three categories of neglected issues

[21] Global Forum for Health Research. 1999. *The 10/90 Report on Health Research 1999.* Geneva.

[22] Committee on Environmental Health. 1999. *Handbook of Pediatric Environmental Health.* Elk Grove Village, Ill.: American Academy of Pediatrics.

[23] Orin Kurland, "Breathing Easier over Indoor Air Pollution," Risk Management; Vol. 40, No. 7, p. 52.

discussed below, namely, i) diseases and conditions related to air pollution; ii) injuries, stress, and other conditions; and iii) vector-related diseases. Of these groups, the energy literature most frequently discusses women, especially because so many are involved occupationally with woodfuels. The literature on gender and energy regularly gives passing reference to health, but does not appear to include health as a priority. Literature on indoor air pollution, however, regularly cites women, followed by children, as high risk groups; it occasionally mentions men, but without health-related analysis, and does not mention the elderly.

1.37 One of the most significant neglected gender issues entails injuries, which are important for two reasons, first, for their health repercussions (see below), and second as an occupational issue (see table 7). Many women derive income from transporting wood for sale and for preparing charcoal, but these activities seldom fall under "occupational health and safety" provisions, assuming such provisions even exist. (Occupational issues can also spill over into child-rearing if fuel shortages adversely affect cooking habits, e.g., frequency of hot meals and boiling water.) The issue of domestic violence is gaining in importance, but only an occasional, passing reference is made to violence toward women when fetching or selling biomass fuels. (Most treatment of violence in the literature is based on the subordinate roles women and girls play in their societies.[24])

Table 7: Occupational, High-Risk and Vulnerable Groups for the Energy Sector

Activity	*Potential Health Risk*
Gathering traditional (biomass) fuels	Accidents, exposure to disease vectors, physical stress for women, children, and men
Fuel use, e.g., cooking, heating, lighting	– *Cooking:* exposure to indoor air pollutants (e.g., upper respiratory diseases, cataracts, TB, lung cancer); risk mainly to women for cooking (including children with their mothers); accidents (mainly burns); risks to children and the elderly – *Heating and lighting:* exposure to air pollutants (see above); household fires; risks to whole family
Traditional energy production, e.g., charcoal preparation and sales	Extremely high occupational exposure to charcoal dust from bagging and sales (e.g., upper respiratory diseases and lung cancer)
Modern energy (LPG) use	Accidents, explosions (e.g., mainly burns)
Modern energy transport	Truck calamities

1.38 The roles of women also need to be better evaluated, especially notions that poor women's time is elastic, or tthat hey are "underproductive" or "underemployed."[25] Figure 2 puts this into perspective.

[24] Dr. Marijke Velzboer-Salcedo and Julie Novick; "Violence Against Women in the Americas: A Violation of Human Rights and a Public Health Problem;" Perspectives in Health; Vol. 5 No. 2, 2001.

[25] Gopalan, and Sumeet; *Domestic Environment…*; *op. cit.*, pp 113-114.

Figure 2: The Role of Women in Solving Rural Energy Problems

"Over the past decade, rural energy needs have been increasingly identified with fuel needs alone, leading to two solutions: planting more trees and introducing new designs for stoves that either are more efficient for traditional fuels or use different energy sources. On the whole, these solutions have not been widely successful for two reasons: the problem was not perceived accurately, and the solutions required more time and effort from rural women who already work long hours."[26] "Only recently have those concerned with fuel shortage begun to consult rural women. The general failure of their technological solutions, which require great investments of women's time, reinforces the fundamental fact that the main barrier to rural development is the scarcity of women's time."[27]

Diseases and Conditions Related to Air Pollution

Indoor Air Pollution

1.39 When compared with outdoor air pollution, indoor air pollution is still in its infancy; within the past decade it has been recognized as a top source of morbidity and mortality, especially in the developing countries. Literature on the topic is burgeoning, especially articles documenting the deleterious effects of exposure to biomass fuels. New topics include "Attributable Risk," showing indoor air pollution, especially solid fuel use, as causing more diseases than were associated with it before (see Table 14). The absence of internationally accepted measurement criteria, such as the six "criteria pollutants" used for outdoor air pollution, poses a considerable hurdle and ranks as a top priority for research, upon which economic costs can be analyzed. Annex VI lists institutional programs on indoor air pollution, summarized in Figure 3.

Figure 3: Organizations Dealing with Alleviation of Indoor Air Pollution

The most prolific work has been done by energy and environmental groups, prompted by the need to provide communities with greater access to energy sources, and at the same time manage their use of polluting fossil and biomass fuels to alleviate deforestation and GHG or climate change. Considerable information has been collected and compiled on alternative or clean energy sources and renewables, such as solar, wind, hydro, and PV energies for small-scale, non-grid electrification to power agricultural activities, small or cottage industries, and household appliances such as TV, radio, lights, stoves, and heaters. Information on biogas, used to supplement household cooking and lighting needs, has also been compiled.

Efforts more directly related to IAP include the assessment of various stoves designed for improved fuel efficiency and emissions; research on types of biomass uses and patterns of consumption; and studies of respiratory and other health consequences from prolonged exposure to wood, coal, and charcoal cooking and heating sources. Community-level interventions with the introduction of more efficient and less polluting stoves have been taking place for the past 15 years or so. More recently, attention to the negative health effects of cooking and heating has grown, and acceptance of the associated impact on gender and poverty.

Since 1996, a growing number of programs have taken on IAP-related community-based activities using a multisectoral perspective. At least three-fourths of these involve improved stoves. However, there is little evidence that these programs internalize end-user customs and practices in using cooking or heating devices in the kitchen or the household. This lack of internalization can significantly affect the degree of exposure to IAP, the adoption of new stoves by the targeted population on a sustainable basis, and the overall effectiveness of the intervention.

Source: Elaine (Weeling) Ooi; "Organizations Promoting Sustainable Development, Alternative Energy Sources and Biomass Fuels Relevant to Alleviating Indoor Air Pollution," World Bank Environment Department, draft Aug. 2000.

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[26] E. Dorothy, J. Dunkerley, W. Ramsey; *Household Energy and the Poor in the Third World;* Resources fort the Future, Washington, D.C., 1979.

[27] Gopalan, and Sumeet; *Domestic Environment…*; *op. cit.*, p.113-114.

1.40 WHO has no distinct global programs to deal with it as it does for other important diseases, e.g., AIDS, malaria, and TB. Instead, acute respiratory diseases are subsumed by the program on Integrated Management of Childhood Illnesses (IMCI) and a new initiative, Adult Lung Health. (It is not clear what effect this emphasis on integration within the health community will have on sectors outside the health community in promoting remedial measures to reduce respiratory diseases.)

1.41 Whereas the issue of chemical indoor air pollutants and respiratory diseases receives ample attention, two other potentially important areas receive less attention: i) diseases other than acute respiratory (table 4); and ii) chemical pollutants that are common in poor households (table 8). By comparison, some literature exists on "cross communication" of outdoor-indoor pollution, especially from motor vehicle fumes in congested areas, but also through cars parked in garages (probably not common in developing countries, certainly not in SSA). The former is often assumed as insignificant in SSA because of low automobile ownership, but it can be serious in areas of cities near public transportation stations and major thoroughfares. While literature frequently points to the health damages of air pollution, little attention is paid to vehicle maintenance, despite the importance of traffic-related deaths in SSA.

1.42 In addition, except for stoves, little attention has been paid to indoor pollutants common among the poor; data generally reflect pollutants typical in industrialized countries. Table 8 is an attempt to rearrange standard analyses of indoor air pollution for poor households, and could be pertinent to schools, hospitals, factories, public buildings, and households. (Although socioeconomic conditions would change markedly, the basic contaminants would remain largely the same.)

1.43 In late 2000, ESMAP began a newsletter, "Indoor Air Pollution: Energy and Health for the Poor."

Table 8: Representative Sources of Indoor Air Pollution in Poor Households

Contaminant	*Possible Sources*
Pollutants Related to Energy Use for Cooking, Heating, and Lighting	
Combustion by-products (CO, NO_x, SO_2, particulates/soot)	Gas/wood/coal/kerosene stoves and space heaters; gas/propane generators or engines; fireplaces, candles, incense, etc.
Biological Pollutants	
Biologic organisms (bacteria, viruses, fungi, protozoa, pollen, arthropods, e.g., insects, mites)	Mold, mildew; stagnant water; water damage to structures; air conditioning and refrigeration drip pans; animals/pets, rodents, insects, humans, pollens, etc.
Dust	Varied, multiple sources
Chemical Pollutants	
Combustion by-products (CO, NO_x, SO_2, particulates/soot)	Outdoor sources, e.g., backdrafts from exhausts (especially motor vehicles, industrial/power smokestacks, municipal incinerators or solid waste burning)
Tobacco smoke (various chemicals)	Cigarettes, pipes, cigars, water pipes, and other local devices
Volatile organic compounds (various chemicals)	Solvents, cleaning fluids, household cleaners (detergents, bleach, scouring powder, furniture wax), paints, glues, resins, propellants; combustion by-products (above); *some* fabrics/furniture/carpeting, ceiling tiles; household water evaporation (bathing, washing clothes/dishes); insect repellants (especially sprays), gasoline/pesticides when used/stored; etc.
Asbestos	Some insulation on walls, ceilings; some vinyl floor tiles; some millboard or wallboard, exterior shingles, textured paints and paint preparation/repair compounds, sealants, roofing, finished plaster, etc.
Formaldehyde	Some particle/wallboard, plywood, furniture, dyed materials/fabrics; combustion gases (gas, tobacco, wood); glues and resins; tobacco smoke, textiles, paper products, and as a preservative in medicines

Source: adapted from *Indoor Air Pollution: A Health Perspective*; Jonathan M. Samet, and John Spengler, eds.; Baltimore, Johns Hopkins University Press; 1991.

The Role of Behavioral Change in Reducing Risks of Indoor Air Pollution

1.44 Household education in alerting low-income families of indoor air pollution risks has not played a major role in energy projects either inside or outside the Bank. By comparison, in water supply and sanitation projects, behavioral change, e.g., hygiene education, was vital in reducing diarrheal diseases. Mothers learned that diarrheas were not an automatic part of childhood and that they could take preventive measures to avoid having their children get sick. Presumably there is a parallel in energy: people can be taught that smoke-filled rooms do not have to be accepted as a part of life, and that there are measures to improve childrens' health. Confirming this notion, some health literature has documented that caregivers are sometimes fail to diagnoseserious respiratory diseases.[28] One article from rural India, for example, showed that people ranked water quality as their main environmental concern, followed by outdoor air

[28] "Health and Nutrition in Communities;" report of a meeting held in Durban, South Africa, June, 2000.

pollution, then sanitation; kitchen smoke ranked fourth.[29] Figure 4 summarizes the need for awareness of air pollution hazards to the poor.

Figure 4: The Need for Awareness of the Risks of Indoor Air Pollution

"Though scientific and medical experts seem to realize that indoor air pollution is potentially a significant problem, the people who are really affected by it—the poor, especially women of DCs—do not seem to be aware of the hazards they and their children face. Two surveys, one in Jakarta, Indonesia,[30] and another in Accra, Ghana,[31] highlight the fact that households rank indoor air pollution as one of the least priority problems in comparison to other problems such as water, wastes, and pests. Logically, even their willingness to pay for the improvements in indoor air quality was found to be low. More significantly, this was found to be true across all income groups. Clearly, there is a need for better awareness and risk communication programs.[32]"

1.45 Many paths are available for changing behavior and could be explored as a first step with little effort beyond field observation. One example is behavior that would encourage or force the poor to economize on fuel, even though the elasticity of household expenditures is quite limited. These could include: (a) building fires in sheltered areas, out of draughts; (b) making fires smaller; (c) dowsing them, and reusing the fuel, instead of allowing them to smolder away; and (d) where feasible, protecting wood to keep it dry (damp wood burns more slowly and creates more smoke). Such simple behavioral measures can improve efficiency by 5-10 percent, and conceivably halve the amount of fuel needed.

1.46 Other measures can shorten cooking time, e.g., presoaking foods or changing diet. (These measures, however, can have negative repercussions on nutrition.) In Nepal, more food was eaten uncooked in response to fuel scarcity, whereas in Guatemala, Mexico, Somalia, and Tanzania, there was a reduction in the consumption of staple foods that require long cooking time,[33] and in Tanzania, beans that took three hours to cook were replaced by rice and cabbage.[34] In addition, modern fuels are often recycled by being burned for household uses, most notably cooking. (This practice can have adverse effects on food preparation, especially the deposition of lead, but is not discussed adequately in the literature.) Finally, fumes from cooking oils, which can be carcinogenic, have been poorly studied relative to smoke from stoves.

Outdoor Air Pollution

1.47 Outdoor air pollution has been covered for decades in the popular press and professional journals. In environmental health literature, outdoor air pollution has focused on the problems of motor vehicle and industrial pollution, focusing mainly on six "criteria pollutants," globally common pollutants measured regularly: oxides of sulfur (SO_x), oxides of nitrogen (NO_x), carbon monoxide (CO), ozone (O_3), lead (Pb), and Total

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29 Parikh, Jyoti and Vijay Laxmi; "Biuofuels, Pollution, and Health Linkages: A Survey of Rural Tamil Nadu;" Economic and Political Weekly; November 18, 2000, pp. 4135-36.

30 C. Surjadi, L. Padhmasutra; D. Wahyunigsih, et al.; *Household Environmental Problems in Jakarta;* Stockholm: Stockholm Environment Institute, 1994, p. 64.

31 G. Benneh, J. Songsore, J. Nabila, et al.; *Environmental Problems and the Urban Household in the Greater Accra Area, Ghana; ;* Stockholm: Stockholm Environment Institute, 1993, p. 126.

32 Gopalan, and Sumeet; *Domestic Environment…*; *op. cit.*, p.115.

33 G. Leach and M. Gowen; *Household Energy Handbook;* World Bank Technical Paper No. 67; Washington, D.C. 1987.

34 Gopalan, and Sumeet; *Domestic Environment…*; *op. cit.*, p.89.

Suspended Particulates (TSP, or Particulate Matter, PM). The capability to focus on these pollutants has permitted a degree of understanding, viz., *a preponderance of evidence*, because of repeated or similar studies throughout the world on the same set of problems, outdoor air pollution that is not yet available for indoor air pollution.. In addition, this has permitted economic analyses and comparisons of environmental and health costs without necessarily requiring additional research. By comparison, there are no equivalent criteria pollutants and comparative economic studies available for indoor air pollution. Tables 20-21 give a numerical breakdown of a search on air pollution, covering literature over nine months. Most of the literature (60 percent) described health effects of developed countries, e.g., lung cancer, respiratory disease, particle sizes, individual pollutants, followed by monitoring techniques, statistics, etc. (18 percent), and tobacco smoke (18 percent).

Biomass Burning

1.48 Exposure to biomass smoke can contribute to stillbirths and low birthweights, which in turn can lead to malnutrition and many other illnesses; biomass smoke contains the same types of pollutants as cigarette smoke, for which there has been more research.[35] Although considerable attention has been paid to the environmental effects of large-scale biomass burning, e.g., forest fires, slash-and-burn (swidden) agriculture, grassland and savannah burning, relatively little attention has been paid to small-scale household use of biomass fuels, such as stoves.[36] Because biomass use tends to be "guesstimates" compared with fossil fuel estimates, some literature suggests that biomass has been drastically underestimated.[37] If that were the case, the potential repercussions of changes in energy policies would be even greater. The IPCC has conducted thorough analyses of proposed solutions to the reduction of greenhouse gases, including those involving residential and commercial buildings (space heating and cooling; thermal integrity; heating and cooling equipment and distribution systems; water heating; lighting; cooking; electric appliances; and office equipment) and community-level measures (e.g., heat islands, vegetation, solar reflection, and methane emissions from solid and liquid waste disposal).[38] Discussions of sustainable biomass consumption do consider products of incomplete combustion from an energy perspective, but not from a health perspective.[39] In addition, occupational exposure to smoke from large-scale biomass burning, whether land-clearing or agriculture, has received scant attention, even in the health community.

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35 Gopalan, and Sumeet; *Domestic Environment…*; *op. cit.*, p. 101-102.

36 *1) Global Biomass Burning*; J.S. Levine, ed.; Cambridge Univ. Press, 1991; cited in "Health, Energy...", Smith, *op. cit.*, p. 24; and 2) K.R. Smith, J. Zhang, R. Uma, V.V.N. Kishore, V. Joshi; and M.A.K. Khali; "Greenhouse Implications of Household Fuels; Annual Review of Energy and Environment; Vol. 25, 2000; pp. 741-763.

37 "Greenhouse Gases from Biomass and Fossil Fuel Stoves in Developing Countries: A Manila Pilot Study;" K. R. Smith et al, Chemosphere, Vol. 26, Nos. 1-4, pp. 479-505, 1993.

38 *Climate Change 1995 (Vol. II), Impacts, Adaptations and Mitigation of Climate Change: Scientific-Technical Analyses --- Contribution of Working Group II to the Second Assessment Report of the Intergovernmental Panel on Climate Change;* Cambridge University Press for the World Meteorological Organization and United Nations Environment Programme, 1996; 720-731.

39 IPCC, *...1995, Vol. II, Impacts...; op. cit.;*p 723.

Multiple Sources of Lead

1.49 Lead is regularly discussed in the literature, and is often presented as a horror story for the twentieth century, but a success story of modern public health. For example, the toxic effects of lead were documented by the Romans and Greeks 2,000 years ago, but only for the past few decades have measures been taken to reduce human exposure. Among the success stories are removal of lead from gasoline and paint, but even these are recent. In 1925, a Blue Ribbon Committee of the surgeon general's office concluded that there was no good evidence for prohibiting lead in gasoline.[40] Moreover, from a public health perspective, these measures, however impressive, have been partial, typically reflecting interventions of a single profession, e.g., engineering or medicine, *not* a *coordinated* effort to improve health. The Bank has been a leader in the environmental field, setting a priority in 1997 to phase out lead in gasoline within five years[41]and in promoting specific activities to integrate lead reduction into projects and policies, especially in Eastern and Central Europe. [42] Regrettably, little attention has been focused on SSA to determine the nature of the problem in cities, even though it is assumed that lead poisoning is a growing problem.[43]

1.50 The issue arises for developing countries of how to build a bridge between the energy and transport communities, which have important contributions to make in reducing lead in fuels, and the health community where, by and large, lead-related diseases are not regarded as a health priority in developing countries. (See also "multiple sources of lead" below.) For example, in 25 years of practice, a Nigerian pediatrician and former Minister of Health never saw a case of childhood lead poisoning, from which he postulated that either lead was not a major problem (even though it is used as a poultice for umbilical cords), or it was not being detected by the health system, perhaps because cases were not being brought to hospitals for proper diagnosis.[44]

1.51 Despite the enormous progress made over the past decades in removing lead from paint and gasoline, considerable work remains to be done in the area of lead poisoning, especially in SSA. Lead became in an important public health problem in the developed, industrialized countries in part because of the reduction in the wide range of infectious diseases of poverty that are still the top health problems in developing countries. Very little work has been done on the nonvehicular sources of lead in developing countries, especially SSA. (The literature review found only a few articles on lead at all in SSA. [45]) Thus, it remains important to illustrate the relative importance of

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40 Shy, Carl; "Progress and Public Health: Lessons from Environmental Lead;" Environmental Impact Assessment Review; December 1990, pp. 417-413

41 "World Bank Offers 'Green Top Ten' in Advance of Summit;" News Release 97/1377 S; June 5, 1997.

42 Lovei, Magda, 1999. Eliminating a Silent Threat: World Bank Support for a Global Phaseout of Lead from Gasoline; The World Bank, Washington, DC, 1999; Magda Lovei; World Bank Technical Paper No. 397, *Phasing out Lead from Gasoline: Worldwide Experience and Policy Implications*; World Bank, Washington, D.C.; 1998; and Phasing Out Lead from Gasoline in Centralk and Eastern Europe: healthg Issues, Feasibility and Policies, in Implemnenting the Envioronmental; Action Plan for Central and Eastern Europe Series; World Bank, Washington, D.C.; 1997.

43 Jerome O. Nriagu, Mary L. Blankson. Kwamena Ocran; "Childhood Lead Poisoning in Africa: a Growing Public Health Problem;" The Science of the Total Environment; Vol. 181, 1996, pp. 93-100.

44 Personal communication with Dr. Koye Ransome-Kuti.

45 Chrysanthus Chukwuma, Sr.; "Environmental Lead Exposure in Africa;" Ambio; Royal Swedish Academy of Sciences; Vol. 26, No. 6, Sept. 1997; pp. 399-403.

these other sources (see table 9), as well as to show how the impressive strides made in reducing leaded gasoline can best be optimized in developing countries, or selected parts where lead *is* or *will be* significant. (In addition, little work has been done on jet fuel emissions.)

Table 9: Sample Multiple Sources of Lead from Transport Fuels

Medium/Method	*Main Sources*
Air/inhaled	Automobile and jet fuel emissions
Water/drunk	Airborne particulates settling on water, or penetrating water table
Food/ingested	Soil/dust deposits eaten directly, air deposits taken up in food, fertilizers, irrigation water, recycled fuels in bakeries, etc.
Occupational	Traffic police, garage mechanics, etc.

Biological Contaminants

1.52 Biological contaminants include pollen, molds, mites, bacteria, etc. and, compared to chemical pollutants, have only begun to receive similar attention as health problems only in the past five to 10 years. Current evidence points to their being responsible for a growing array of diseases, including acute/chronic respiratory, asthma, and sudden infant death syndrome (SIDS).[46] In addition, the gray literature points to a number of secondary effects that can exacerbate indoor air pollution, e.g., moisture causes lead-based paints to blister and chip, worsening the problem of lead poisoning[47] (see table 9.) The literature does not indicate whether better heating, ventilation, or aeration would alleviate these problems, making it difficult to assess a role for the energy sector.

Health Effects of Fuel Types

1.53 As a rule of thumb, the cheaper the fuel, the more polluting. Traditional or noncommercial, fuels viz, wood, charcoal, and dung, are more hazardous to human health than modern fuels, viz, gasoline, diesel, natural gas, and jet (see figure 5, the energy ladder, for a full list). Traditional fuels pose a health hazard because they expose humans to particulates, oxides of sulfur and nitrogen, carbon monoxide, fluoride (from coal), aldehydes, and polyaromatic hydrocarbons. The health risk varies by type of fuel and length of exposure. Most of the literature does not compare the relative differences in health effects among fuel types. Instead, the literature on modern fuels concentrates on detailing health effect in technical terms, e.g., particle size, general or occupational exposure, and measurement criteria, with a heavy emphasis on cancers. In this area, work done in the Bank may be on the cutting edge: one book actually dealt with the effects of diesel and gasoline together;[48] and another study lists the DALYs from diesel and

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46 Rylander, Ragnar, and Ruth Etzel, eds.; *Indoor Mold and Children's Health;* Environmental Health Perspectives (Environmental Health Perspectives Supplements, Monograph based on conference April, 1998),Vol. 7, Supplement No. 3; June 1999. and Savilahti, Risto and Jukka Uitti, Pekka Laipalla, Tuula Husman and Pekka Roto; "Respiratory Morbidity among Children Following Renovation of a Water-Damaged School;" Archives of Environmental Health; Vol. 55, No. 6; November/December, 2000; pp. 405-410.

47 Personal communication with Dr. Janet Phoenix, MD, lead specialist at the Environmental health Center of the US National Safety Council.

48 Lakdasa Wijetillek and Rapti Goonesekere*; Mitigating Transport Pollution in Developing Countries: an Analysis of the Fuels Reformulation Option;* World Bank Technical Paper No. 419 (Energy series);Washington, D.C.; 1998.

gasoline emissions.[49] In SSA, about 20 percent of energy comes from coal, mainly from South Africa, which is used for cooking and heating in Botswana, Namibia, and South Africa. Most research on coal used for cooking comes from China, where there are strong associations with lung cancer.[50] In addition, little research has been done on the health effects of fuel additives and substitutes at the household level in developing countries; rather, the research focus has been on developed countries and outdoor air pollution. For example, ethanol, a known lung irritant, breaks down into aldehydes, which are known carcinogens. This is an area where the Bank will have to rely on the outside for guidance, but could be instrumental in getting the issue on research agendas; one such opportunity involves gelfuels, which are being piloted in five countries in SSA.

1.54 In keeping with an overall trend in the health literature to broaden research beyond cancers, several studies point to the wide range of possible health damages not typically associated with energy. One article cites the possibility of jet fuels being linked with endocrine disruption. [51] (Endocrine disrupters mimic hormones in the body and can cause damage to the reproductive system.) Another points to the linkages between asthma and MTBE (methyl tertiary butyl ether, an additive in unleaded gasoline used to reduce carbon monoxide and ozone), which normally is discussed as a contaminant of water supplies and is known to be carcinogenic in animals. [52] Still another discusses the effects of diesel exhaust on neural behavior, taking it beyond the respiratory effects normally associated with this pollutant.[53] These additional effects add support to the notion that health damages have not been fully evaluated for energy or economic consequences.

The Energy Ladder and Socioeconomic Aspects

1.55 A World Bank energy study shows that, as people move up the economic ladder, they change heating and lighting fuels, but not necessarily cooking fuels;[54] this change tends to come later.[55] Whereas cooking is a relatively minor end-use of energy consumption in industrialized countries and Eastern Europe, it is the largest home energy use in developing countries, where the main cooking fuels are liquid petroleum gas (LPG), biogas, kerosene, efficient charcoal, charcoal, household coal, wood, crop residues, and animal dung. A major consideration therein is the low conversion efficiency of biomass stoves; traditional stoves convert energy at about 12-18 percent efficiency rate, thus producing high levels of pollution and requiring transport of large quantities of

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49 Ksenyia Lvovsky, et al.; "Environment and Health;" Background Paper for the Environment Strategy, Environment Department, July 2000.

50 Gopalan, and Sumeet; *Domestic Environment…*; *op. cit*., p. 103.

51 E. Merril; "Endocrine Disruptors: An Evaluation of Solvents Deicers and Jet Fuels;" Operational Technologies Corp, Dayton, Ohio; 1997.

52 Peter Joseph, Editorial: "Is Urban Asthma Causes by Methyl Tertiary Butyl Ether (MTBE)?" Archives of Environmental Health; Vol. 55, No. 1; January/February 2000; p. 69.

53 Kaye H. Kilburn; "Effects of Diesel Exhaust on Neurobehavioral and Pulmonary Functions;" Archives of Environmental Health; Vol. 55, No. 1; January/February 2000; p. 69, pp. 11-17.

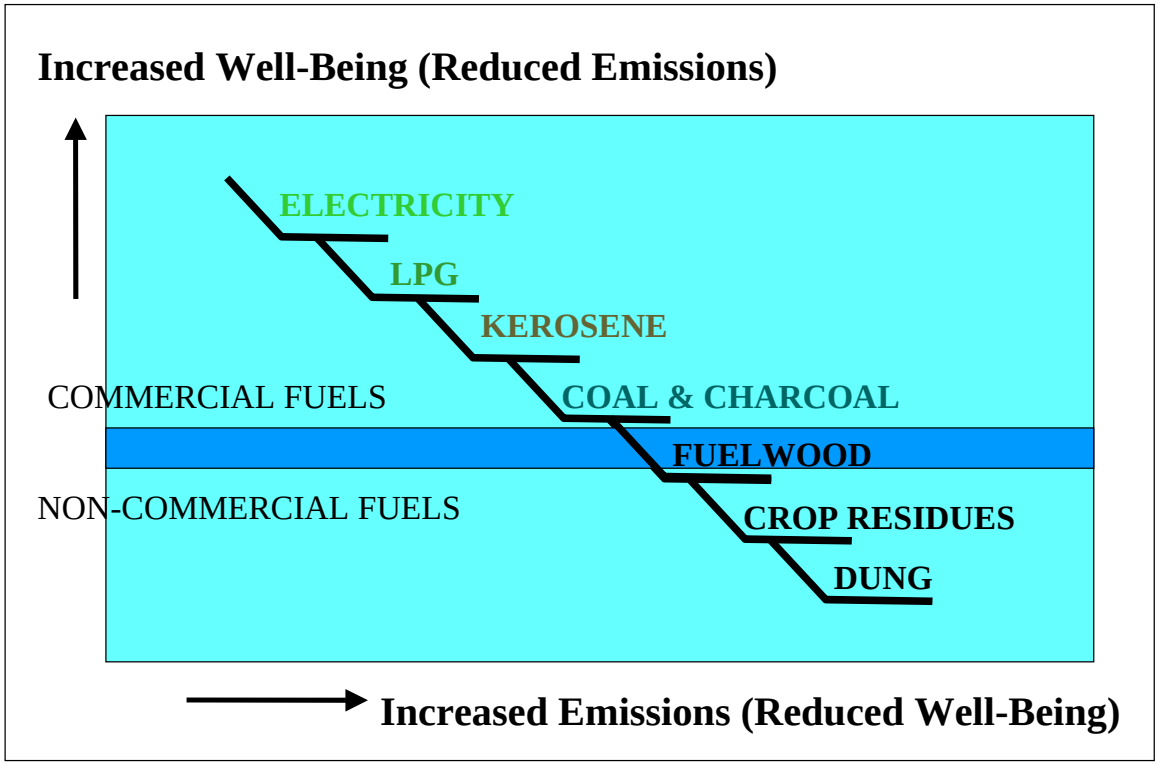
54 World Bank. 1996. "*Rural Energy and Development: Improving Energy Supplies for Two Billion People.* Development in Practice. Washington, D.C.; chapter two.

55 Global Consultation on Indoor Air Pollution; May 2000.

fuel. Indoor pollution from biomass combustion in eight countries studied ranged from four to 90 times the WHO standard for peak pollution guidelines.[56]

1.56 In addition, evidence is emerging on the socioeconomic dimensions of household decisions. Most notably, it appears that there is about a 10-year time lag from the time households change their lighting and heating fuels to when they change their cooking fuels. In addition, end-of-month budget problems also force households to revert to cheaper biomass fuels, and to possibly cut into food budgets. One study also showed that males and females make different decisions when prioritizing expenses for lighting, refrigeration, and entertainment (e.g., TV, music equipment), with cooking and space heating ranking a lower priority for males.[57] Moreover, the efficacy of stoves in reducing pollution appears to diminish with age, which presumably would argue for replacement.[58] Figure 5 shows the overall change in well-being as people climb the energy ladder: as incomes increase, households buy cleaner fuels, spend less time gathering fuels, and are subjected to lower levels of harmful emissions.

Figure 5: Well-Being and the Energy Ladder



Source: adapted from Kirk R. Smith and Youcheng Liu; Indoor Air Pollution and Developing Countries; in J.M. Samet, *Epidemiology of Lung Cancer;* Lung Biology in Health and Disease Series; Vol. 74, New York: Marcel Dekker, 1994, p. 153.

[56] World Bank. 1995. "A Strategy for Rural and Poor People in the Developing Countries." Draft. Power Development, Efficiency and Household Fuel Division, Industry and Energy Department. Washington, D.C.

[57] Angela Mathee, "Community-wide Electrification Programme in South Africa; *op. cit.*

[58] Naeher LP; B.P Leaderer BP; and K.R. Smith; "Particulate matter and carbon monoxide in highland Guatemala: indoor and outdoor levels from traditional and improved wood stoves and gas stoves;" Indoor Air; Sept. 2000; Vol. 10, No. 3; pp. 200-5.

Myth? Aerated Homes and Outdoor Cooking Do Not Generate Harmful Air Pollution

1.57 The literature search found only one article comparing the effects of indoor and outdoor pollution.[59] The article compared chronic bronchitis rates in two rural Bolivian villages, one where cooking was done exclusively indoors, and another where it was done primarily outdoors. The overall prevalence of chronic bronchitis (both seasons, for men and women) was 22 percent and 13 percent for indoor and outdoor cooking, respectively. This translated roughly into a decrease of risk of 60 percent for outdoor over indoor cooking. Given that respiratory ailments are such an important health issue in developing countries, the relative risk is important enough to receive further attention. One reason for the high risk could be "spiking," i.e., the intense increase in fumes when fires are stirred. [60]

1.58 By comparison, illnesses and deaths due to carbon monoxide poisoning have been reported in poorly aerated houses from combustion heating appliances.[61]

Myth? Smoke Repels Mosquitoes and Other Insects

1.59 The literature is inconclusive on the benefits of smoke in repelling mosquitoes in areas with endemic malaria.[62] Conceivably, reducing smoke could exacerbate malaria, and eliminate the potential benefit of keeping insects away from food stored in the house. Individual scientists cite various views: a) "fogging" (spraying) is most effective on nuisance mosquitoes; b) household smoke keeps mosquitoes at bay; c) smoke has no effect on highly infested areas; d) smoke reduces biting frequency, but not malaria levels, etc.[63] Smoke is also said to help protect foods that are stored indoor from insects. (An additional problem may arise if mosquito coils are used to repel mosquitoes; some evidence points to the coils being carcinogenic and exacerbating asthma.[64])

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59 "Domestic biomass fuel combustion and chronic bronchitis in two rural Bolivian villages;" R. Albalak, A.. Frisancho, and G.J. Keeler; Thorax; Vol. 54, 1999, pp. 1004-1008.

60 "Comparison of Emissions and Residential Exposure from Traditional; and Improved Cookstoves in Kenya;" Majid Ezzati, Bernard M. Mbinda, and Daniel M. Kammen; Environmental; Science and Technology; Vol. 34, No. 4. 2000, pp. 578-583; and "The Contributions of Emissions and Spatial Microenvironments to Exposure to Indoor Air Pollution from Biomass Combustion in Kenya;" Majid Ezzati, Homayoun Saleh, and Daniel Kammen; Environmental Health Perspectives; (in press).

61 Liu, Kai-Shen; Maria Katrina Paz, Peter Fessel, Jed Waldman, and John Girman; "Unintentional Carbon Monoxide Deaths in California from Residential and Other Nonehicular Sources;" Archives of Environmental Health; Vol. 55, No. 6; November/December 2000; pp. 375-381.

62 Bockarie, M.J., Service, M.W., Barnish, G., and Salia, F.; "The effect of woodsmoke on the feeding and resting behaviour of Anopheles gambiae s.s.;" Acta Tropica Vol. 57; pp. 337-340; 1994; and Ghebreyesus, T.A., Haile, M., Witten, K.H., Getachew, A., Yohannes, M., Lindsay, S.W., and Byass, P. 2000. "Household risk factors for malaria among children in the Ethiopian highlands;" Transactions of the Royal Society of Tropical Medicine and Hygiene; Vol. 94; pp. 17-21; 2000.

63 Personal communications with IAP specialists at USAID/USAID "Global Consultation on Indoor Air Pollution," May 2000, and mosquito/malaria specialists L. Barat, CDC/World Bank, and R. Anderson., R&L Environmental Services (Canada).

64 S. West, A. Hildesheim, M. Dosemeci; "Non-viral Risk Facto for Nasopharyngeal Carcinoms in the Philippenes: Results from a Case-Control Study;" Internal Journal of Cancer; Vol. 58, No. 6, Sept. 15, 1994; pp. 899-900; and B.S. Quah, A.R. Mazidah, and H. Simpson; "Risk Factors in the Last 12 Months in Preschool Children;" Asian Pacific Journal of Allergy and Immunology; Vol. 18, No. 2; June 2000; pp. 73-39.

Injuries, Stress, and Other Conditions

1.60 Injuries have generally been neglected in the literature. In the developed countries, back injuries are a significant cause of absenteeism,[65] but are often not caught in health statistics like DALYs because they are so difficult to measure and are not necessarily reported to doctors unless they are severe or require hospitalization. As such, in "modern sectors," injuries might be captured in employment data. While it is obvious that descriptions of absenteeism in industrialized countries could not be applied to developing countries, the effects of carrying heavy loads of fuelwood merit a closer look. One area, however, might be a better understanding of the actual degree of under-estimation of injuries. When the state of Minnesota examined the impact of non-fatal injuries comprehensively for the first time, they found that falls cost the state about 3.5 times more than car crash injuries (US$126 and US$36 million respectively),[66] which generally get much more attention and funding. In the developed countries, back injuries are a significant cause of absenteeism, [67]but are often not caught in health statistics like DALYs because they are so difficult to measure and are not necessarily reported to doctors unless they are sever or require hospitalization.

Injuries and Other Health Effects to Women, Children, and the Elderly

1.61 Four types of injuries would be significant to the energy sector:

- burns, mainly to children (and the elderly) from cooking, heating, and lighting fires
- poisoning, mainly children, from ingesting fuels like paraffin
- injuries to the back, neck, and head from fetching heavy loads, mainly to women; men and boys are also at risk, but the literature does not address them except in passing, and
- injuries from household fires, especially in high-density housing.

1.62 For example, 140 of some 2125 people surveyed in South Africa (about 6.5 percent) had experienced incidents of paraffin poisoning (see table 5). About 85 percent (on average) of those fetching wood are women. (In peri urban areas, fetching firewood might entail a higher exposure to malaria, but this will depend on local conditions. In rural areas, this is generally not the case, since mosquitoes are pervasive in endemic areas.) Table 24 (Annex II) gives a detailed breakdown for hours spent per day fetching firewood, which range from a high of 7 hours in Ethiopia to a low of 0.7 hours in Burkina Faso, Kenya, and Nigeria. Whereas many studies analyzed time spent on domestic chores collectively, the literature review encountered nine studies devoted to time spent fetching firewood (Table 24). In addition, the weight of the loads was generally not analyzed; this is a serious omission to health considerations, since heavy weights are known to produce a wide range of injuries (see below) and can also be a cause of miscarriages. Figure 6 helps put the situation into perspective.

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65 "Back Pain Leading Disability: Study;" Business Insurance; Nov. 16, 1998; Meg Fletcher, based on a survey conducted by Gallop for CIGNA insurance; 1998, Brain Communications

66 "Falls are a Leading Cause of Injury in Minnesota;" The Nation's Health; October 2000, p. 9.

67 "Back Pain Leading Disability: Study;" Business Insurance; Nov. 16, 1998; Meg Fletcher, based on a survey conducted by Gallop for CIGNA insurance; 1998, Brain Communications

Figure 3: Physical Stress and Other Hazards of Fetching Fuel

Current energy production and use entail *occupational* hazards for women. The estimated 10,000 women fuelwood carriers in Addis Ababa, who sell one-third of the wood fuel consumed in the city, suffer frequent falls, bone fractures, eye problems, rheumatism, anemia, and miscarriages, from carrying loads often weighing 40-50 kg—nearly as much as their own body weights.[68] The Addis case is particularly sad in that the women fetching fuelwood to sell are also perceived as an environmental threat to deforestation, and are even considered as "agents of forest destruction."

In addition to physical stress, women face various forms of violence associated with their role as providers of fuelwood. "Physical and psychological violence against women has been reported: rapes while gathering fuelwood around refugee camps in Somalia, undergoing sniper fire to gather fuel in Sarejevo, and bride suicides related to women's inability to meet their family's wood fuel needs in India."[69]

1.63 Other health problems also related to energy availability: a) cooked meals and their effects on nutrition; b) boiling water to reduce diarrheas (still a main source of morbidity and mortality in developing countries); c) burns and scalding in cooking areas from cooling food; and d) the effects of high energy costs (modern or traditional) on nutrition, one of many household choices and trade-offs that confront poor families.

1.64 According to WHO, households respond to fuel shortages through several "coping strategies" that may have negative impacts on the nutrition and health of children and other family members:

- More time spent on collecting fuelwood leads to increases in caloric needs, risk of assault, and injury and accidents.
- Cooking with inferior biomass fuels leads to increased air pollution, time needed to tend the fire, and decrease of items requiring long periods of cooking.
- Coping by spending less time cooking leads to: decreased food production, purchase preservation and storage; less time available for income generation, resting, space and water heating, hygiene; less overall food preparation; eating more warmed-up food; preparation of special foods for children, pregnant, and lactating women.[70]

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68 Haile, F., *Women Fuelwood Carriers in Addis Ababa and the Peri-Urban Forest*, International Labor Organization, 1991; p. 18.

69 Elizabeth Cecelski, "Gender Perspectives on Energy for CSD-9 --- Draft position paper including recommendations proposed by the ENERGIA Support Group and the CSD NGO Women's Caucus," ENERGIA, the International Network on Gender and Energy, 2000.

70 WHO, *Health and Environment in Sustainable Development: Five Years after the Earth Summit*; WHO/EHG/9708; cited in Gopalan, and Sumeet; *Domestic Environment…*; *op. cit.*, Table 6, p.93.

Figure 7: Child Safety in Non-Electrified Households in South Africa

A larger-scale health and safety survey of nonelectrified households in South Africa showed that about 6.5 percent had experienced (sometimes fatal) incidents of paraffin poisoning of children. Burns in the household are one of the top four causes of death for children in South Africa.[71] One study cited that rural children had a higher incidence than urban children, with 14 and 4 percent, respectively, of children surveyed having suffered from fire burns (but did not explain the difference).[72]

Source: *Energy and Development Report, 2000 –Energy Services for the World's Poor. The World Bank and ESMAP*, ESMAP World Bank, 2000.

Injuries and Stress from Natural Disasters

1.65 Natural disasters have been receiving more attention in the literature, partly because the frequency of extreme events has been increasing, attributable in part to climate change and global warming from the generation of greenhouse gases. (For details see "climate change," next section.) Whereas deaths associated with such disasters tend to be regularly tallied, numerous other health effects and costs do not. Health effects immediately after a disaster tend to be neglected when compared with estimates of property damage. Health coverage tends to focus on safe water and emergency health services, but seldom recognizes the costs of human deaths or injury, or the psychological effects of losing family, home, and employment or the socioeconomic effects of stress in the months following disasters. Mental stress, and perhaps even suicide rates, are known to increase in the months following disasters.[73] A better estimation of human health damages could help justify energy sector interventions.

Electromagnetic Fields (EMFs)

1.66 Diseases linked to electromagnetic fields (EMFs) are frequently discussed in the literature from developed countries and may be important in selected areas, such as urban centers, of developing countries. EMFs have been linked with occupational risks and risks to people living under transmission lines (highest risk for children of brain cancers and leukemia), based mainly on animal studies. Data from human studies were considered insufficient or too weak, or the exposures were too low to warrant statistical significance. In 1998, however, EMFs were designated a "possible human carcinogen" (this is the lowest of three ratings—"known," "probable," and "possible"). By comparison other "new" issues, such as sleep disturbances and inhibition of drug functions[74] were identified as possibly linked to EMFs. In addition, numerous electric appliances (hair dryers, vacuum cleaners, dishwashers, copy machines, color TVs, air

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71 L. Lerer; "The Epidemiology of Fatal Childhood Burns;" South African Medical Journal; Vol. 84, 1994, p. 169.

72 Eberhard, Anton A., and Clive van Horen; *Poverty and Power: Energy and the South African State*; East Haven, Conn.; Pluto Press; 1995; p. 78

73 Krug, Etienne G.; Kresnow, Marcie-jo; Peddicord, John P.; Dahlberg, Linda L.; Powell, Kenneth E.; Crosby, Alex E.; Annest, Joseph L.; "Suicide after Natural Disasters;" The New England Journal of Medicine; Feb. 5, 1998; Vol. 338, No. 6; pp. 373-378. Since publication, these findings have been disputed, suggesting that, whereas mental health problems *do* increase substantially after disasters, it is not clear that suicide rates increase as well. Kimberley I. Shoaf; Letter to the Editor: "Suicides after Natural Disasters;" The New England Journal of Medicine;- June 18, 1998 -- Vol. 338, No. 25.

74 "National Institute of Environmental Health Sciences Report of on the Human Effects for Exposure to Power-Line Frequency Electric and Magnetic Fields;" (Report of a Scientific Working Group, June 1998) National Institutes of Health, Report No. 99-4404,

conditioners, and computer monitors) have also been studied, with similar conclusions about cancer, and also that they may be involved with endocrine disruption.[75]

Vector-Related Diseases

Dams

1.67 The health consequences associated with dams have been an integral part of environmental and environmental health literature. The main health effects entail the spread of vector-related diseases, principally malaria and schistosomiasis, as shown in table 10. Recently, however, the topic seems to have become scarce in the literature. *Conceivably*, this could be because most of the large, controversial dams have already been built or contracted. By comparison, several articles appear on irrigation dams and the subsequent spread of malaria to the riparian and nearby populations.[76] For example, a study in Ethiopia showed a sevenfold increase in malaria among about 7,000 children under 10 years of age living within three kilometers of small dams, compared with children living outside mosquito flight ranges. SSA has the highest death rate from malaria in the world. (Recently, the potential increase of malarial habitat that might spread from global warming has been scaled down.[77]) In addition, holes dug for power transmission lines can spread malaria.

Table 10: Death and Disability of Top Ten Vector-Borne Diseases (1998)

Disease/Condition	*DALYs* (thousands)[a]	*Deaths* (thousands)[b]	*Population at Risk* (millions)[c]
Malaria	39,267	1,110	2,400
Schistosomiasis	1,699	7	600

Source: a and *b:* WHO; *The World Health Report 1999. Part 3:* Statistical Annex. Geneva., 1999, pp. 85–115; *c:* WHO web site on specific diseases (<http://www.who.int/home/ map_ht.html#Tropical Diseases>, accessed September 2000) and McMichael, A. J., A. Haines, R. Sloof, and S. Kovats. *6. Climate Change and Human Health*. Prepared for WHO, WMO, and UNEP; Geneva: 199; WHO), table 4-1.

1.68 Similarly, there appears to be no published literature on varied-use dams, which provide irrigation and power at the village or regional level. Since releasing water (draw down) is more difficult to control, it is more difficult to predict and control the effects on vector habitats, i.e., snails and mosquitoes, which spread schistosomiasis and malaria, of varied-use dams.

1.69 WHO has produced an excellent paper on the health effects of dams.[78]

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75 "EMF's Biological Influences: Electromagnetic Fields Exert Effects on and Through Hormones;" Janet Raloff; Science News; Vol. 153, Jam. 10, 1998.

76 Ghebreyesus, Tedros A., Mitiku Haile, Karen H. Witten, Asefaw Getachew, Ambachew M. Yohannes, Mekonnen Yohannes, Hailay D. Teklehaimonot, Steven W. Lindsay, and Peter Byass. 1999. "Incidence of Malaria among Children Living Near Dams in Northern Ethiopia: Community-Based Incidence Survey." *British Medical Journal* 319 (663–66).

77 Martens, Pim; "How Will Climate Change Affect Human Health?" American Scientist; Vol. 87, November–December, 1999; pp. 534–41.

78 WHO; *Human Health and Dams: The World Health Organization's submission to the World Commission on Dams (WCD);* Protection of the human environment, water, sanitation and health series; WHO Document no.: WHO/SDE/WSH/00.01; 2000; 43p.

Climate Change

1.70 Climate change has been receiving increasing attention, with considerable attention being paid to the energy and transport sectors as sources of greenhouse gases. Inclusion of health in the discussions, has, however, not kept pace, despite the potential for high levels of negative health repercussions—indeed, some could argue that the attention accorded to health has been minimal. For example, the Intergovernmental Panel on Climate Change (IPCC) has produced five significant reports.[79] The first (1991) gave health a passing reference, but the latest (1996) concludes that the health effects of climate change would be wide-ranging and predominantly negative.[80] During the official preparations for the Kyoto Conference (December 1997), health was not an official agenda item (although WHO and health NGOs attended the conference). On the positive side, a new journal, *Global Change and Human Health*, has just been started.

1.71 Table 11 lists the main effects of climate change, showing that the indirect effects may be greater than direct ones. In addition to effects listed below, other effects could emerge as a result of changing fuel prices. These include:

1.72 - *The spread of vector-related diseases* through development of dams that are currently technically but not economically feasible. In Africa in 1997, 39 dams were considered technically feasible; 20 of these were considered economically unfeasible, leaving 19 that could be developed.[81] - *The exacerbation of burden of disease*, related to the use of biomass fuels from increased pressure to use cheap, more polluting household fuels.

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[79] 1)*Climate Change: Science, Impacts and Policy: Proceedings of the Second World Climate Conference*; J. Jager and Ferguson, eds.; Cambridge University Press, 1991; 2) *Climate Change 1992: The Supplementary Report to the IPCC Scientific Assessment*; Cambridge University Press, 1992; 3) *IPCC's Second Assessment Report; 1995; 3*) *Climate Change: Science, Impacts and Policy: Proceedings of the Second World Climate Conference;* J. Jager and Ferguson, eds.; Cambridge University Press, 1991; 4) *Climate Change 1995:(Vol. I), The Science of Climate Change, Contribution of Working Group I to the Second Assessment Report of the Intergovernmental Panel Change on Climate Change*; and 5) *Climate Change 1995 (Vol. II), Impacts, Adaptations and Mitigation of Climate Change: Scientific-Technical Analyses --- Contribution of Working Group II to the Second Assessment Report of the Intergovernmental Panel on Climate Change;* Cambridge University Press for the World Meteorological Organization and United Nations Environment Programme, 1996.

[80] An update from meetings held in January 2001 is forthcoming: IPCC Third Assessment Report "Climate Change 2001: The Scientific Basis." its summary is available from: http://www.ipcc.ch/

[81] International Journal on Hydropower and Dams: Hydropower and Dams, 1997 World Atlas and Industry Guide; pp. 4-6.

Table 11: Health Effects of Climate Change

Possible Main Direct Health Effects	*Possible Main Indirect Health Effects*
Extreme temperature variations: death, illness, and injury from thermal stress[82]	*Extreme cold:* transport-related injuries and death
Storms: drowning and injury	*Storms:* loss of housing, mental and physical stress of displaced persons, and increase in water-related infectious diseases
Floods: drowning and injury	*Floods:* (same as storms)
Brush and forest fires: injury and death	*Brush and forest fires:* (same as indirect effects of storms, but to a lesser extent)
	Habitat alteration: infectious diseases, plus epidemics
	Food production: malnutrition
	Water quantity and quality: diarrheal diseases
	Aggravation of air pollution: aggravation of existing illnesses
	Desertification and droughts: malnutrition, plus mental and physical stress of displaced persons
	Rising sea level: water pollution, saltwater intrusion, susceptibility to storms, vector diseases, and malnutrition
	Social and demographic dislocations: mental and physical stress in displaced persons and loss of infrastructure

Source: Adapted from *Climate Change and Human Health*; A. J. McMichael, A. Haines, R. Sloof, and S. Kovats, eds., WHO: Geneva, 1996; Fig. 1-1, p. 12.

The Challenge of Uncharted Areas

1.73 Whereas attention to household energy in developing countries is at the cutting edge of the literature, this literature review identified gaps that constitute uncharted areas having potentially significant repercussions for the sector. In particular, the beneficial effects of environmental health interventions appear to be systematically underestimated. Better valuation of such benefits could influence policy choices for several sectors. Four new concepts are proposed to help address these uncharted areas, summarized in figure 8.

[82] Thermal stress refers to the body's inability to respond to rapid changes of extremes in heat or cold, such as heat waves or cold spells. Cold spells are relevant, because global warming, that is, increase in the average temperature of the earth's atmosphere, entails greater climate variability and a wide range of weather extremes.

Figure 8: Four Challenges of Uncharted Areas

1. Quantification of the Full Burden of Diseases from Dependence on Biomass Fuels. Current statistics underestimate health damages by neglecting the effects besides ARI that are related to gathering and using biomass fuels. A better understanding and quantification of these can help improve the outcome of energy projects.

2. Economic Valuation of the Full Burden of Disease and Benefit of Improved Energy. Economic benefits of energy projects could be enhanced by better valuation of the full range of health benefits, relative to cost-effectiveness of different preventive interventions such as ventilation, improved stoves, modern fuels, and awareness of the health hazards of smoke.

3. Better Understanding of Socioeconomic Underpinnings of Behavioral Change. Compared to the focus on technology, very little has been done to tap community efforts at self-help in reducing harmful exposures to smoke or improving household economic decision-making.

4. Policy Response: a Paradigm Shift? A better understanding of the full range of health and socioeconomic benefits may call for a shift in policies based on appropriateness and feasibility, e.g., better sectoral collaboration or subsidies for improved energy.

1. Quantification of the Full Burden of Diseases from Dependence on Biomass Fuels

1.74 Current data reflect separate diseases and groups that would respond to the same types of remedial measures irrespective of different curative measures. For example, table 12 shows that enhanced indoor air quality through better stoves and household ventilation could have beneficial effects collectively on about a dozen types of respiratory diseases listed separately (see table 34). Such rearrangement could change their ranking, and thus the cost/benefit analyses of remedial measures. For example, the impact on respiratory disease alone, currently the number-one source of DALYs globally and in SSA, nearly doubles (see table 34).

Table 12: Burden of Disease in SSA by Main Remedial Measures (1990)

Remedial Measures	*Disease or Condition*	*Years with Disability*	*Annual Deaths*	*DALY*
Improved housing and air pollution abatement	Respiratory disease	3,017,000	1,565,000	45,312,000
Vector control, sanitation, and drainage	Tropical cluster or vector related	8,064,104	1,123,300	35,922,104
Improved water and waste management	Water and sanitation related	1,468,000	888,539	31,208,000
Household and traffic injury reduction	Unintentional injuries	5,322,009	335,300	15,067,000
Subtotal infrastructure related		17,871,113	3,912,139	127,509,104
Subtotal childhood cluster[a]		1,501,000	788,000	28,093,000
Subtotal remaining burden of disease		48,158,000	3,326,861	137,236,104
Grand total burden of disease		**67,530,113**	**8,027,999**	**292,838,208**
Percent potential for infrastructure interventions		26.5	48.7	43.5

a. Childhood cluster includes pertussis (whooping cough), poliomyelitis, diphtheria, measles, and tetanus.
Source: *Environment and Health: Bridging the Gaps*, table 2-7; forthcoming, 2001.

1.75 Table 13 takes Table 12 a step further by estimating the *possible range* of health benefits available outside the health sector in SSA, reflecting current data that do not include other respiratory diseases than ARI. Measures inside and outside the health care system could achieve the same order of magnitude, each averaging about 15-20 percent. In theory, therefore, it is possible to produce the same order of magnitude of health benefits at only a fraction of the cost, because investments have already been justified for reasons other than health. Although the figures are still estimates and require rigorous statistical analyses, in the absence of statistically significant data, common sense and professional judgment argue for systematic examination of these possibilities.

Table 13: Burden of Disease Relieved by Remedial Measures (1998)

	Percent of Range of DALYs Potentially Reduced	
Environmental Health Remedial Measures	*Low*	*High*
Infrastructure and other sectors:		
Improved housing and air pollution abatement	6	8
Improved water and waste management	8	9
Vector control, sanitation, and drainage	3	4
Road, workplace, and housing design	1	1
Subtotal of environmental health types	17	22
Health care/education remedial measures:		
Subtotal of health care types	15	20
Other remedial measures:		
Subtotal other	68	58
Total	100	100

Source: *Environment and Health: Bridging the Gaps*, table 2-8; forthcoming, 2001.

1.76 A rough framework has been developed and could be improved to help harmonize infrastructure interventions so that collectively they can improve health with only minimal additional costs to the existing investments. Preliminary figures indicate that these benefits are underestimated and could be equivalent to 6 percent of GDP for SSA (1998). Table 14 shows the major risk factors that would need integration into the different sectors, including energy (see Tables 6, 12, and 15, column 3, percent).

Table 14: Major Risk factors in Developing Countries

Risk Factor	*Percent of Total LDC Deaths*	*Percent of Total LDC DALYs*
Malnutrition	14.9	18
Water/hygiene/sanitation	6.7	7.6
Solid fuel use	4.7	4.3
Unsafe sex/unwanted pregnancies	2.5	3.7
Alcohol	1.6	2.7
Occupation	2.3	2.5
Traffic injuries	1.8	2.2
Tobacco	3.7	1.4
Hypertension	3.8	0.9
Illicit drugs	0.2	0.4
Outdoor air pollution	0.7	0.4
TOTALS	**42.9**	**44.1**

Source: Kirk R. Smith and Sumi Mehta, 'The Burden of Disease from Indoor Air Pollution in Developing Countries;" paper prepared for USAID/WHO Global Technical Consultation on the Health Impacts of Indoor Air Pollution and Household Energy in Developing Countries; Washington D.C., May 3-4, 2000; p.15.,

1.77 The quantification of IAP-related diseases and conditions is still underestimated. There is a need to better quantify household fuel-related diseases and conditions, especially for women and children (and the elderly, not addressed in the literature). Preliminary calculations on attributable risk show that by looking beyond acute respiratory infections (about 82 million DALYs), 87 million additional DALYs from other respiratory diseases could be simultaneously targeted. Additional conditions (injuries, burns, etc.) and vector-related diseases could also be targeted but were not apportioned. (See table 35, which lists the full range of diseases and conditions related to the use of biomass fuels.) While there are many gaps in the literature on topics considered key to understanding respiratory disease by the research community, e.g., dose response curves for individual pollutants, there *is* sufficient evidence to proceed with reducing indoor air pollution and promote cleaner fuels. The Bank has no advantage in direct involvement with these, but can make a considerable contribution in recalculating the burden of disease by preventive measures outside the health sector, especially because of the resources it (HNP) has already invested in promoting the DALY concept and working closely with WHO on developing health statistics.

2. Economic Valuation of the Full Burden of Disease and Improved Energy Benefits

1.78 These ratios are based on the premise that the contributions from each sector will vary. A clearer understanding of their relative health impacts by sector activity can also help identify interventions from other sectors or subsectors that can mutually reinforce each other—the difference between promoting health benefits and maximizing them. Current back-of-the-envelope calculations show that, for every additional dollar addressing health topping up infrastructure projects, it is conceivable on average to produce US$2.30 in health benefits in SSA (1998), and about US$5 for reducing indoor

air pollution. See table 15, "Possible Efficiency Ratio" column, for preliminary figures. (see also Annex II for details).

1.79 A segmentation of intervention options by cost-effectiveness, differentiated by urban/rural areas, is warranted, i.e., (i) *education only* associated with biomass fuels; (ii*) improved ventilation only* for biomass fuels; (iii): *improved stoves* for traditional biomass fuels and testing more efficient burning/less polluting woods; and (iv) introduction of *new cleaner fuels, as appropriate*. The segmentation by cost-effectiveness would help tailor appropriate policies according to: different factor endowment (e.g., access); ecological zone; cultural habits (outdoor cooking), receptiveness, and substitution; mobility (that affects distribution and end-use of new products); and so on.

Table 15: Benefits of Infrastructure and Energy Interventions

Interventions to Relieve the Burden of Disease	*Targetable SSA Burden of Disease*		*Possible Efficiency Ratio*
	DALYs (Millions)	*Percent*	
Infrastructure and Energy Improvements	*69.2*	*21*	*2.4*
Indoor air quality, housing, and education	17.1	*5t*	4.4
Outdoor air quality fortTransport, energy, and industry	5.7	*2*	0.9
Transport management: education, enforcement, and insurance	1.7	*1*	1.8
Water, sanitation, waste management, and hygiene education	27.5	*8*	1.7
Vector control and improved drainage and irrigation (plus partial sanitation and waste management)	17.1	*5*	3.7
Infrastructure outreach for high-risk groups	N.A.	*N.A.*	N.A.
Living environment	0.6	*0*	N.A.

Source*: Environment and Health: Bridging the Gaps*, forthcoming, 2001

1.80 The burden of IAP-related diseases and conditions is still undervalued. Better valuation of *benefits* depends on better quantification, and better *costing* of the alternative cost-effectiveness interventions is needed to determine policy choice. For example, the USEPA has estimated that reducing air pollution from 1970-90 saved US$16 in averted health damages for every US$1 spent.[83] Another study estimated that it would be possible through efforts to reduce carbon emissions to avoid 700,000 annual deaths caused by particulate matter in air pollution, for a cumulative total of 8 million deaths globally between 2000 and 2020.[84]

3. Better Understanding of the Socioeconomic Underpinnings of Behavioral Change

1.81 Many factors have been neglected because of the stress on technology. These cover a wide array and include: (a) cooking procedures to consume less energy

[83] *The Benefits and Costs of the Clean Air Act, 1970-1990;* United States Environmental Protection Agency; May 3, 1996, draft.

[84] "Short-term Improvements in Public Health from Global Climate Policies on Fossil Fuel Consumption: an Interin Report;" Working Group on Public HEalth and Fossil-Fuel Consumptionl, Ther lancet; Vol. 350; No. 9088; p. 1341.

(e.g., soaking beans overnight); (b) household budget allocation (e.g., use of more polluting fuels at the end-of-month); (c) consumer preferences (e.g., many women complain more of smoke in their eyes than in their lungs); and (d) reducing exposure to disease vectors (mainly mosquitoes and snails) after dam construction, which can spread around the entire water body, river, and areas of water use after project closure.

4. Policy Response: A Paradigm Shift?

1.82 Reducing the energy-related burden of disease may call for a paradigm shift. Policy response, which could then be justified on health grounds, would require better quantification and valuation of biomass-associated health risks, which have only been partially calculated because of a focus on ARI. This policy response requires (a) gauging the willingness on the part of the poor to pay, as well as determining a possible introduction of subsidy for investment, operations, or maintenance; and (b) synergies through key coordination with other sectors and partners. The main hindrance to cost appears at the household and project levels. Of the three uncharted areas above, the Bank has a comparative advantage to deal with economic analyses. Even more important, it may be possible to move forward *without* additional research, *if* current knowledge points to the same interventions for the Bank, e.g., improve household energy.

- Willingness to pay. IAP interventions could easily be prioritized due to least-cost/high-health-outcome ratios compared to much higher ratios (at least four times higher) for ambient air abatement or other infrastructure interventions. Policy and market failures (no market for clean fuels for the poor) or imperfect markets (open access; free woodfuels) are usually specific to each context and need to be assessed and addressed accordingly. There is a also need to determine if interventions will be based on: (i) willingness to pay (WTP) of the poor, i.e., are they willing to climb the "reduction in indoor emission" ladder (average expenditure on energy for the poorest quintiles is 20 percent and 8 percent[85] in urban and rural areas respectively); (ii) subsidy for investment, operations (cost of fuel) and/or maintenance, which should be carefully assessed and structured to target the poor; or (iii) a combination of both that would entail a marginal subsidy that needs to be determined. In addition, outcome-based indicators need to be developed to monitor interventions.
- Multisectoral synergies intervention and partnerships. There is a need to (a) tap opportunities from different sectors to optimize environmental health synergetic gains, especially with the water, environment, and health sectors, and (b) identify IAP partners to harmonize and leverage Bank intervention. Better internalization of environmental health concerns in the environmental assessment process could be implemented with on-the-shelf information, e.g., burden of disease calculations, environmental impact assessment procedures, safeguard policies, and so forth.

[85] Sanghvi, Arun; *A Bright Future? Energy in Africa's Development*, Draft,.2000.

Considerations for Follow-Up (Stage 2)

1.83 From stage 1a, the literature review, and discussion with energy-sector staff, a selection of three priority areas, broken into 10 complementary activities was drawn up for *consideration* in the next stage (table 16). Given that some of the activities require collaboration with other Bank sectors and outside agencies, these actions have been subdivided into 21 complementary actions (table 32) by different criteria to allow for different levels of input for areas that are important to the energy sector, but not practicable for any single unit like AFTEG or a larger program like ESMAP. These will need critical comment from different perspectives, e.g., AFTIE and AFTEG, ESMAP, ENV, and HNP, to see which are feasible within the Bank or in collaboration with other institutions. From this list (and other suggestions), a set of recommendations can be drawn up. Ranking in this report reflects an environmental health perspective; input from other professions and sectors will be needed to make the list into a set of recommendations for the Bank.

Table 16: Top Ten Actions to Be Prioritized

I. Operations
Define indoor air pollution in "operational" terms and devise policy response, targeting the poor.
Devise "entry points" for collaboration on energy, environment, and health.
Tap synergies through partnerships, e.g., RPTES on health benefits of fuel gel, UNDP on rural hybrid solar-wind electrification, and others as appropriate (see Annex VII for potential partners).
Prepare case studies on energy-health opportunities in projects with initial focus on PRSPs and CDDs.
Estimate effects of exacerbating mosquito-borne diseases through reduction of indoor air pollution.
II. Operations Research
Explore how awareness campaign to change behavior can be integrated into operations to improve health.
Explore linkages with child health.
Explore linkages with gender issues.
Determine health effects related to small/medium sizes enterprises (SME).
III. Economics and Policy
Develop better economic valuation and monitoring techniques.

1.84 **Implementation dilemma:** Stage 2 follow-up within the Bank will be complicated on three counts. First, follow-up will require multisectoral collaboration. The relative importance of linkages listed in table 2 will vary among sectors and regions, and thus in work programs and budgets. Second, the wide variety of Bank sectoral priorities, lending instruments, and Bankwide directives proposing different approaches to poverty reduction make it difficult to make precise recommendations on how and where to operationalize environmental health work, e.g.:

- Structural or sectoral adjustment lending
- Country assistance strategy and environmental analysis
- Comprehensive development framework
- Poverty reduction strategies
- Community-driven development
- Cross support.

1.85 Third, currently cross support on health issues, apart from AIDS in SSA, has not been extensive in the Bank, with no lessons learned that can be used for guidance on energy-health collaboration.

Annex 1

Objectives and Methodology

Background and Objectives

A1.1 The rationale behind this examination of energy and environmental health is that most causes of disease, injury, and death in developing countries lie outside the purview of the health care system. These include inadequate infrastructure (e.g., sanitation, water, waste removal, housing), traffic injuries, and inefficient energy for cooking, lighting, and heating, all of which are based in other sectors. Yet policies of the sectors exerting the negative health impacts are not set by health criteria; and the health sector tends to focus on the health care delivery system, not necessarily on the sectors that are the source of the problems. To address this issue, a small program,[86] "Environment and Health—Bridging the Gaps," was begun under the Africa Region's Urban Environmental Management Initiative to help redress these imbalances, concentrating on urban and rural infrastructure linkages. The work in infrastructure is now being applied to the energy sector.

A1.2 Historically, energy-environmental health analyses have focused on outdoor air pollution from petroleum-based fuels of industrial and vehicular sources, mainly in the industrialized countries, and, to a lesser extent recently, on indoor air pollution in developing countries. This focus has meant a relative neglect of several factors that may be equally, if not more, important to the energy-environmental health linkages in developing countries, viz.:

- The burden of disease associated with indoor air pollution,
- Health problems stemming from the use of traditional fuels, and
- Consequences due to lack of access to modern energy and an overall energy deficit.

A1.3 The relative importance of this issue is discussed in this literature review.[87]

Overall Objective of Literature Review (Stage 1A):

A1.4 The specific objectives of the overall ESMAP proposal (see figure 9) are to:

a) Identify the main energy and health problems, especially the "hot spots"; describe the various linkages related to different stages of energy

[86] Funded by the Norwegian, Swedish, and Swiss trust funds.
[87] Section 1 is intended to full Stage 1A of the proposal to ESMAP for support on Environmental Health and Energy.

production and use; and derive the burden of disease attributable to these problems, including those related to *lack* of electricity rather than *pollution;*

b) Devise methodologies to value and prioritize energy-related health problems;

c) Develop remedial measures and guidelines for projects with an initial focus on the environmental assessment process; and

d) Recommend specific interventions at the household level.

Figure 9: Overall Objectives of Energy and Environmental-Health Review

This literature review is a initial step in a broader inquiry looking into the linkages among energy, health, and environment. As such, the literature review focuses on SSA, while concentrating on household fuels, as these appear to have the greatest health potential, but also looks at electricity and transport fuels.

Specifically, the literature review aims to clarify energy-related health problems; to identify "hot spots" for project interventions; to determine actual and untapped health benefits; and to review the Africa Energy Strategy for health repercussions.

The broader inquiry is based on past work on the infrastructure sector (i.e., water supply, sanitation, waste management, housing, urban development, and transportation) that has shown that many health benefits of Bank projects are untapped; this may also be the case for the energy sector. The untapped benefits revolve around the predominance in SSA of three of the top-ranking causes of death, disease, and injury: i) ARI; ii) diarrheas; and iii) vector-related diseases (mainly malaria), and the potential for preventive environmental health measures to reduce these diseases (see table 3). Infrastructure improvements in water supply, sanitation and, waste disposal, plus hygiene education, have been crucial to reducing the first two. As yet, the energy sector has not reached its full potential in helping reduce respiratory diseases as well as other health effects. This literature review is a step in recognizing that potential.

The current literature review begins by examining the long-recognized role association of indoor air pollution from poor-quality fuels as an underlying cause of acute respiratory disease. Other diseases and conditions are also involved, but the associations have been less clear or poorly documented; these include: i) *chronic* respiratory diseases like TB and lung cancer (counted separately from acute in health statistics); ii) injuries to women and children associated with poor household fuels; iii) cataracts and blindness (from extended exposure to smoke); iv) or the possibility of exacerbating or spreading malaria by reducing household smoke. These were included to determine whether they are key or fringe issues, if and how they lend themselves to energy sector interventions, and at what cost. Traditional household energy is emphasized, because of its greater impact on the poor (see Figure 1), followed by health linkages with electricity and transport fuels.

Considerable attention has been paid to health *costs*, most notably those associated with ambient air pollution from industrial and automotive sources, and, to a lesser extent, indoor air pollution from low-quality biomass fuels for cooking, heating, and lighting. By comparison, much less attention has been paid to the health *benefits* of improved access to energy, except for a few issues, e.g., provision of electricity to health care services, overall labor savings for household chores, and reduction of respiratory diseases from improved stoves. A main objective of this literature review is to help redress this imbalance, and determine if neglected issues *are* important and what measures would be needed to address them appropriately in Bank operations, or agencies outside the Bank.

A1.5 The work will be conducted in five steps:

a) Conduct a literature review to identify energy-related health problems, especially "hot spots," and to determine actual and untapped health benefits; review the Africa Energy Strategy, which corresponds to this report, for health repercussions, to be followed by the remaining steps:

b) Examine energy and health linkages in conjunction with other sectors and prioritize environmental health interventions pertinent for energy projects, with a focus on interventions at the household level;

c) Devise a methodology to value the social costs of environmental health problems related to energy production and use, taking into account vulnerable and high-risk groups, e.g. women/cooking, or high-risk areas, e.g., schools near areas of heavy transport activity, impact of leaded fuels, etc.;

d) Help delineate energy sector responsibilities vis-à-vis health and thus prevent overlapping institutional mandates from different agencies involved with energy and health, e. g., housing, transport, etc.; and

e) Suggest remedial measures for specific problems, e.g., indoor-outdoor pollution, cooking-lighting-heating fuels, vehicular emissions; and prepare guidelines, checklists, and monitoring indicators suitable for incorporation into Bank-type projects based on the suggested measures.

A1.6 In addition, the work would help clarify the seemingly contradictory observations about health consequences due to air pollution in SSA. That is, as a region, SSA does not have high levels of outdoor air pollution despite the very high burden of disease attributable to indoor air pollution and outdoor cooking. Moreover, the work will help refine initial estimates from infrastructure, in Phases 1-3 of *Environment and Health, Bridging the Gaps,* to energy. (These estimates calculated that investments outside the health care system can have an equal share of reducing the burden of disease as those of the health care system, i.e., 20 to 30 percent.)

Objective and Subjective Literature Searches

A1.7 This literature review combines objective and subjective searches. *Objective* searches were conducted by: a) searching for specific topics in numerous databases through the Bank's Sectoral and Information Technology Resource Center and, b) summarizing the findings presented at a USAID/WHO consultation on indoor air pollution, which included literature reviews (May 2000, see below). *Subjective* searches were conducted by perusing thirteen public health journals and newsletters and identifying issues based on professional judgment (see table 13).

Table 17: Journals and Newsletters Searched in Subjective Review

– Journal of the American Publican Health Association (JAPHA) – The Nation's Health (newspaper of the APHA) – Epidemiology – Environmental Health Perspectives – Archives of Environmental Health – Environment and Urbanization – Science News – Global Change and Human Health	– Global Links (Global Health Council newsletter) – International Journal of Occupational and Environmental Health – PSR Reports (newsletter of Physicians for Social Responsibility) – Perspectives in Health (Pan American Health Organization journal) – PAHO Today (PAHO newsletter) – Journal of Environmental Health

A1.8 The literature can also be subjective depending on the reader's background as shown in Figure 10. The tendency for different professions and the general public to use the same language with different meanings also accounts for some confusion in

dealing with environmental health issues. This literature review reflects an *environmental health perspective* with an emphasis on gaps and weak or neglected areas, which is often more difficult to do than describe contents of literature searches, since other professionals could draw different conclusions from the same material. (Consequently, the recommendations from the literature review are presented as a "draft," since it is important to get the perspective of other sectors to make the recommendations practicable.)

Figure 10: Same Language, Different Meanings

Because environmental health is multisectoral, effective communication and collaboration are often compromised by inconsistent use of the same language by different professional groups, especially when dealing with the health effects of pollution. Some of this difficulty can be overcome by the use of subtitles in reports instead of using the general headings of environmental health or pollution management.

Respiratory diseases. The term "respiratory disease" can refer to many diseases and conditions, but in the energy literature, it is frequently used as a synonym for "acute respiratory infections," often cited as the number-one cause of death, disease, disability, and injury in developing countries. This inconsistent use of terms has lead to an underestimation of the health effects of energy, when many other respiratory diseases may be included, as well as many diseases and conditions not related to the respiratory system, e.g., cataracts and blindness from repeated exposure to smoke. Health statistics do not necessarily help the issue because they are based on diagnosis and treatment, rather than preventive measures. For example, respiratory infections are categorized as "acute" or "chronic," "upper" or "lower," in addition to which certain respiratory infections such as TB are counted separately. Other diseases such as cancers are not "infections" and are listed separately.

Measurement of health effects of lead. An engineer could observe that the health effects of lead reduction from cleaner motor vehicle fuels are easy to measure by monitoring air pollution and lead levels in blood. By comparison, an epidemiologist could find them difficult to monitor because lead comes from many sources besides vehicular exhausts (see table 14, "Multiple Sources of Lead"), and can be drawn from prior exposures stored in bone. In addition, the presence of lead in blood does not necessarily mean damage; elevated blood levels indicate an increased probability of damage, which need specialized tests.

The anomaly of ozone. Ozone (O_3) is commonly discussed as an outdoor air pollutant, derived mainly from motor vehicle fuel. Yet, O_3 can also be a significant indoor air pollutant, derived from leakage of natural gas bottles, as well as an indoor air *purifier*.

Approach

A1.9 This dual approach of looking at direct and indirect issues, of doing both objective and subjective literature searches, was followed to capture multidimensional issues that can fall between the cracks and to ensure a broad perspective in prioritizing issues. Because there are so many linkages not readily apparent, this literature review casts a very wide net with the understanding that by identifying the fringe issues, one has a better notion of the middle and whether or not we are addressing the right cross-sectoral linkages. This additional step helps those without a health background appreciate and evaluate the number of variables involved, and also can define entry points for collaboration with other sectors, NGOs, and the private sector, all of which would depend on local circumstances. Thus, energy can play a dual role, helping alleviate problems directly linked to the sector, but also facilitating other sectors to help address the same problems (see table 2).

A1.10 Table 30 gives the broad perspective, showing energy linkages to other sectors and agencies outside the Bank, since the Bank does not have any comparative advantage to do some of the needed research, such as establishing health effects of indoor air pollution beyond respiratory diseases, for which there is currently only moderate evidence. Over the long term, such issues could have an effect on policy, e.g., increasing the rate of return for investments. The literature review takes an additional step of identifying indirect causes and "fringe issues," points in the literature that are poorly represented, but potentially may be very important locally or in the future (see Table 31). This approach does not argue that the energy sector should address indirect or fringe issues, but rather that it has the opportunity to extend health benefits by collaboration with other sectors in many cases, if institutional settings permit.

The Energy Context

A1.11 This review focuses on environmental health impacts attributable to household energy as used by the poor and, to a lesser extent, electricity and transport fuels. Energy use in SSA relies predominantly on traditional fuels, with 70 percent generated from biomass, 16 percent from oil, 7 percent from coal, 7 percent from renewable sources, and 0.6 percent from gas (see table 18). Typically, the burden of traditional environmental health risks linked to poverty—diarrheal, respiratory, and vector-related diseases—declines as income grows. For the energy sector, this means that, as incomes rise, people go up the "energy ladder," moving from traditional fuels (wood, charcoal, twigs, corn husks, dried dung, etc.) with high potential for deleterious health effects, to somewhat cleaner intermediate fuels like kerosene (paraffin), and finally to clean, modern fuels like liquid petroleum gas (LPG or "bottled" gas) and electricity. Within SSA, despite a slow increase in the overall economic performance (about 2.2 percent annual growth, 1990-95), which generally includes some income improvement for the poor, growth did not translate into a change in the composition of traditional vs. modern energy—the poor have not climbed up the energy ladder. As a result, the cluster of diseases related to indoor air pollution (respiratory diseases, eye diseases, etc., see table 2), which accounts for 7 percent of the burden of disease in SSA (1998), remains primarily attributable to traditional environmental risks linked with poverty and lack of overall services. In addition, although motor vehicle use in SSA is very low compared with the rest of the world, considerable health problems are directly linked with transport fuels, especially congested town centers where residents have high exposures to air pollution (see figure 1 for a summary of the energy-environmental health context).

The Health Context

A1.12 *The Health Situation in SSA.* Table 18 shows the top four diseases in SSA over the last decade, roughly those diseases that have accounted for 10 percent or more of the burden of disease, viz., AIDS, malaria, diarrheal diseases, and respiratory diseases. Regrettably, the dropping in rank of diarrheal and respiratory diseases does not mean a reduction in their prevalence, but rather that HIV/AIDS (human immunodeficiency virus)/AIDS and malaria have been added to the burden. Energy-sector interventions can play a major role in reducing respiratory disease, and make substantial contributions to the control of HIV/AIDS and malaria.

Table 18: Rank and Share of the Burden of Disease in SSA (1990–98)

	Rank and Share of the Burden of Disease	*Percentage 1990*[a]	*Percentage 1998*[b]
	1. AIDS	2.8	16.6
	2. Malaria	9.2	10.6
	3. Diarrheal diseases	10.9	7.5
	4. Acute lower respiratory infections	10.2	7.0
	Subtotal of top four	43.1	47.1

Source: a. Murray, C. and A. Lopez, eds.; *The Global Burden of Disease*; Global Burden of Disease and Injury Series. WHO and the World Bank. Cambridge, Mass.: Harvard School of Public Health;. 1996; pp. 561–64; . b. *The World Health Report 1999. Part 3: Statistical Annex.* WHO: Geneva; 1999; p. 115.

A1.13 Figures 11 and 12 summarize the broad linkages among environmental health and the energy sector. Figure 11 summarizes the main cross-sectoral linkages associated with the use of traditional energy sources, caused in large part by a lack of access to modern energy;we say "caused in part" because many household activities are culture bound and many continue to rely on traditional energy, especially for cooking and socializing, even when electricity and other forms of modern energy are available. (Only a few articles exist on the subject, but there appears to be a time lag of about a decade.[88]) Figure 11 also reflects a broad public health perspective and expands the range of health issues typically associated with the lack of energy.

[88] Angela Mathee, "Community-wide Electrification Programme in South Africa: Implications of Environmental Quality and Health Standards;" paper presented at USAID/WHO consultation on indoor air pollution, May, 2000.

Figure 11: Health Problems from Traditional Energy and Lack of Modern Energy

A. *Health Problems that may be related to the lack of clean fuel:*

1. Problems related to gathering fuel away from home, mostly the responsibility of women and children.
Accidents, e.g., falls, road traffic accidents that occur when fetching the fuel.
Cuts/abrasions – picking/cutting/carrying wood, charcoal, and others.
Skin diseases due to handling coal or other fuel that could cause skin irritation and/or allergies.
Increased exposure to vector-related diseases, e.g., schistosomiasis, onchocerciasis, malaria.
Physical stress from finding and carrying fuel, sometimes several hours per day, possibly leading to back, head, and neck injuries and, in extreme cases, miscarriages.
Diarrheal diseases, i.e., boiling of contaminated drinking water may not be a priority.

2. *Problems related to living in households due to lack electricity.*
Health problems related to the lack of a cold-chain (lack of fresh food).
Eye problems due to poor lighting, especially for children to read and study in the evenings.
Increased safety and security problems in the evenings – crime, accidents.
Accidents, especially burns to children, from cooking fires.

3. Health-care-related problems
Diminished effectiveness of vaccinations because of poor/no storage.
Poor sterilization of reusable supplies, e.g., needles/syringes; can lead to infection on reuse.
Safety and security for health care workers, especially on home visits.
Accidents to patients during emergency treatment procedures because of poor lighting.

B. Health problems related to pollution:

1. Outdoor air pollution:
Respiratory diseases due to exposure to air pollutants from industrial and transport sources. Industrial sources include power plants, chemical and smelting plants, and other factories. Incomplete combustion of fuel from transport vehicles also produces several pollutants, including particulate matter that could penetrate the lower respiratory system.
Heart diseases (similar to the sources causing respiratory diseases).
Neurological problems due to carbon monoxide, lead, and other hydrocarbons from vehicles.
Road traffic accidents due to decreased visibility.
2. Indoor air pollution:
Respiratory diseases – from cooking/heating fuel smoke, especially biomass, and tobacco smoke.
Heart diseases – similar to sources for respiratory diseases.
Eye diseases – due to wood and coal used as cooking fuel.

A1.14 Figure 12, by comparison, summarizes the main environmental health energy issues discussed in the literature, although they are not necessarily recognized as linked because of the tendency for specialization and fragmentation. The issues discussed less frequently or neglected altogether are described below.

Figure 12: Main Recognized Environment-Health-Energy Issues

Indoor air pollution. Apart from tobacco smoke, the environmental health effects of indoor air have been poorly studied relative to outdoor (or ambient) air pollution, which has concentrated on six "criteria pollutants" used to set air quality standards. Fossil fuels (coal, petroleum, natural gas) and biomass fuels (wood, charcoal, grass, crop residues, dung) have been and will remain the main energy sources for the next fifty years. About half of the world's population still cooks with biomass fuels, often in poorly-ventilated houses. Fine particles (less than 10 microns in diameter) are serious offenders for indoor pollution because people spend so much time indoors; fossil fuel exhausts and wood smoke are the major culprits. Coal used for cooking and heating adds lung cancer to the list of respiratory ailments. Chinese women, e.g., have the highest rates of lung cancer globally for women who do not smoke tobacco.[89] (In China, coal is the major fuel, whereas in SSA, it is firewood and charcoal.)

Cooking fuels. The main issue for household pollution is cooking fuels due to their scale in the developing countries. *It is estimated that exposure to rural indoor air pollution in developing countries is 60 times greater than in urban areas of developed countries, and that overall daily exposures are about 20 times greater.* Most estimates of health damages from air pollution have been on SO_2 and particulates, both important to outdoor air. While they do contribute to indoor air pollution, they are not the major source. Nearly 2 billion people do not have access to "modern" forms of energy such as electricity and oil and will probably continue to rely on biomass fuels for the next fifty years. About one-third of energy consumption in the developing countries comes from burning wood (including charcoal), crop residues, and animal dung, mostly in rural areas. Biomass fuels produce the equivalent of twice the energy mined in China or the United States in one year. Indoor smoke in houses with poor ventilation can increase respiratory illness. For example, in a study of 500 children in the Gambia, children who were strapped to their mothers' backs were six times more likely to develop respiratory illness than other children. [90]

Vector-related diseases. Neglect of vectors in hydropower or irrigation projects has exacerbated the spread of schistosomiasis, for which 600 million people are currently at risk. For example, prior to damming the Senegal River around 1985, there literally was one case of schistosomiasis along the river. After completion of the dam, 187 villages were infected. While not of numerical significance internationally, such epidemics can be devastating locally. The current environmental assessment (EA) process does not include systematic consideration of health factors except those related to water and air pollution and accidents during construction and operation.[91]

Search Methodology

A1.15 Table 19 summarizes library searches for air pollution in terms of numbers of articles located by broad topic on "ambient air pollution," "indoor air pollution," and "general air pollution," broken into developed and developing countries, and "literature reviews." (Caution: figures below reveal title counts only, not content analysis.)

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89 Zheng, Qingying. "The Relationship Between Incidences of Lung Cancer Among Chinese Women and Air Pollution in Kitchens." In Xiaoya Tang. *Women and Environmental Issues in China;* in *Earth Women*. Beijing: Chinese Society for Environmental Sciences; 1995.

90 Reddy, A. K. N., R. H. Williams, and T. B. Johansson. 1997. *Energy After Rio: Prospects and Challenges*. United Nations Development Programme (UNDP) in collaboration with the International Energy Initiative, the Stockholm Environment Institute, and the U.N. Commission on Sustainable Development. New York: UNDP;--- and Smith, Kirk R., *Fuel Combustion, Air Pollution Exposure, and Health: The Situation in Developing Countries*; East-West Center Reprints, Environment Series No. 1; Honolulu, Hawaii: East West Center, 1993.

91 Picquet, M., J. C. Emould, J. Vercruysse, and V. R. Southgate. 1996. "Meeting at Manson House, London, 18 May 1995. The Epidemiology of Human Schistosomiasis in the Senegal River Basin." *Transactions of the Royal Society of Tropical Medicine and Hygiene*; Vol. 90, No. 4, p. 340.

Table 19: Numerical Results of Library Searches on Air Pollution

Database	*Articles on Ambient Air Pollution*		*Articles on Indoor Air Pollution*		*Articles on (General) Air Pollution*	
	Developed Country	*Developing Country*	*Developed Country*	*Developing Country*	*Developed Country*	*Developing Country*
Bank library	1	0	23	1	922	21
Medline	957	6	2,453	28	32,694	102
Health Star	465	4	1,978	19	8,139	55
Environment	1,815	21	1,434	17	20,037	223
GeoBase	852	11	151	8	11,168	99
Totals	**4,090**	**42**	**6,039**	**73**	**72,960**	**500**
Percent Developing Countries		**1.0%**		**1.2%**		**0.6%**
	Literature Reviews on Ambient Air Pollution		*Literature Reviews on Indoor Air Pollution*		*Literature Reviews on Air Pollution*	
	Developed Country	***Developing Country***	***Developed Country***	***Developing Country***	***Developed Country***	***Developing Country***
Bank library	0	0	0	0	0	0
Medline	111	2	314	6	2,384	19
Health Star	60	1	249	4	1,012	15
Environment	0	0	0	0	0	0
GeoBase	9	0	1	0	85	2
Totals	**180**	**3**	**564**	**10**	**3,481**	**36**
Percent Developing Countries		**1.7%**		**1.8%**		**1.0%**

Source: Literature searches by the Bank's Sectoral and Information Technology Resource Center, Feb.-Nov. 2000.

A1.16 An American Public Health Association "topic of the week" literature search on air pollution, covering nine months of publications, listed 118 articles from 23 journals, covering a broad spectrum of public health issues (see table 20) dealt mostly with human health effects (about 60 percent), such as lung cancer, respiratory disease, particle sizes, and individual pollutants. Of these, only five referred to developing countries, and 15 to indoor settings. The next major topic dealt with measurement, such as monitoring techniques, statistics, etc. (18 percent), followed by tobacco smoke (18 percent). There was only one article each on economics, research, and climate change (see table 21). While neither table is statistically significant because they are only numerical counts, not analyses, they give a picture of major themes and suggest that neither indoor air pollution nor developing countries are discussed regularly, relative to the other dominant topics.

Table 20: Total Number of Articles over Past Nine Months on Air Pollution

Journal Title	*Number of Articles*
American Journal of Epidemiology	15
American Journal of Public Health	1
Archives of Environmental Health	5
Archives of Internal Medicine	1
BMJ (British Medical Association)	5
Cancer Causes and Control	2
Environmental Health Perspectives	23
Environmental Research	7
Epidemiology	7
International Journal of Epidemiology	4
JAMA (The Journal of the American Medical Association)	2
Journal of Clinical Epidemiology	1
Journal of Epidemiology and Community Health	3
Journal of National Cancer Institute	3
Journal of Occupational and Environmental Medicine	2
Journal of the Royal Society of Health	2
The Lancet	9
MMWR (Morbidity and Mortality Weekly Report)	1
New England Journal of Medicine	3
Occupational and Environmental Medicine	16
Preventive Medicine	1
Risk Analysis	2
Science	3
Total Number of Articles on Air Pollution	**118**

Source: American Public Health Association (Doody) Literature Review Service "Topic of the Week"

Table 21: Distribution of Articles over Past Nine Months on Air Pollution

Main Topics	*Number of Articles*	*Percent*	*Mention of Developing Country in Title*
Human health effects (of which dealt with indoor air)	72 (15)	61 (21%)	China (2), Turkey (2), Brazil (1)
Measurement and monitoring	22	18	
Tobacco smoke	21	18	
Research	1	< 1	
Economics	1	< 1	
Climate change	1	< 1	
Totals	**118**		

Source: American Public Health Association Literature Review Service "Topic of the Week" (Doody)

Annex 2

Valuation of Health Effects

A2.1 Table 22 compiles the major findings of the literature search for this section and provides key statistics relevant to SSA, in particular showing the reliance of the poor on traditional energy sources, and their susceptibility to health problems related to getting energy and breathing polluting fuels. The literature search for SSA did not produce one willingness to pay (WTP) study to improve stove efficiency and ventilation or to switch to other fuels, whereas WTP studies to assess water users' preferences are performed on a regular basis.

Table 22: Key Energy Findings and Statistics for SSA

Population
Population: 627 million (1998, WDI) **Urban population**: 209 million (1998, WDI) **Rural population**: 418 million (1998, WDI) **Population living in extreme poverty (less than US$1/day)**: 300 million, 48 percent of total (1998, Ravaillon/WB)
Energy Sources
Breakdown of energy sources: Total: 264.8 MTOE of which: coal (7.3 percent), oil (15.9 percent), gas (0.6 percent), electricity (6.5 percent) and b***iomass*** *(69.8 percent and 83.9 percent without South Africa)* (1997, IEA) **Use of fuelwood for cooking by the entire population and the poorest of the poor in 14 countries:** *Total population: 86 percent (of which 80 percent from firewood and 20 percent from charcoal); poorest of the poor: 94 percent in rural areas and 84 percent in urban areas* (1991-95, LSMS/WB) **Breakdown of electricity sources:** Total: 271 billion kWh (208 for South Africa) of which: hydropower (16.5 percent), coal (73.3 percent), oil (3.3 percent),gas (2.2 percent) and nuclear (4.7 percent --South Africa only) (1997, IEA) – Stock of woody biomass: 90,609 million of m3 (1994, WB) – Sectoral woodfuel share*: households (87 percent*), industry (11 percent) and other (2 percent) (1996, IEA)
Fuelwood Collection and Consumption Patterns
Average consumption of fuelwood per capita: 0.7 to 0.9 m^3 per year (1990-96, FAO and IEA, respectively) Willingness-to-Pay studies in SSA for improved stoves: none Average expenditure on energy for the poorest quintiles: 1-5 percent for two countries (1993-95, ESMAP/WB 2000); and 20 percent and 8 percent in urban and rural areas, respectively; open access (free fuelwood) is not mentioned (2000, Sanghvi/WB) Average distribution of household fuelwood collection responsibilities among men, women, and children in rural areas: 7 percent, 85 percent, and 8 percent, respectively (1985-99 and various studies) Average time spent per day fetching fuelwood in rural areas by women: 1.25 hour (1985-99 and various studies) Average fuelwood load per day in rural areas by women: 10-20 kilograms (1985-91 and various studies)

Energy-Related Burden of Disease and Associated Cost-Effectiveness of Interventions
Total burden of disease: 325.2 million DALYs (1998, WHO and authors for all of the below) **Environmental health burden of disease:** – 63.6 million DALYs (20 percent and 10 percent for the poorest quintile) – Energy-related burden of disease: 22.9 million DALYs (7 percent and 3.5 percent) – Ambient air pollution burden of disease and cost-effectiveness: 3.7 million DALYs (1.1 percent and 0.5 percent); US$350/DALY – Indoor air pollution burden of disease and cost-effectiveness: 19.2 million DALYs (5.9 percent and 3 percent); US$75/DALY – Average acute respiratory infection prevalence: 18 percent for the urban and rural poorest quintile in 22 countries (1990-98, DHS)

Source: Listorti and Doumani, *Bridging…*; 2001, and sources cited in Tables 7 to 12.

Overall Underestimation of Health Effects

A2.2 Preliminary calculation ranks indoor air quality improvement (19.2 million DALYs or 5.9 percent of SSA's burden of disease and 3 percent affecting the poorest quintile), which includes a cluster of respiratory, eye, and circulatory system diseases, as the most cost-effective intervention among a menu of infrastructure interventions designed to alleviate the burden of disease attributed to environmental health in SSA that would help the poorest of the poor as well as the population at large. The efficiency ratio is US$4.4 of lower-bound social benefits for each dollar spent. A cost–of-illness approach has been applied on DALY attributed to indoor air pollution with a US$75/DALY averted. The cluster does not include other diseases such as malaria (caused by exposure to mosquitoes while collecting fuelwood), injuries (falling while collecting fuelwoods; the Ethiopia case, for example, which surveyed 57 women from various age brackets, is extreme but quite revealing: the load burden exceeds body weight by 9 kilograms on average; and women were exposed to violence and even rape while collecting woodfuel *for commercial use*), and associated physical (head and back injuries) and mental stress (see table 23). Also, child and elder burns from cooking and heating as well as poisoning (paraffin) are not reported in Africa except for the case of South Africa, where burns resulting from exposed flames in the household are the fourth most important cause of death for children. Also, 4 and 1 percent of children surveyed in rural and urban areas, respectively, in South Africa had experienced paraffin poisoning and even in a few cases were reported dead.[92]

[92] Eberhard and Van Horen 1995.

Table 23: Environmental Health Externalities Usually Neglected in Valuation

Sector or Subsector	*Selected Negative Externalities*	
	Environment: Typically Disaggregated	*Environmental Health: Typically Aggregated as "Public Health" or "Health"*
Energy (which could accentuate global warming and climate change)	Air pollution from various pollutants, including greenhouse gases; ozone layer damage; watershed pollution; coastal and marine pollution; deforestation; biodiversity loss; resettlement; resource depletion; depletion of carbon sink; and noise and odor pollution	Respiratory, eye, and circulatory system diseases; VRD (dams); diarrheal, and other infectious diseases; lower IQ for children (from lead-based fuels); mental and physical (fuelwood) stress (the latter could lead to miscarriage); injuries (falling) while collecting fuelwood; child and elder burns resulting from exposed flames (cooking or heating); food chain contamination, including food and arsenic poisoning; possible cases of leukemia in children (transformers and transmission lines); possible cases of skin cancer and cancer due to chemical interaction in air; and spread of AIDS (construction and O&M workers)

Source: Listorti and Doumani (2000).

Indoor vs. Outdoor

A2.3 A summary of outdoor air pollution cost-effectiveness in Delhi, Mexico and Santiago, Chile shows that dollar per DALY averted varies tremendously for transport interventions.[93] Only 9 interventions of 31 to reduce outdoor air due to urban transport are moderately cost-effective, with interventions reaching less than US$1,000/DALY (US$158-793).[94] Other interventions vary between US$1,080 and US$74,946 per DALY averted. If adjusted for SSA with a benefit transfer, these figures remain tremendously high compared with improved stove interventions at US$50-100/DALY averted.

Fuelwood

A2.4 Discussion on economics of fuelwoods tends to focus on the supply side (stock, distribution chain, open access, deforestation, etc.) of natural resources and associated measures on the demand –side, such as improving stove efficiency (several woodfuel consumption sources are cited below). It is worth mentioning that the literature search for SSA did not produce any willingness to pay (WTP) studies to improve stove efficiency and ventilation or to switch to other fuels, whereas WTP studies to assess water users' preferences are performed on a regular basis (if it concerns well structure, a WTP questionnaire should capture most of the socioeconomic benefits and improvement of living conditions, including the reduction of cost, time, physical load, and associated health risks borne by consumers). Only one WTP study for household fuels in the Philippines (where prices of household fuels are not subsidized and markets are not subject to heavy regulation) was found with household fuels representing 2 percent of the average household expenditure. The 2000 Energy and Development Report derives median monthly expenditures for the poorest quintile through the LSMS surveys for Cote d'Ivoire (1 to 5 percent for energy compared to 5 to 7 percent for water) and South Africa (1 to 3 percent compared to 1 to 10 percent); and for the average households (1 to 8

[93] World Bank; "Health and Environment," Background Paper for "Environment Strategy," Draft, April, 2000.

[94] The *World Development Report 1993* suggests that interventions up to USUS$150 per DALY-saved can be considered cost-effective.

percent for energy compared to 10 to 13 percent for water) and South Africa (10 to 14 percent compared to 5 to 10 percent). Ghana, which is part of the study, does not figure in the data. In Energy and Poverty Reduction in Africa (Sangvhi 2000), the median expenditures allocated on fuels for the poorest quintile reach 20 percent and 8 percent in urban and rural areas, respectively. This is a sharp increase, compared to the LSMS surveys.

A2.5 In rural areas, the alternative to WTP or expenditure surveys is to use the time spent collecting, transporting, and using biomass fuels of various kinds (i.e., to examine time-efficiency in terms of other fuels). The literature search did not allow for enough data to measure collecting time and load for fuelwood alone. Several surveys bundle the time and load for several activities such fuelwood, water, and other domestic activities. Several surveys were not included because the figures used were confusing. However, almost all of the surveys and studies mention that mainly women (85 percent on average) and, to a lesser extent, children (7 percent) and men (8 percent), assumed the time and load burden of fuelwood collection and transport (see table 24) in rural areas. On average, rural African women spend one hour moving a load of 10-20 kilograms of fuelwood per day. Table 24 shows values for fuelwood collecting time and load for commercial and household use by women in seven African countries. Unlike the average constant household firewood load per day (10-20 kilograms), women's collecting time varies tremendously across countries, communities, and villages due to different ecological zones and factor endowments. Although physical injuries from falls sustained while collecting fuels are rarely mentioned, the physical stress of collecting and carrying the load is a function of time and load. In the absence of any means of transport, men, women, and children usually carry the load on their heads, but also on their backs and on their hips. If we assume that there are no predisposing factors among the carriers, which is rarely the case in SSA (nutrition and so on), this burden is translated with time in head (arthrosis) and back (vertebral column and scoliosis) injuries. The carrying of babies (usually strapped to their backs) by women with newborns (2-5 kilograms, depending on the age) while collecting fuelwood could exacerbate the back injuries in the long run.

Table 24: Estimates on Fuelwood Collecting Time and Load

	Botswana (before 1995)[1]	*Burkina Faso (1995*[2] *and before 1995)*[1]	*Ethiopia(1985*[3] *and before 1995)*[1]	*Ghana (1987,*[4] *before 1995*[1] *and 1999)*[5]	*Kenya (before 1995)*[1]	*Niger (before 1995)*[1]	*Nigeria (before 1995)*[1]	*South Africa (before 1995)*[1]	*Sudan (1985)*[6]	*Tanzania (1989*[7] *and before 1995)*[1]	*Zambia (1991*[8] *and before 1995)*[1]	*Zimbabwe (1992)*[9]
Use	Househ.	Househ.	Com/House	Househ.	Househ.	Househ.	Househ.	Househ.	Househ.	Househ.	Househ.	Househ.
Women Load (Kg/day)		N.A.	30[3]	20[4] N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	25[7]	20[8]	N.A.
Women Collect.; Transp. Time (Hr/day)	0.6	0.1 2.4[2] 4.5	0.9 3.3-6.3[3] 7.0	0.2[4] 0.6 0.7 0.8 1.4[5]	0.1 0.7 0.8 1.4 1.6 1.9	4.0	0.1 0.3	0.9 1.3	1.7	0.3 0.2-0.6[7] 1.1	0.7 1.9[8]	0.5
Women part. (%)		77[2]	81[3]	77[4] N.A.					100	83-77[7]	93[8]	N.A.
Children part. (%)		0[2]	19[3]	14[4] N.A.					N.A.	11-15[7]	5[8]	N.A.
Men part. (%)		23[2]	0[3]	8[4] N.A.					0	6-8[7]	2[8]	N.A.

Source: [1] Gopalan, H. N. B. and Sumeet Saksena, ed. 1999. Domestic Environment and Health of Woman and Children. United Nations Environment Program and TataEnergy Research Institute, Nairobi. [2] Cecelski, Elizabeth, 2000. *The Role of Women in Sustainable Energy Development*, National Renewable Energy Laboratory (Burkina Faso);" [3] Haile, Fekerte, 1991. *Women Fuelwood Carriers in Addis Ababa and Peri-Urban Forest* (Ethiopia); [5] Wilbert Tangey, Sarah Glyde and Newlove Kwashie, 1999. *Rural Transport Services and Gender in Ghana: Study Report.* Gender Development Institute (Ghana). [6] Fruzetti, L. 1985. "Farm and hearth: rural women in farming community." In Afshar, H., ed. Women, Work, and Ideology in the Third World. London: Tavistock.v (Sudan). [4,7,8] Barwell, Ian, 1996. *Transport and the Village: Findings from African Village-Level Travel and Transport Surveys and Related Studies*, World Bank Discussion Paper No. 344 (Ghana, Tanzania and Zambia). [9] Mehrutu, A. and C. Mutambirwa. 1992. "Time and Energy Costs of Distance in Rural Life Space of Zimbabwe: case study of the Chiduku Communal Area." Social Science and Medicine 34 (1): 17-24 (Zimbabwe).

Comparison of Different Databases and Statistics

A2.6 Comparing data derived from a variety of sources remains complicated. However, a few comparable elements can be reported consistently. Difficulties arise for the following reasons:[95]

- The IEA database presents data for only 23 countries. In order to complete the figures, 31 countries are grouped under "Other Africa" and their corresponding data are “guesstimated.” Consumption for sectoral woodfuel is only available for 1995 and 1996, and data for the remaining years are only considered globally (data are estimated in terms of Ton of Oil Equivalent (TOE) of primary supply of combustible renewable and waste, making it difficult to retrieve the corresponding figures for woodfuels considered under this item for each country).
- The FAO database provides almost comprehensive figures (all countries are included except 6 nonwoodfuel-determining countries : Cape Verde, Djibouti, Sao Tome and Principe, Saint Helena, Comoros, and Seychelles). The time series are continuous for the whole scope of the study: 1980-1996. Assumed per capita consumption rather than actual figures characterize the FAO figures.
- The UNDP/World Bank Energy Sector Assessment estimates woodfuel consumption in conjunction with demographic data from 36 countries. Most of the nonwoodfuel-determining countries are not included (Cape Verde, Djibouti, Equatorial Guinea, The Gambia, Mauritius, Sao Tome and Principe, and Seychelles) except for Madagascar and Namibia. Also, in 1994, the World Bank produced estimates of the stock of woody biomass through satellite mapping by region. The aggregate figure for SSA reaches 90,609 million of m3 distributed as follows: West Sahelian Africa (3,446), East Sahelian Africa (6,479), West Moist Africa (2,498), Central Africa (28,001), Horn of Africa (6,444), and Tropical Southern Africa (18,678).
- The ESMAP figures include data for 39 countries out of 49. In fact, no data were reported for Botswana, Cameroon, Central African Republic, Chad, Djibouti, Equatorial Guinea, Eritrea, Guinea, Mauritius, Saint Helena, South Africa, and Zimbabwe. The ESMAP documents present data of inconsistent quality and report data for more than one reference year in only 10countries.
- The ENDA/IEPE documents report data for only 28 countries. Sectoral consumption data are not available.

A2.7 Table 25 shows aggregate woodfuel consumption in Africa according to the different data sources and different reference years.

[95] Amous, Samir, 1999. The Role of Wood Energy in Africa, Forestry Department, Food and Agriculture Organization, Rome.

Table 25: Aggregate Woodfuel Consumption in Africa (1,000 m^3)

Regions	*IEA 1996*[1]	*FAO 1995*[2]	*UNDP/WB 1991*[3]	*FAO 1990*[4]	*Enda/IEPE 1989*[5]	*ESMAP 1981*[6]
West Sahelian Africa	5,765	29,095	24,966	27,328	14,469	7,476
East Sahelian Africa	126,242		78,207	95,264	-	57,299
West Moist Africa	173,125		111,586		23,992	2,542
Central Africa	68,911	87,925	86,345	77,469	14,076	
Tropical Southern Africa	115,829	85,095	109,241	78,656		54,142
Insular East Africa	-	9,766	-	7,724	9,607	
Non-Tropical Southern Africa	63,177	12,586	-		-	39
Other Africa	119,947		-	-		
Total Sub-Saharan Africa	672,996	486,248	410,345	428,017	82,671	121,498

[1] Data are available for 23 individual countries, 31 other countries being grouped under OTHER AFRICA. Therefore, regional figures were not relevant. In addition, woodfuel data by item are provided only for 1995 and 1996. Data from North Africa is included.
[2] Data are available for all countries.
[3] Data available for 36 countries, UNDP/WB Energy Sector Assessment. Figures are in ton and a FAO conversion factor was used. Wood density : 1 m^3 of wood = 0.725 tons.
[4] Data are available for 47 countries.
[5] 1989 is the best year in terms of data availability (the figures include 17 countries' data)
[6] 1981 is the best year in terms of data availability (the figures include 10 countries' data)
NB. Unless stated, data from North Africa were removed from the series.
Source: Millington, Andrew C., Ritchard W. Critchley, Terry D. Douglas and Paul Ryan. 1994. Estimating Woody Biomass in Sub-Saharan Africa, The World Bank; Biomass Energy: Data, Analysis and Trends, Conference Proceedings, Paris, France – March 23-24, 1998. International Energy Agency, European Commission – Research Directorate (DG XII) and United Nations Environment Programme – Industry and Environment, 1999; FAO website: http://www.fao.org/forestry/; Amous, Samir, 1999. The Role of Wood Energy in Africa, Forestry Department, Food and Agriculture Organization, Rome.

The Sectoral Share of Woodfuel Consumption

A2.8 Data derived from different sources are difficult to compare. However, it is interesting to have a breakdown of woodfuel by households and other sectors. Table 26 shows the breakdown of woodfuel in Africa by share of user according to household, industry, the energy sector, and other sectors, from three different data sources: IEA, ESMAP, and others.

Table 26: Woodfuel Use by Final Energy User in Africa

Final Energy Users	*IEA 1996*	*ESMAP 1981*	*Others 1990*
Households	87%	95.6%	95.9%
Industries	11%	2.1%	1.7%
Other sectors	2%	2.3%	2.4%
Total	100%	100%	100%

Source: Biomass Energy: Data, Analysis and Trends, Conference Proceedings, Paris, France – March 23-24, 1998. International Energy Agency, European Commission – Research Directorate (DG XII) and United Nations Environment Programme – Industry and Environment, 1999.

Per Capita Woodfuel Consumption

A2.9 *Per capita* consumption among the different data sources shows some similarities among the different sources despite subregional discrepancies. The aggregate subregional averages show similar regional woodfuel behavior pattern within a limited geographical area. Table 27 shows relatively comparable aggregated figures, particularly between FAO and ENDA sources and between IEA, ESMAP, and other national sources. Table 27 also shows aggregate woodfuel consumption in Africa according to the different data sources and different reference years.

Table 27: Per Capita Woodfuel Consumption in Africa (m^3/year)

Regions	*IEA 1996*	*FAO 1990*	*ENDA/IEPE 1989*	*ESMAP 1981*	*Others 1990*
West Sahelian Africa	0.676	0.639	0.567	0.616	0.710
East Sahelian Africa	1.114	0.889	-	2.978	1.181
West Moist Africa	1.136	0.912	0.968	0.945	1.014
Central Africa	1.074	0.918	0.851	-	1.348
Tropical Southern Africa	1.457	1.009	0.898	1.444	1.392
Insular East Africa	NA	0.540	0.781	-	0.000
North Africa	0.079	0.080	0.364	0.998	0.482
Non-Tropical Southern Africa	1.490(*)	0.273	-	0.028	1.222
Other Africa	0.844				
Total Africa	0.929	0.697	0.727	1.523	1.096

(*) Data are available only for South Africa. --- Source: "Biomass Energy: Data, Analysis and Trends," Conference Proceedings, Paris, France – March 23-24, 1998; International Energy Agency, European Commission – Research Directorate (DG XII) and United Nations Environment Programme – Industry and Environment, 1999; and FAO website: <http://www.fao.org/forestry/>.

A2.10 Table 28 gives a breakdown of fuelwood used for cooking in 14 surveyed countries in Africa. Ninety-four and 84 percent of the poorest of the poor in rural and urban areas respectively use fuelwoods (88 percent use firewood and 6 percent use charcoal).

Table 28: Share of Fuelwood for Cooking in Selected Countries in Africa

	Year	*Survey*	*Firewood for Cooking*			*Charcoal for Cooking*			*Fuelwood for Cooking*		
			Poorest Quintile		*Population Average*	*Poorest Quintile*		*Population Average*	*Poorest Quintile*		*Population Average*
			Rural	*Urban*	*Total*	*Rural*	*Urban*	*Total*	*Rural*	*Urban*	*Total*
Burkina Faso	1995	HPS	93	94	89	0	0	2	93	94	91
CAR	1993	HPS	99	99	99	0	0	0	99	99	99
Cote d'Ivoire	1995	HPS	91	43	57	3	53	26	94	96	83
Gambia	1993-94	HIS	99	88	89	0	0	1	99	88	90
Ghana	1992	LSS3	90	55	67	2	43	25	92	98	92
Guinea	1993-94	HIS	99	71	81	0	29	17	99	100	98
Guinea Bissau	1991	HPS	1	17	10	74	67	69	75	84	79
Kenya	1992/93	WMS	98	16	73	0	24	6	98	40	79
Madagascar	1993	HIS	100	70	85	0	22	14	100	92	99
Senegal	1991	PS	98	47	61	0	42	21	98	89	82
South Africa	1993	LSDS	74	6	26	3	11	5	77	17	31
Tanzania	1993	HRDS	100	69	79	0	30	17	100	99	96
Uganda	1993	HIS	98	61	85	1	35	12	99	96	97
Zambia	1993	HPS2	97	38	64	2	50	24	99	88	88
Average	**1991-95**		**88**	**55**	**69**	**6**	**29**	**17**	**94**	**84**	**86**

Source: Africa Development Indicators, 1999. The World Bank, Washington, DC (various surveys).

The Policy-Measurement Quandary

A2.11 *Public Health vs. Ecology?* Measurement re-emerges as a central issue in devising policies and priorities. In principle, measurement criteria of pollution from different sectors are compatible because they are technical, mainly a question of the accuracy of the measuring equipment; in practice, however, ecological, engineering, and public health criteria are not necessarily mutually inclusive. Because public health and ecology both are multidimensional, their respective criteria/standards are often used inaccurately by diverse professions, who emphasize pollutants *or* populations at risk, but not necessarily together. Many engineering criteria were designed with health in mind, but not as the overriding principle. BOD, for example, meeting standards can still be pathogenic and unsuitable for drinking. Engineers would not mix water quality and pathogenicity, but others involved with water management do.

A2.12 The situation is similar for carbon monoxide (CO), one of the six "criteria pollutants" used to set air quality standards. CO, mainly from vehicle emissions, is more an irritant than a public health threat (except for people regularly stuck in traffic or exposed occupationally). But indoors, CO becomes a major component of household air pollution, exacerbated by tobacco smoke. CO measured *indoors*, however, is generally not used in setting criteria. In addition, general environmental criteria can also conflict with public health at the policy level. For example, energy efficiency in tobacco production, an important source of revenue in SSA, can be in direct conflict with public health agendas aimed at reducing smoking. These observations underscore the need for teamwork from the outset, and also zero in on measurement inadequacies.

– Investment patterns do not necessarily reflect environmental health goals. Nigeria, which contains 13 percent of SSA vehicles, has not included

pollution reduction in projects or its National Environmental Action Plan (NEAP), although it is discussing the use of unleaded fuel over the medium term. (Information was unavailable for South Africa, which contains 34 percent of the total vehicle fleet that still uses leaded fuel.)

– Thumbnail calculations showed that, conceivably, improved stoves could have four times the impact at half the cost than transportation investment in reducing the burden of disease. Values were derived by comparing measures aimed at reducing traffic fatalities with those aimed at reducing household pollution, e.g., better stove designs, overall ventilation, and pollution abatement, which are low cost when compared with transportation interventions (except for education).

A2.13 These observations do not suggest a shift in investments from transport to improved stoves, nor that the energy sector has been remiss; they merely illustrate different conclusions drawn from different perspectives. Addressing respiratory illness also raises the question of how better investments can alleviate poverty at the household level since so many of the determinants of respiratory infections occur at that level. Thus, for SSA, policies that address deforestation could link ecology with health: by examining the effects of costs on the consumption of more polluting fuels; by establishing indoor air pollution ratings for household fuels; by educating mothers about household smoke, etc. Some data already exist on these topics, but not on their health repercussions. These are examples of areas where behavioral change has been poorly explored and needs to be addressed in Bank projects.

Annex 3

Linking Environmental Health and Energy in Projects

Environmental health checklist for energy sector projects

A3.1 Table 29 shows the major health issues for projects currently listed in the Bank's sectoral codes.

Table 29: Energy Sector Environmental Health Checklist[96]

Typical Energy Projects and Components	*Major Health-Related Issues*	*Main Remedial Measures and Comments*
Distribution and transmission Aside from installation and improvement of transmission lines or distribution system, also includes upgrading, maintenance, and rehabilitation of power facilities; provision of workshop equipment and maintenance vehicles; management information system; technical assistance; and institutional strengthening		Implementation TORs should include:
	a) Occupational health and safety issues such as exposures to chemicals, excessive heat, dust, noise, biological agents such as mosquitoes (malaria) and the like, and ergonomic hazards for workers during construction, maintenance, rehabilitation, and/or upgrading of power facilities, including installation or improvement of transmission or distribution system.	a) Awareness campaign and affordable protective gear and equipment
	b) Ambient air pollution is an issue especially for populations living within a certain distance from power plants. Most common pollutants are SO_2, PM_{10}, CO, and other chemicals. NO_x may also be present, especially in areas in which vehicular traffic may increase due to activities related to the installation or upgrading of power plants and/or transmission systems. Respiratory diseases in the exposed population may increase due to such activities.	b) Gradual reduction of emissions to reach WHO standards through (as appropriate) regulatory measures, economic instruments, and moral suasion; demand management programs; improvement of production processes; alternative energy sources; and so on
	c) Some studies show childhood cancers due to exposure to electromagnetic fields (EMFs) in people living around high-voltage installations or equipment.	c) Resettlement of population at risk
	d) Physical and mental stress due to displacement of populations from construction of power plants and transmission lines	d) Counseling

[96] This and other sectoral checklists can be found at <http://www.worldbank.org/afr/environmentalhealth/>.

Typical Energy Projects and Components	*Major Health-Related Issues*	*Main Remedial Measures and Comments*
	e) Safety concerns for the surrounding communities due to the danger of fire and explosions from accidents in the power plants and transmission system f) Herbicide exposures from intensive use of herbicides underneath and around electricity power lines and oil pipelines	e) Adequate mitigation and preventive measures and awareness campaign f) Awareness campaign
Electric power and other energy adjustment Similar to former	Refer to above	Refer to above
Hydro Similar to former, but more focused on hydroelectric generation	Refer to above. In addition, water and vector-related diseases, such as schistosomiasis and malaria, must be considered. Safety concerns from accidental drowning may also be considered.	Refer to above. Implementation TORs should include possible alteration of habitats for snails (schistosomiasis) and mosquitoes (malaria) and awareness campaign.
Other power and energy conversion Similar to hydro. In addition, includes development and adaptation of other types of power generation, e.g., bagasse-coal plants, environmental projects, e.g., tree planting, forest protection, and so on	Refer to above. However, coal-fired power plants and bagasse have been shown to be especially polluting in terms of SO_2 and dust particulate, thus, emphasis must be given to respiratory diseases.	Implementation TORs should include gradual reduction of emissions to reach WHO standards through (as appropriate) regulatory measures; economic instruments and moral suasion; demand management programs; improvement of production processes; alternative energy sources, and so on
Thermal Similar to former but focused on gas and steam turbine generator sets and exploring geothermal sources	Refer to above. In addition, drillings for geothermal may unearth certain heavy metals that may pollute surface and groundwater, thus giving rise to specific diseases depending on the chemical or heavy metal.	Implementation TORs should include proper disposal of unearthed soil.

Source*: Environmental Health: Bridging the Gaps*; .World Bank Discussion paper, forthcoming, 2001, Table 9-3.

Fringe Issues and Entry Points

A3.2 The breadth of issues identified in the literature search is intended to show linkages that open doors for collaboration and that find entry points for multisectoral work. It is not intended as a list of priorities. For example, *searches on indoor air pollution or specific pollutants* might identify the substantial risks of household cooking and heating fuels on acute respiratory diseases, and also the very low cancer risks from automatic dishwashers or showers (i.e., residues or byproducts from chlorine and other chemicals that can be carcinogenic). Whereas the potential cancers would be a fringe issue for the energy sector, they could possibly serve as entry points for addressing occupational health issues, interesting health personnel in developed countries to monitor indoor air pollution in developing countries, or even to tap into private sector for funding. Table 30 presents the main environmental health linkages with other sectors.

Table 30: Main Sectoral Environmental Health Linkages with the Energy Sector

Sector	*Linkages*
Agriculture and rural development	Spread of malaria and schistosomiasis from all sized dams; indoor air pollution from use of biomass fuels; electricity for pumping water for agriculture and drinking; house fires from household cooking, heating, and lighting fuels; slash-and-burn agriculture contributing to rural community and indoor air pollution and possibly global warming; widespread air pollution from smoking food; when considering multiple sources of lead, food chain contamination and food poisoning, including lead poisoning in granaries using traditional millstones reinforced with lead joints.
Infrastructure and urban development	Household ventilation to reduce indoor air pollution; electricity for pumping drinking water (e.g., boreholes); water pollution caused by vehicular/industrial fuels (diarrhea and food chain contamination); house fires from household cooking, heating, and lighting fuels; outdoor air pollution from: vehicular/industrial fuels (especially from inefficient combustion of two-stroke engines); waste management facilities that generate dust (e.g., from trucks on access roads), and toxic fumes (from incineration); health effects of climate change and global warming due to various uses of fuel.
Health	Vector-related diseases spread through dams; acute respiratory diseases from use of poor-quality household fuels; diminished operation of health facilities from energy deficit (e.g., basic lighting, no cold storage of medicines or sterilization of syringes); women's and children's health problems from fetching heavy loads of biomass fuels (e.g., injuries, miscarriages for women); child and peri-natal health problems due to household fuel shortages (e.g., malnutrition from fewer cooked meals, diarrheas from unboiled water).
Industry	Health consequences of fuel changes in small- and medium-sized industries; contributions to indoor air and water pollution and climate change and global warming; lead smelters; health and safety inside industrial power plants as well as surrounding areas.
Environmental and natural resources	Injury and disease from effects from deforestation (e.g., floods, landslides), desertification, land degradation from foraging for biomass fuels.

Source: *Environment and Health: Bridging the Gaps*, World Bank Discussion Paper; Table 9-1; forthcoming, 2001.

A3.3 In addition, the objective search might miss several health effects not related to respiratory disease, e.g.:

- Negative repercussions of climate change and global warming, especially the indirect effects that outweigh the direct effects
- The physical strain of fetching fuelwood; some women carry 40-50 kg (100-110 lbs.)
- The localized, but potentially intense, environmental stress placed on areas around hospitals by families who "camp" in the area and need fuelwood.

A3.4 Table 31 summarizes issues identified in the literature into three categories: pertinent for the energy sector, possibly important, and probably fringe. Assigning priorities can be done as needed to determine whether they are useful entry points for collaboration with other sectors.

Table 31: Representative Sample of Fringe Issues and Indirect Linkages

Pertinent for Energy Sector	*Possibly Important*	*Probably Fringe*
	Indoor Air Pollution	
– Household fuels as a source of respiratory disease besides ARI	– Mold and dampness as a source of respiratory diseases (can heating play a role?) – Indoor smoke as a deterrent to mosquito-borne illnesses and a means of food protection from insects	– Multiple sources of indoor air pollution from nonenergy sources, including tobacco smoke, which could possibly be main source of respiratory disease rather than energy
	Other Environmental Health Issues	
– Spread of vector-related diseases (mainly malaria and schistosomiasis) from dams for *power* – Potential for injuries from fetching biomass fuels (head, neck, back, and miscarriages) – Nutritional repercussions to children from household cooking practices and boiling water – House fires from household cooking, heating, and lighting fuels; burns to children from use of same fuels	– Spread of vector-related diseases (mainly malaria and schistosomiasis) from dams for *irrigation* – Household smoke as a deterrent for malarial mosquitoes – Biomass fuels as a contributor to global warming (plus linkage with gender issues?) – Electric/magnetic fields from power lines as possible human carcinogen – Multiple sources of lead – air pollution from vehicle exhausts as a source of water pollution – Violence to women fetching/selling fuels	– Nutritional deficiencies that can cause the effects often attributable to lead poisoning – Lead as source of tooth decay – Dampness leading to breakdown of leaded paint – Environmental stress caused by visitors to hospitals who live for weeks around hospital

Annex 4

Recommendations for next Steps

A4.1 Table 32 gives a variety of issues to be examined further within the Bank. The selection of issues reflects an environmental health analysis, and should be examined from other perspectives. Many complementary topics are listed separately to allow for different collaboration from other sectors or agencies, since the Bank may not have the technical competence or comparative advantage to take the lead in some of the work, especially that requiring background studies. The list below reflects the same top ten concerns shown in Table 12 but subdivided into the following categories to allow for different priorities and levels on input:

- i) operations, ii) operations research, iii) economics and policy
- i) energy sector as lead sector, ii) multisectoral
- i) short term, 0-2 yrs.; ii) medium, 2-5 yrs. and iii) long, 5-10 yrs.

Table 32: 21 Actions To Be Prioritized for Energy in the 21st Century

Issue	*Health effects*	*Priority (in Years)*
I. Operations: A. Energy Sector Can Play the Leading Role		
1. Define indoor air pollution in "operational" terms and devise policy response	a) Need overall direction in Bank on how to approach energy-environmental health issues, then b) Can help structure pilot components to reduce respiratory diseases and other health problems, especially through improved stoves and household ventilation (in collaboration with South Asia), and c) If needed, produce guidelines on how to prepare components and link with environmental assessments	0-2
2. Devise "entry points" for collaboration on energy, environment and health	a) AIDS can serve as an entry point for energy sector to build up relationship with health sector by addressing work crews at high risk of spreading and contracting AIDS; (b) Can also address localized environmental stress to local areas plus air pollution due to cooking habits of large numbers of hospital visitors who visit families for long stays]	0-2
3. Coordinate with the regional program for the traditional energy sector on health benefits of fuelgel and UNDP-funded hybrid solar-wind programs in rural areas	Ready to field-test new, clean-burning fuels in five countries, would make sense to monitor health changes and coordinate closely with other measures on indoor air quality. Assess the socioeconomic benefits of hybrid solar-wind electrification programs	0-2
4. Prepare and implement case	a) Madagascar because it as one of few SSA	0-2

Issue	*Health effects*	*Priority (in Years)*
studies in Madagascar, Kenya, Uganda, Ghana, etc. (PRSP/CDD)	countries that included EH in PRSP; b) Kenya because potential health problems of drought-related energy deficiency in emergency projects have not been examined, and c) Uganda because it has health component in ongoing project	
I. Operations: B. Multisectoral Issues		
5. Estimate realistic effects of exacerbating or spreading mosquito-borne diseases through reduction of indoor air pollution	Smoke can keep mosquitoes at bay, but few studies have addressed the potential increase in risk of malaria, endemic and on the rise in SSA	0-2
6. Prepare guidance note on how to operationalize environmental health components in energy and infrastructure projects	Because the field is so broad, staff inside and outside the Bank could benefit from guidance on how/when to: a) include an environmental health component and what types of components are feasible within the project cycle; b) increase efficiency in addressing missed health issues; c) justify projects where health benefits have been excluded; and d) data needs	2-5
7. Devise surrogate indicators for remedial measures in infrastructure and energy to target poor populations	Considerable data already exist that can be repackaged into surrogate measures to show populations at risk with a focus on the poor; e.g., poor neighborhoods, air/water pollution levels, age/sex distribution of population, school demographic information	2-5
8. "Operationalize" response to reduce multiple sources of lead to enhance lead reduction in energy/transport projects	Can help identify small components that could be implemented by health agencies or NGOs to complement and reinforce energy or transport investments	5-10
II. Operations Research: A. Energy Sector Can Play the Leading Role		
9. Explore possibilities for behavioral change to enhance energy improvements to reduce indoor air pollution	Little work has been done on social determinants of indoor air pollution and how people can help themselves reduce respiratory disease and other health effects in conjunction with energy-sector improvements	0-2
10. Explore linkages with child health	Current work tends to concentrate on indoor air pollution, but implications for diarrheal diseases and malnutrition may be considerable; main issues revolve around fuel source/cost as they influence mothers' cooking habits, including boiling water	0-2
11. Explore linkages with gender issues	Current work tends to concentrate on time savings and indoor air pollution, but implications for injuries, miscarriages, and low birthweight may be considerable; no region-wide SSA estimates exist for amount of time women spend fetching fuel	0-2
12. Determine specific health effects related to small- and medium-sized enterprises (SME), and establish links with industry sector	As SMEs upgrade fuels, they change occupational and environmental health problems or change pollution patterns, e.g., kitchens, laundries, bakeries, brick-making, welding shops, breweries, food processing (especially smoking meat/fish); changes in occupational health risks have not been examined	0-2
13. Evaluate health effects from two-	As SSA urbanizes and grows, use of motor bikes is	2-5

Issue	*Health effects*	*Priority (in Years)*
stroke engines in SSA	expected to rise; may pose outdoor pollution and safety hazards different from automobiles; health issues have not been well examined for developing countries (except for India)	
14. Devise actual and surrogate measures for indoor air pollution	Current statistics focus on outdoor pollutants, making it difficult to monitor and evaluate indoor air pollution reduction measures	5-10
II. Operations Research: B. Multisectoral		
15. Examine health consequences of operating "multi-use" dams for water supply and irrigation	a) Future Bank-funded dams are expected to be multi-use, but proposals have not looked at health and may have negative impacts on vector-borne diseases, and b) small dams, which are not tracked as closely as large dams, have spread malaria in SSA	2-5
16. Collaborate (outside the Bank) on estimating economic effects of energy-related diseases for which there is only moderate or suggestive evidence	Evidence is strong for respiratory disease, but not for other factors such as heart disease and blindness, which have large health and economic impacts (nor are there estimates for health effects on women and children of fuel inadequacy).	5-10
III. Economics and Policy: A. Energy Sector Can Play the Leading Role		
17. Develop better economic valuation and monitoring techniques	a) Overall health effects tend to be underestimated, and can help justify better rates of return for many types of projects or components considered too expensive; b) health improvements due to energy interventions are not monitored, nor are key vulnerable groups, or focal points that can serve as proxies for energy improvements.	0-2
18. Delineate and quantify health effects besides air pollution	Most energy-health analyses focus on indoor air pollution, but a broader range of issues has not been examined to determine if they are important, and may be missing considerable health benefits (e.g., Nos. 8-15 above).	2-5
III. Economics and Policy: B. Multisectoral		
19. Promote paradigm of health improvement rather than pollution management	Need to look at environmental health in broad terms first, before setting priorities from various sectors. Current emphasis within Bank tends to emphasize pollution, *or* health, *or* vector-related diseases (important to SSA) separately and may be missing synergistic effects.	2-5
20. Update the 1990 literature review on the impact of economic development policies on health	Overall determinants of macroeconomic policy have not been analyzed since 1990, when study concluded that health is not a main factor in establishing sector policies except for the health sector.	2-5
21. Estimate role of biomass fuels and climate change	Role of biomass fuels has been poorly studied relative to CO_2 and other greenhouse gasses; a) may establish greater importance of biomass, which IPCC cites as underestimated, and b) may contribute to substantial indirect health effects of climate change and global warming.	5-10

I. Operations

Leading Role for the Energy Sector

1. ***Define indoor air pollution in "operational" terms.*** It is hard to implement a strategy to reduce air pollution without defining its components or "monitorable" criteria, neither of which currently exist when compared with the myriad of studies available on the 6 criteria pollutants and their role in industrialized countries. Nor is there any general guidance in Bank policies on how to deal with the multisectoral or energy aspects of indoor air pollution. Considerable literature exists about the *determinants* of indoor and outdoor air pollution, and on numerous efforts to reduce indoor air pollution by improving stoves. By contrast, little information exists that would help formulate responses in projects beyond work on stove efficiency done under the energy sector. For example, despite the valuable information on indoor air pollution effects, it is still unclear, apart from improved stoves, what conditions could be addressed at the household level in components or projects. In particular, little exists that combines multisectoral interventions from energy, housing, and health education. Nor have there been efforts to find feasible *replicable* monitoring criteria to test efficacy of stove improvements on human health, as opposed to reducing exposure, which has been done in numerous single studies. Nor are their overall policies in the Bank on how do deal with indoor air pollution, e.g., should it be integrated into the Bank's safeguard policies or environmental and social assessment procedures? What would a component look like? (This could be linked with No. 7 on developing surrogate monitoring criteria.)

   It might also be feasible to collaborate with an outside agency, NGO, or university on devising such criteria as well as in preparing training materials in health education to illustrate to target populations, especially mothers, that respiratory diseases are not a normal part of childhood and that smoke-filled houses can be responsible for respiratory diseases. (This could be combined with No. 9 on behavioral change.)

2. ***Devise "entry points" for collaboration on energy, environment, and health.*** Currently, multisectoral collaboration inside and outside the Bank is weak, and needs to be built up. This recommendation has a secondary function, viz., of finding entry points to foster collaboration with health agencies in general, so that mutually beneficial links can be established for the energy sector. In keeping with the notion of harmonizing sectoral investments, explore areas where energy can take the lead in fostering intersectoral collaboration, such as:
   - AIDS as an entry point for energy/health sector dialogue in general because of the high risk to energy sector work crews, which are at high risk of contracting or spreading AIDS;
   - Hospitals as an energy/environmental health entry point from the vantage of large numbers of families who visit patients and prepare meals (and often sleep) outside hospitals and may contribute to air pollution and other health problems in food preparation[97];

[97] Improving health care service delivery in rural health facilities through access to energy; Draft report on Uganda prepared for AFTEG, Dec. 2000.

- The cold chain, specifically as a contribution of the energy sector to communicable disease reduction programs;
- Multiple sources of lead, as a means to anchor improvements in lead reduction in gasoline; and
- Indoor air pollution and urban malaria control.

3. ***Coordinate with the Regional Program for the Traditional Energy Sector.*** The RPTES is ready to field-test new, clean-burning gelfuel in five countries, and it would make sense to monitor health changes and coordinate closely with other measures on indoor air quality; it could also provide a pilot to try household education to teach mothers, for example, that respiratory diseases from smoky homes are not necessarily a part of growing up. (This was the strategy used in conjunction with the reduction of diarrheal diseases.) In addition, since gelfuels are based on ethanol and organic pulp, they should be monitored for health effects over the long term, mainly because household exposures tend to be so concentrated during cooking times. At the community level, there is a need to assess the socioeconomic benefits of new hybrid solar-wind electrification programs such as the UNPD-funded Alizé program in Mauritania as a complement to RPTES, which focuses on households. (This could be combined with recommendation No. 9 on behavioral change.)
4. ***Prepare case studies in: Malawi, Madagascar, and Ghana.*** This could also take the form of contributions to the areas like the PRSP (Poverty Reduction Strategy Program), in which little has been done to integrate environmental health issues. In addition, possibilities for work with other regions should be explored for its pertinence to SSA, especially work on indoor air pollution in South Asia, and outdoor air pollution in Latin America and Asia (see Table 33).

Table 33: Worksheet on Possible Bank Projects for Follow-up

Country/Project	*Project Description*
SSA Region	
Cap Verde	Energy/water
Cap Verde	Renewable energy
Chad	Household energy
Madagascar	Energy sector development
Mali	Regional power (3 of 3)
Mauritania	Energy/water/sanitation
Mauritania	Regional power (2 of 3)
Senegal	Regional power (1 of 3)
Senegal	Traditional fuels (ongoing)
Tanzania	Power VI
Uganda:	Power III
Possibilities for Collaboration in Other Bank Regions	
China	China air pollution project
East Asia – Energy	(GEF); Household energy project (mainly urban)
East Asia – Urban	Tranjiu air pollution and housing
India	Indoor and outdoor air pollution
Mexico	Outdoor air pollution

Multisectoral Collaboration

5. ***Estimate effects of exacerbating or spreading insect-borne diseases by reducing indoor air pollution.*** If the energy sector and other parts of the Bank, e.g., ENV, HNP, ESMAP, are to address respiratory diseases associated with indoor air pollution, it would be wise to evaluate the repercussions to insects at the household level, most notably the notion that smoke keeps insects at bay. Regrettably, the literature is inconclusive on the issue, with only a handful referring to this problem. In essence, "common knowledge" holds that mosquitoes are repelled by smoke (as well as insects that attack food). However, technical knowledge presents contradictory evidence concerning the efficacy of smoke as a repellant. It might therefore be wise to get a better understanding of the basic factors at play. Although the health sector would be interested in following the issue, the role of indoor smoke on reducing malaria would not rank high on their list of priorities because household smoke is not a part of their armamentarium to combat malaria. (A Canadian NGO is interested in working with the Bank on this area in a vehicle that could be funded by Canadian trusts funds.)
6. ***Guidance Note on Environmental Health Components in Energy Projects.*** Prepare a guidance note on how and when to include environmental health components in energy and infrastructure projects. No such advice currently exists, especially advice that shows the economic benefits of including environmental health components in projects, nor guidance on data requirements. A Guidance Note would show the pertinence of environmental health in energy operation to the following:

- Structural or Sectoral Adjustment Lending -- Macroeconomic Matrix
- Structural or Sectoral Adjustment Lending and Strategic Environmental Assessment -- Action Impact Matrix
- Country Assistance Strategy Environmental Analysis Matrix
- Comprehensive Development Framework Matrix
- Poverty Reduction Strategy Paper
- Community-Driven Development
- Cross support.

This could complement No. 1 on defining indoor air pollution in operational terms.

7. ***Devise surrogate indicators to target the poor and estimate damages from disasters.*** Considerable data already exist that can be repackaged into surrogate measures, e.g., poor neighborhoods, air/water pollution levels, age/sex distribution of population, school demographic information, and so forth. The World Resources Institute[98] attempted such work in looking at the possible damages to human health of increased green-house gas emissions (mainly $C0_2$) by overlaying pollution patterns in megacities with populations under five years old. (World Development Indicators staff expressed interest in such an endeavor, but expressed concern at not being able to develop and maintain the data if they do not currently exist. One possible solution would be to begin with an initial exercise every two to five years to build up methodologies and linkages with Bank staff and outside agencies who could begin compiling the data.) For disaster-prone or areas subjected to long-term weather extremes like drought, it would also be useful to devise surrogates for physical and mental health damages in support of the death counts that currently represent health issues most commonly. (This could be combined with recommendation No. 4, on case studies.)

8. ***"Operationalize" multiple health sources of lead.*** Reduction in lead has been an important facet of the Bank's environmental efforts, which have, by and large been a success. In much of SSA, the main sources of lead, except for capital city centers, may come from other sources such as occupational exposures. A clearer understanding of these sources and means to eliminate them could help anchor the positive effects of the Bank's programs elsewhere, and prepare the ground for SSA when lead is addressed more systematically in the Clean Air Initiative.[99]

II. Operations research

Leading Role for the Energy Sector

9. ***Explore possibilities for behavioral change relative to indoor air pollution.*** What can people do to help themselves? Do poor people assume that smoke-filled houses are the norm and are they aware of the link to respiratory disease? This has not been explored in terms of energy. However, a lesson from the water/sanitation

[98] "Short-term improvements in public health from global-climate policies on fossil-fuel combustion: an interim report;" Working Group on Public Health and Fossil-Fuel Combustion; The Lancet; Volume 350, Issue 9088; 8 November 1997; pp. 1341-1349.

[99] Working Group on Public Health and Fossil-Fuel Combustion; The Lancet; *op. cit.*.

sector may be transferable. In the early 1970s, researchers realized that many people who did not have access to clean water and sanitation facilities did not associate the high levels of diarrheal diseases, seen as a part of childhood, with access to water and waste disposal. Hygiene education was essential to reducing diarrheal diseases related to water, and is now common in the water sector. Behavioral change, however, can take from 10 to 20 years to implement, and thus falls outside the Bank's project cycle. (This could be combined with recommendation No. 3, on gelfuels (RPTES) and community energy.)

10. ***Explore linkages with child health and the elderly.*** Currently in the energy sector, neither child- nor elderly-health issues are well described. Within the health sector, childhood issues tend to focus on respiratory diseases associated with indoor air pollution. Other issues would include: a) *malnutrition,* particularly that due to poor *food preparation*, e.g., how cooking habits are linked to fuel costs and availability, the number of cooked meals prepared as a function of the amount of time spent fetching fuelwood or its costs; b) *diarrheal diseases*, e.g., the effects of boiling water; and c) injuries from cooking fires, e.g., the number of children being burned from falling into fires, or scalded from knocking over cooking pots; and d) injuries from fetching wood. (This could be linked to recommendation No. 11, on gender linkages, which is listed separately because considerable literature already exists.)

11. ***Explore linkages of gender.*** Currently in the energy sector, gender issues look at time spent fetching fuel, and exposure to indoor air pollution. There are no comprehensive assessments, only a few studies of the amount of time spent fetching traditional household fuels in SSA; such assessments could show an added benefit for projects. By comparison, little has been done to connect the broader gender issues, especially those related to a) *pregnancy*, e.g., the effects of physical stress (in Ethiopia, some women carry their own body weight) on low birth weight and miscarriages; b) *injuries:* to back, head, and neck (which are one to the top causes of absenteeism in the industrialized countries), etc. Many of these issues have been explored under "gender," but they have not been related to energy per se.

    There are no assessments for SSA as a region of: a) the actual risks for back injuries; b) exposure to peri-urban malaria; c) climate change and global warming, etc. Considerable literature exists about the time-saving effects of modern fuels, but only a few studies exist on the health effects of such fuels. In industrialized countries, head and back injuries are one of the highest sources of worker absenteeism. Regrettably, general health statistics like DALYs do not capture these data because they are more likely to be found in occupational health reports as opposed to international health data. It would seem a logical area to examine, given the heavy loads women carry regularly. (This could be linked with No. 10, on children and the elderly.)

12. ***Determine health effects related to small- and medium-sizes enterprises (SME).*** As energy sources are improved for SMEs, what are the positive and negative health consequences that should be included in project analysis? These are on several levels: a) *public and private institutions*, e.g., kitchens, laundries, and heating plants in institutions that in SSA tend to be public, such as schools and

hospitals, or private businesses which, by their size, may have institutional type-needs, such as hotels and restaurants; b) *small businesses*, e.g., the different needs of bakeries, brick-making, welding shops, breweries, food processing (like canned juices/vegetables); c) *village level activities*, e.g., food processing, such as smoking fish and meat, or wood carving; d) *consolidation of individual generators*, e.g., providing village-level energy as opposed to a series of diesel power generators; e) *skilled labor*, as they change from hand tools to power tools; f) *dual requirements for heating and cooling/exhaust*, e.g., food processing may have special needs like heat for pasteurization plus refrigeration or freezing for storage and transport; and g) the degree of recycling of used fuels for baking and other food preparation, which can be a significant source of lead poisoning.

13. ***Evaluate health effects from two-stroke engines in SSA.*** Many cities rely on motor bikes/scooters for transport. In dense areas, these can have considerable negative health effects. How do these differ from regular automobile and truck sources? In principle, this might improve health by lowering outdoor air pollution, but the net effect on air pollution needs to be weighed against the changes in traffic accidents and occupational hazards and the exchange between indoor and outdoor air pollution.[100]

14. ***Devise surrogate measures for air pollution.*** In SSA (as well as other regions), it is difficult to estimate the effects of air pollution because of poor data. Considerable information already exists in the health and other sectors that could be used to draw estimates of the potentially serious risks; we suggest combining and analyzing data such as those from schools, population distribution, access to clean energy, number of cars, etc. (This could be combined with No. 7 as a multisectoral endeavor but, given the current attention being focused on air pollution, it is given its own entry where energy can play a lead.)

Multisectoral Collaboration

15. ***Operating "multi-use" dams for water supply, irrigation, and flood control.*** Differing consumer needs will require different water management techniques, in particular seasonal "draw downs" for irrigation. The latter could have a negative impact on vector-related diseases, especially malaria and schistosomiasis, in addition to seasonal workers. In addition, small- and medium-size dams, which are known to spread malaria, have received less scrutiny than large dams. Procedures for mitigating against the spread of vector-related diseases could be incorporated into the environmental assessment process (where they are currently absent.)

16. ***Economic effects of diseases with moderate or suggestive evidence of linkage.*** Collaborate outside the Bank (e.g., with CDC or WHO) on estimating economic effects of energy-related diseases for which there is only moderate or suggestive evidence. Besides respiratory diseases, for which there is a strong correlation with air pollution, it would be useful to derive estimates for the effects of air pollution on blindness and TB (moderate evidence) and for cardiovascular diseases and asthma (suggestive evidence). Current theoretical recalculations of the burden of

[100] "Pollution from Motorcycles: Issues and Options;" Conference papers, World Bank meeting , March 9, 2000, sponsored by East Asia and Pacific Region, Environment and Social Development Sector Unit (EASES)

disease relative to these other factors have virtually doubled the targetable burden of diseases that can be relieved from energy and infrastructure interventions. It would be useful to get more realistic estimates. (When recalculating those diseases that are "targetable" to those that are "possible" through infrastructure interventions, the burden of disease was reduced to about one-half, i.e., from 44 percent to about 20 percent. If this same proportion held true for energy, it could mean conceivably increasing benefits from energy interventions by 50 percent.) (This could be combined with No. 17, on better valuation techniques, and No. 18, on health effects besides air pollution.)

III. Economics and Policy

Leading Role for the Energy Sector

17. ***Develop better economic valuation techniques.*** Preliminary calculations could be refined into more realistic estimates. This work should be coordinated with work on devising surrogates. Preliminary findings, shown in table 34, show that the potential missed benefits could be significant—indeed, possibly doubling the averted health damages to the lungs due to air pollution, i.e., adding an additional 82 million DALYs to the current estimate of 81 million, without looking at the factors other than damage to the lungs, such as cataracts, blindness, and heart diseases. To put this in its full perspective, table 35 lists the full range of diseases and conditions cited by WHO as part on the "biofuel cycle and its impacts on health." (This could be combined with No. 15, on the economic effects of diseases with moderate/suggestive evidence, and No. 18, on health effects besides air pollution.)

Table 34: Possible Health Benefits Missed by Focusing on a Single Disease

Respiratory Disease/Condition	*World DALYs (1,000s)*	*Developed DALYs (1,000s)*	*Developing DALYs (1,000s)*
Counted in top ten or alone			
Acute respiratory infections (lower)	82,344	1,355	80,990
Subtotal "counted in top ten"	82,344	1,355	80,990
Diseases counted separately			
Acute respiratory infections (upper)	975	50	924
Tuberculosis	28,189	142	28,047
Chronic obstructive	28,654	2,449	26,205
Asthma	10,986	1,208	9,706
Other	18,932	1,303	17,089
Cancer (lung, trachea, bronchus)	11,176	3,122	8,054
Subtotal "counted separately"	87,736	5,152	81,971
Combined total	**181,256**	**9,629**	**171,015**
Possibly omitted in calculation of benefits	45%	14%	47%

Source: a) For table, *Environment and Health: Bridging the Gaps*, Table 2-9; forthcoming, 2001; b) for DALYs in table: Murray, C. and A. Lopez, eds. 1996. *The Global Burden of Disease.* Global Burden of Disease and Injury Series. WHO and the World Bank. Cambridge, Mass.: Harvard School of Public Health.. 85–115.,

Table 35: Full Range of Health Effects from Biomass Fuel Cycle

Step of Fuel Cycle	*Activity*	*Possible Health Effects*
Production	Preparing dung cakes	Fecal/oral infections
	Charcoal production	Carbon monoxide (CO)/smoke poisoning; burns/trauma; cataracts
Collection	Gathering fuel	Trauma; reduced infant/child care, bites from snakes, etc.; allergic reactions; fungus infections
Transportation	Transportation of biomass fuel	Backaches; severe fatigue; damaged reproductive organs over time (prolapsed uterus)
Processing	Cutting up fuel	Trauma; cuts; abrasions
Combustion	Smoke	Conjunctivitis; acute respiratory infections (ARI), including pneumonia; cor pulmonale; adverse reproductive outcomes; lung cancer; higher rate of infant morbidity/mortality; depressed immune response; chronic obstructive lung disease (COLD), chronic bronchitis, emphysema, asthma
	Toxic gases (CO)	Acute poisoning; low birthweight; higher rate of stillbirths
	Heat	Burns and scalds, cataracts
	Cooking position	Arthritis and related bone disease; back pain

Source: WHO: *Indoor Air Pollution from Biomass Fuel*; WHO/PEP/92-3 A.; cited in Gopalan, H.N.B.; and Sumeet Saksena, eds.; *Domestic Environment and Health of Women and Children*; Delhi: United Nations Environment Program and the Tata Energy Research Institute, 1999; Tabl6 6, p. 93.

18. ***Delineate and quantify health effects besides air pollution.*** There are no assessments for SSA of: a) the actual risks for back injuries (a major source of absenteeism in developed countries); b) exposure to peri-urban malaria, c) climate change and global warming; and d) the effects on heart disease or blindness, etc. Collectively, these could be considerable. (This could be combined with No. 15, on the economic effects of diseases with moderate/suggestive evidence and No. 17, on better valuation techniques.)

Multisectoral Collaboration

19. ***Promote paradigm of health improvement rather than pollution management.*** How would Bank sectoral policies change if they were be more attuned to multi-sectoral issues? The current single-sector focus may be missing health benefits, and current procedures do not promote cross-sectoral support, as opposed to cross-regional support within the same sector. What are the sectors and issues that lend themselves to cross-support, and what are the budget and administrative implications? In essence, this would follow the lead of the environmentalsector, which has moved from promoting "pollution control" to "pollution management," a broader perspective that includes policy issues and incentives, to avoid pollution.
20. ***Update literature review on impact of economic development policies on health.*** Technical literature is constantly evolving, but this is not necessarily true of literature on the influence of health on establishing macroeconomic policies. Is it still true that health has had little influence on sectors other than its own, as was concluded in *The Impact of Development Policies on Health* in 1990? It would be useful, in keeping with other work done on "Rio plus 5" and "Rio plus 10," to examine the role of health in determining policy outside the health sector. Clearly,

pollution has emerged as more important as an environmental health problem since 1990, but has it really changed policies in the sectors that may be responsible for generating the highest levels of pollution?

21. ***Estimate role of biomass fuels and climate change.*** Most attention has been paid to modern fuels, and the role of biomass fuels has been underestimated. A great deal of attention has been paid to fossil fuels in the literature, but much less by comparison to biomass fuels, as well as their direct and indirect health effects, except for indoor air pollution per se, but not as a contributing factor to climate change and global warming. Can remedial measures be "operationalized" into components or projects? This emphasis would be different from other the recommendations above examining the health effects in addition to air pollution, because the underlying energy issues are reasonably well known when compared to the role of biomass fuels. The IPCC has acknowledged that combustion from biomass fuels was not analyzed as well as the overall processes generating the main greenhouse gases.

Annex 5

Review of Outside Literature on Energy Policy

A5.1 This section presents the findings of a literature review conducted in preparation of *Bridging Environmental Health Gaps* (1996).[101] That review concentrated on policy determinants of energy as they impinge on human heath, because policy issues are less likely to change in the short term relative to technical issues, which change rapidly.

A5.2 Prior work from "Environmental Health: Bridging the Gaps" suggests that preventive environmental health interventions appear strongest when done as part of the infrastructure and energy sectors. --- Indeed, they appear to be as effective as interventions from the health sector, but are available at a fraction of the cost because energy and infrastructure projects have already been justified on other grounds. --- The efficacy of infrastructure interventions, e.g., drinking water, sanitation, drainage, waste management, have been well documented inside and outside the Bank. However, those of the energy sector have not. In this regard, it appears that the energy sector is about a decade behind the water and waste management sectors in analyzing and tapping environmental health benefits. That is, environmental health is now being discussed in earnest within the energy sector, trying to identify linkages, costs, and remedial measures practicable in Bank projects. By comparison, such discussions took place in the late 1970s on water supply, followed later by sanitation, waste management, and drainage. Infrastructure projects regularly consider hygiene and environmental health components, when appropriate. This delay is due, in part, to the greater attention that has been paid to diarrheal diseases than to respiratory diseases by the international community; both of these diseases rank as some of the highest causes of death and debility in developing countries. Other factors are discussed below in the interests of finding ways to bring the potential of energy sector interventions up to their full realization.

A5.3 The conclusions of the study cover a broad spectrum of positive, neutral, and negative observations. On the positive side, the literature review indicates that environmental health is a burgeoning field with an extensive and expanding literature, especially on the health effects of indoor air pollution. On the negative side, one is drawn to the conclusion that the burgeoning literature is focusing inward, applying environmental concepts *within* a given sector, rather than broadening its focus. Cross-sectoral linkages have been poorly developed relative to the total amount of literature. Numerous environmental health textbooks do exist, but many of these are uneven in their treatment of cross-sectoral issues. Many list a broad range of cross-sectoral topics in side-by-side chapters pointing out environmental health repercussions, but the multisectoral linkages are not necessarily summarized or woven together within the text. Health

[101] James A. Listorti, *Bridging Environmental Health Gaps;* AFTES Working paper, No. 22, World Bank, 1996. The full annotated bibliography and multisectoral analyses are available on: http://afr.worldbank.org/aftie/SECTOR/WATER/UWM/HEALTH/V1INDEX.HTM

literature tends to focus on the health sector itself, except for "Occupational and Environmental Health," which focuses mainly on the former, and reflects conditions in the industrialized countries. When the environmental or ecological literature deals superficially with health, it tends to accentuate pollution. Thus, one is drawn to conclude that, in general, the term "environmental health" is used very loosely and that many reports talk around health or only deal with a very small number of a much larger set of interlinked variables. Similarly, priorities are not accorded to different topics by their innate seriousness, with an equal push from the forces driving research (viz., the existence of prior studies that can be continued, the capabilities of technology, the range and costs of monitoring), and basic funding, which probably reflects the priorities of the industrialized nations and of teaching hospitals.

A5.4 Moreover, the extensive literature is instructive, confusing, and contradictory, all at the same time. The main difference among articles depends on the clarity of an abstract or executive summary in explaining an assumption or, similarly, if one is reading an informative article, doing a literature search on a given topic, or conducting a broader literature review. On the positive end, it means that the literature treats many "new" topics that were virtually nonexistent a decade ago, e.g., the mental health dimensions of urbanization, and the disproportionate stress therein that falls on women. The field of "comparative risk assessment," which has been applied since the mid-1980s, also advanced the field. On the neutral side, confusion stems from an inconsistent use of terms such as "volatile organic chemicals," "hydrocarbons," "polyaromatic hydrocarbons," "photochemical oxidants," and "acid aerosols" to describe similar categories of air pollutants; sometimes categories are mutually inclusive, e.g., lead being treated separately from total suspended particulate matter, or tuberculosis being treated separately from respiratory tract infections.

A5.5 On the negative side, one finds much "cut-and-paste" literature, where technical concepts are lifted nearly verbatim but are inherently wrong when inserted into a new text because they are misapplied or have not allowed for the background assumptions from the original study. Because many works only refer to the original source, but do not cite it, much of the data are taken out of context and their geographic setting, leading to inaccurate conclusions. Thus, at the citywide level, one finds situations where lead in air pollution is a focal point of discussion, when, as in Mexico City, exposure from traditional glazed pottery receives scant attention outside of health studies, and may actually pose a greater health hazard than lead from gasoline. And at the household level, one finds hepatitis in infants being blamed possibly on deficient sanitation and poor hygiene, when a closer epidemiological look revealed that the jaundice was caused by application of mentholated powder reacting with the unhealed umbilical cord, which is also a source of lead.[102]

A5.6 Fortunately, to balance these confusing inconsistencies, literature reviews explaining the technical and statistical differences among these studies are frequent. Nonetheless, much of the literature is contradictory in areas that are not even controversial. One finds, for example, about a dozen different references to "the single most important disease" globally, viz., water-related illnesses (mainly diarrheas), ARI, tuberculosis, etc., leading, again, to inaccurate conclusions. One finds environmental health problems that appear to be overstated as frequently as they appear to be understated. This is most common in dealing with air pollution, where the

[102] O. Ransome-Kuti; "Child Health in Nigeria: Past, Present, and Future," Archives of Diseases in Childhood; 1986, vol. 61, pp. 198-204.

seriousness of lung cancers is often transferred as an outcome of ambient air pollution, whereas epidemiologically such cancers are more a function of tobacco smoking. By comparison, the role of tobacco smoking in respiratory disease is often omitted from analyses dealing with ambient air pollution.

A5.7 By and large, the outside and Bank literature searches produced a wide range of documentation on different aspects of environmental health, but very few works on comprehensive treatment of the subject, except for textbooks, which favored situations in the industrialized countries. Predictably, most articles accentuated pollution in the industrialized countries, with examples and calculations based frequently on EPA standards because EPA has done the most work on the topic.

A5.8 In general, environmental health considerations are addressed mainly under pollution, with an increasing emphasis on air pollution, and the risks of nuclear power.

A5.9 Environmental health has received ample consideration under the areas of spreading disease vectors (e.g., snails, mosquitoes) through dam construction and hydropower, although their relative importance in the literature appears to be declining. The most important strides have been made in thinking out the economic dimensions of fuel use and associated damages to human health.

A5.10 Given the importance of respiratory ailments, indoor household pollution has been very poorly represented in developing countries. Literature tends to focus on individual pollutants, with a particular emphasis on lead, without looking at the broader context of other pollution sources, and in particular of the role of tobacco smoke on respiratory disease. The social context has also been lacking, such as physical stress from fetching fuel, the cost implications of household fuel prices on nutrition, etc.

A5.11 The health literature citing *indoor air pollution* as one of the major causes of death and disease worldwide has been growing in importance relative to considerations of ambient air pollution, which has been the focus until now. Part of the prior emphasis on ambient air stems from three factors. The earliest studies in the 1950s were provoked by the drastic episodes of pollution in London and Donorra (Pennsylvania). Although the focus then was ambient air, the resultant studies inevitably drew attention to indoor pollution as predisposing or confounding factors. Second, indoor air pollution research in the industrialized countries has been set mainly in the context of tobacco smoke, which, however important it may be, diverted attention to broader environmental factors such as heating, cooking, and lighting fuel, plus a wide array of chemicals emanating from building materials such as carpeting, paint, asbestos, and the “new” disease of sick building syndrome. Third, serious widespread indoor air pollution, excluding tobacco smoke, is largely a rural and peri-urban phenomenon linked with poverty and thus has had less influence in determining research directions.

A5.12 The main links between environment and health stem from indoor air pollution for heating, lighting, and cooking and the resultant accidents (mainly burns) from fires, ambient air pollution from coal-fired electricity plants (though this tends to be more an ecological problem than an environmental health one), spreading of vector habitat (mainly snails and mosquitoes) from dams, and the physical stress of getting firewood.

A5.13 Energy policies in developing countries have not given adequate attention to the health consequences of the different stages of energy production, i.e., extraction, consumption,

and pricing. Deforestation has led to added stress and threatens to reduce nutrition in poor households, where women spend ever-increasing amounts of time in gathering firewood. Policies to increase woodfuel reserves rarely touch the households suffering from "fuel poverty." Efforts have been directed at increasing domestic fuel efficiency, but only recently has attention been devoted to improving housing and cooking stoves in the context of health risks associated with chronic inhouse exposure to fumes from biofuels (covered in only one Bank Technical Paper). The health effects of household cooking-heating-lighting smoke, however, tend to be taken out of the context of tobacco smoke, which is known to be a confounding, if not more important, factor in respiratory illness. Fuel subsidies have not taken health and pollution into consideration, nor have they promoted nonpolluting, safe fuels. Pricing policies tend to favor urban areas, where air pollution is generally greater, over rural areas. Hydropower, especially large dams, remains high on development priority lists. Yet, associated health risks "still do not figure predominantly" in project preparation and implementation.

A5.14 A growing literature has documented the relationship between domestic fuel use, respiratory infections, and low birthweights, identifying biofuel use as a major hazard. Yet, this information has not yet been integrated into energy policies mitigating urban or rural indoor air pollution. Similarly, developing countries need better analysis of the effects of fuel gathering, its shortage, fuel substitution, and food preparation. Epidemiological evidence is increasing on the links among energy use, outdoor air pollution, and the incidence of respiratory illness and cancer. Yet few studies have recommended regulatory measures or identified high-risk populations or areas for special attention.[103]

A5.15 The concepts of the "energy ladder" and "fuel poverty" are gaining in acceptance, i.e., that the cheaper fuels are more polluting and more detrimental, and that respiratory ailments respond as a function of fuel use and energy efficiency. Approximately one-half the world's population cooks with *biofuels*, i.e., firewood, dung, twigs, and crop residues, wherein cooking accounts for about one-third of the energy consumption. In developing countries, women and children encounter the greatest risk because of poor ventilation in poor housing. It is estimated that exposure to rural indoor air pollution in developing countries is 60 times greater than it is in urban areas of developed countries, and that overall daily exposures are about 20 times greater.[104] In addition to biofuels, *coal* is also a major contributor to indoor air pollution, but does not constitute a major energy source in Africa. Research is under way to alter stove designs to improve fuel efficiency, but the research does not necessarily aim to reduce smoke. Nor is such research currently a high priority in the energy sector. The role of *tobacco smoke* has long been established as a predisposing and exacerbating factor in respiratory disease. The more recent literature has also implicated the role of passive inhalation. The bulk of the literature on health and energy (as well as transport), however, still tends to focus on ambient air pollution, with a particular emphasis on vehicular sources. *The rural and peri-urban poor* fit this paradigm, but fuel subsidies are often directed at urban areas, and those who have already have climbed the energy ladder to less polluting fuels.

A5.16 *Fuel supply*, or more commonly, fuel scarcity, has received ample attention in the ecological literature, in particular the link between deforestation and fuel poverty. The health consequences have received less attention. These consequences are wide-ranging: the physical

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[103] WHO, *Impact...*, p. 96-97.

[104] K.R. Smith, *Biofuels, Air Pollution and Health: A Global Review*; New York: Plenum Press, 1987

stress from gathering firewood, diminished nutrition because of fuel prices, the role of women and children, and so forth. The caloric energy expended to do daily chores, with large shares devoted to fetching fuel and water, can consume one-third of a woman's daily energy expenditure. To earn income, many women prepare food for sale, using several stoves at once, or extending their cooking time in general. Both consume more fuel and increase exposure to cooking fumes. Conversely, to save on cost, some women shorten cooking time or flame intensity, resulting in undercooked foods that can cause diarrheas and worm infections or, in some cases, poisoning (because some pesticides are broken down by heat). Similarly, lower-cost fuels tend to contain higher levels of pollution.

A5.17 *Industrial energy* supply has received considerable attention in the literature, with a range of new studies being devoted to the economic evaluation of damage to human health. Large cities in developing countries encounter a double-edged sword in this regard, that is, they have high levels of industrial and vehicular pollution, coupled with the range of indoor air pollution discussed above. Because of the low industrial activity in Africa relative to other parts of the world, industrial energy is not a regional problem, except in pockets. Most of the literature on the health effects of such pollution tend to be based on monitored air quality, extrapolated to humans and combined with health statistics, such as hospital emergency room admissions. Studies of ambient air pollution dealing with the air as it enters the lungs, e.g., in the form of acid aerosols, are very few. In the area of mining, occupational health has a well-established literature, such as black lung disease and accidents.

A5.18 Similarly, the environmental health consequences of *hydroelectric power* have been well documented. Dam safety has been considered an integral part of best practices for engineers, and vector-related diseases, most notably schistosomiasis and malaria, were among the first environmental backlashes described. Onchocerciasis is also a problem in dam spillways (the Tse-tse fly that spreads the “river blindness” needs high-oxygen-content water for breeding). In addition, these and other diseases can be spread by the temporary concentration of workers and the permanent settlements that later arise. Regrettably, these risks “have rarely been adequately addressed.”[105] In addition, *resettlement* associated with dams has been described extensively in the literature. There do, however, seem to be two main analytical contexts that do not necessarily dovetail, one treating socioeconomic issues such as tenure, access to credit, community participation, etc., and the other, with much fewer citations, dealing with a wide array of health-related issues. The latter includes a decline in nutrition status from the upheaval, exposure to pollutants from industries that cluster near hydroelectric facilities, poor community health services that were initially intended to deal with work accidents, etc.

A5.19 In an unusual trade-off, environmental and health objectives have negatively competitive goals. In an effort to reduce deforestation and oil imports, many developing countries are promoting coal as a substitute for wood. Where coal might not provide a feasible alternative for widespread industrial use, countries can produce or even import enough for household use. As a household fuel, coal is a particularly noxious pollutant because household stoves tend to burn inefficiently (when compared with industrial ovens) and the fumes are expelled into the immediate area in houses that are often designed to keep the elements out and not for efficient ventilation. (Indeed, sometimes they are designed to keep smoke in so as to reduce insects.)

[105] WHO, *Impact...;* p. 113.

Annex 6

Institutional Programs on Indoor Air Pollution

[Prepared by Elaine (Weeling) Ooi for the World Bank Environment Department, August 2000.]

Organizations Promoting Sustainable Development, Alternative Energy Sources, and Biomass Fuels Relevant to Alleviating Indoor Air Pollution

A6.1 The attached is a nonexhaustive reference document created to assist Bank staff interested in designing IAP-related projects, and in identifying potential partner organizations to help implement activities at country and regional levels. It includes organizations and programs actively promoting energy-efficient forms of cooking, eating, or lighting in an environmentally sustainable manner *and/or* the mitigation of indoor air pollution from these activities, in predominantly poorer rural economies and communities.

A6.2 The most prolific work has been done by energy and environmental groups, prompted by the need to provide greater access to energy sources to these communities, at the same time conserving and managing their use of polluting fossil and biomass fuels to alleviate deforestation and GHG or climate change. Considerable knowledge has been compiled on alternative/clean-energy sources and renewables, such as solar, wind, hydro, and PV energies for small-scale, non-grid electrification to power agricultural activities, small and cottage industries, and household appliances, e.g., TV, radio, lights, stoves, and heaters; and biogas to supplement household cooking and lighting needs.

A6.3 Efforts more directly related to IAP include the assessment of various improved stove designs with respect to fuel efficiency and emissions, research on types of biomass uses and patterns of consumption, and studies of respiratory and other health consequences from prolonged exposure to wood, coal, and charcoal cooking and heating sources. Community-level interventions with the introduction of more efficient and less polluting stoves have been ongoing for the last decade and a half, primarily from the standpoint of energy and the environment. More recently, attention to the negative health effects of cooking and heating has grown, as well as acceptance of the associated impact on gender and poverty.

A6.4 In developing the attached list, priority was given to organizations and networks that are already key actors in IAP-related work or those with a potential role of moving forward the IAP agenda. More has been done in the areas of operational research and assessments of feasible options to combat IAP than on their actual application in vulnerable communities. An effort is made here to identify actors actually engaged in community-level interventions, with a multisectoral perspective, and those that integrate end-user (i.e., women/household-level decisionmaker) behavior and practices in the interventions, to increase the likelihood of adoption and sustainability.

A6.5 Since 1996, a growing number of programs has taken on IAP-related community-based activities with a multisectoral perspective. At least three-quarters of these involve improved stoves. There is little evidence that, when designing interventions, these programs adequate internalize end-user customs and practices within the kitchen/house when cooking/heating devices are in use. This can significantly affect the degree of exposure to IAP, the adoption of the stoves by the targeted population on a sustainable basis, and the overall effectiveness of the intervention.

A6.6 The organizations are grouped under three headings; some may belong to more than one category, but have been placed under only one.

1. Organizations and programs[106] supporting implementation of community-based activities, further categorized by their respective areas of interest:
   a) Integrated/multisectoral approach
   b) Energy/environment focus
   c) Gender focus
   d) Technology/stoves focus

   Initiatives motivated solely or primarily on health grounds are few, but health is among the key considerations in the integrated/multisectoral programs.
2. Major networks and clearinghouses thatidentify and source skilled researchers and practitioners. Included are key individuals who have made major research contributions and developed the knowledge base in IAP issues. Their names and publications may be sourced from the various networks. For health impact assessments and studies, HEDON is particularly useful.
3. Organizations primarily engaged in operational research and policy advocacy; these include principal think tank and knowledge management organizations on sustainable development and IAP.

1) Organizations Supporting Community Based/Household-Level Activities

a) Integrated/Multisectoral Approach

A6.7 *Intermediate Technology Development Group* (ITDG)/UK has regional offices in Africa, South Asia, and Latin America. It carries out community-level projects in household energy related to IAP in improved stoves/micro hydro/wind energy/housing/designing structural improvements in Nepal, Sri Lanka, Peru, Kenya, and Zimbabwe. Has several projects in Kenya, one of which targeted the Maasai, has a strong component in community participation/decisionmaking, and use of local skills and materials. Intermediate Technology Consultants (ITC) and Healthlink (previously called AHRTAG) are part of ITDG.

A6.8 *Aga Khan Rural Support Program* (AKRSP) has an integrated community-development scheme to improve the social, economic, and health conditions in the remote northern areas of Pakistan, including Gilgit and Chitral. This program has been rated a success by AED, in terms of institutional development at the village level and because of the dramatic increase in real incomes in one of the poorest communities in the country. Included in the Rural Support Program is an indoor air pollution component including the introduction of appropriate

[106] Programs within the Bank (e.g. ASTAE, ESMAP, GEF) and of WHO, EHP/USAID which are already known to the Bank IAP community will not be described.

stoves, community outreach, and education. AKRSP's parent entity, the Aga Khan Foundation, carries out community-based projects in Asia, Africa, and Central Asia.

A6.9 *The Stockholm Environment Institute* (SEI) is one of the lead agencies conducting research, consulting, and training activities to promote global sustainable development. It supports various aspects of work in indoor air pollution from the standpoint of health, energy, stoves, technology development, and environment, under its sustainable energy program. Working collaboratively with international and national partners, it also supports implementation of projects in IAP and health in Africa and Asia, some of which are community based. *Lund Center for Habitat Studies* (LCHS) often cooperates with SEI in its studies of the impact of housing design/architecture on IAP.

A6.10 *International Centre for Integrated Mountain Development* (ICIMOD) has a regional collaborative program for sustainable development in the Hindu Kush, Himalayas and other community-based projects in rural energy. Rural poverty alleviation is complemented with environmental stability focusing on mountain farming, infrastructure, and natural resources management. ICIMOD conducts analytical work on energy use patterns, technologies, and policies, for application into its operations. Has a strong gender thrust and focuses on wood, hydropower, biogas, and solar energy. Supported by another unit of ICIMOD, the natural resources division of community forestry and degraded lands, ICIMOD's work on IAP has a significant space heating angle to it. In the mountainous habitat of its clients 60 percent of energy consumed is used for heating versus 40 percent for cooking.

A6.11 *Integrated Rural Development Initiative* (IRDI) is a Ugandan NGO with representation from ordinary farmers, NGOs, tertiary and research institutions, and government ministries. IRDI undertakes policy research, advocacy, and implementation of community-driven sustainable and environment-based development projects in environment conservation and rural development. Among its fields of interest are sustainable energy use in household and industry, agroforestry and gender, improved cooking stoves, and low-cost renewable energy.

b) Energy/Environment Focus

A6.12 *The Regional Wood Energy Development Program* (RWEDP) for Asia, based in Bangkok, is an FAO-sponsored initiative that promotes the integration of wood energy in the planning and implementation of national energy and forestry programs in 16 Asian countries. It assesses wood-energy situations, plans wood-energy development strategies, and implements-wood energy supply and utilization programs. These include assessments of alternatives to wood-energy problems, namely, kerosene/gas subsidies, improved stoves, modern applications of biomass and other solutions to manage woodfuel emissions, pollution, and greenhouse gas. The continued growth of woodfuel consumption in absolute terms has RWEDP focusing its efforts on addressing the inevitability of sustainable wood-energy use.

A6.13 FAO has other regional/ global programs that support bioenergy use and capacity-building for rural energy planning in renewables.

A6.14 The *UNEP*-supported *African Rural Energy Enterprise Development* (AREED) Initiative is directed at the African rural energy service sector. Ongoing in five SSA states, AREED will develop capability within African NGOs, financial institutions, and UN agencies to nurture local private energy enterprises using renewable energy technologies, with modest amounts of start-up support. Partner organizations include the African Development Bank,

Development Bank of Southern Africa, Agricultural Finance Corporation, Centre for Innovation and Enterprise Development (Ghana), Botswana Technology Centre, Renewable Energy Information Network of Namibia, Centre for Energy, Environment and Engineering (Zambia), Biomass Users Network Zimbabwe, Southern Centre for Energy & Environment, and Organisation for Rural Associations for Progress.

A6.15 UNEP's Collaborating Centre on Energy and Environment operates similar programs, including:

- i) operations, ii) operations research, iii) economics and policy,
- i) energy sector as lead sector, ii) multisectoral
- i) short term, 0-2 years; ii) medium, 2-5 years; and iii) long, 5-10 years.

A6.16 *E & Co Services*, as the investment service arm of the Rockefeller Foundation in energy and environment, is one of the leading charitable trusts on renewable energy. E & Co Services assists and supports eligible businesses, organizations, and communities in developing countries gain greater and more equitable access to energy services through economically self-sustaining projects. It promotes energy technologies that are renewable, efficient, and clean. Small loans and some technical assistance for professional engineering, financial analysis, business planning, and other services of a technical nature are provided to the eligible entity by E & Co. E & Co is increasing its portfolio in this field and is already operating in all regions of the world.

A6.17 *Alternative Energy Development, Inc.* (AED) is a Washington-based renewable energy consulting firm that promotes and implements renewable energy projects and greenhouse gas mitigation options. Active primarily in Asia, Latin America, and North America, AED's specialization in commercial renewable energy options includes solar photovoltaic systems for households, mini- and micro-hydro for village electrification, windpower for grid connection, and small biomass power plants for rural power supplementation. The company takes projects from identification through to financing and implementation.

A6.18 *Winrock International* is another NGO promoting sustainable agriculture, rural development and civil society building. Its research and technical assistance programs include some policy analysis, research, and evaluation as well as implementation of community-level projects in sustainable rural development and integrated natural resource management. Under its clean energy program, renewable energy, primarily electricity, is promoted through solar, wind, water, and biomass sources.

A6.19 The environment and energy programs of *ENDA Tiers Monde*, based in Senegal, support lifestyle improvements of the rural and urban disadvantaged through sustainable development initiatives. To increase rural access to energy, ENDA has implemented a number of solar-energy projects for lighting, battery recharging, pumping water, and refrigeration. At another level, ENDA Senegal has also implemented four micro-power stations to operate health and research facilities/centers in remote areas of the country. ENDA is also known for its communications development efforts, which enable/facilitate a wider variety of people to participate in their own development process, through information access and sharing.

A6.20 *Development Alternatives* (DA), Technology and Action for Rural Advancement (TARA), and People First are all part of the parent DA Group of India. DA is a research and consulting NGO that also undertakes grassroots projects in sustainable development. It focuses

on community management systems, natural resource management, waste minimization and recycling, and technologies and renewable energy systems for sustainable livelihoods. Essentially operative in India, it has forged a collaboration with the Environment and Development Group (ENDA Tiers Monde) of Senegal to disseminate knowledge about their experiences.

A6.21 *Green Africa Network* (GAN) is a Kenyan NGO that conducts R & D, provides training and consultancy services, and implements eco-friendly community-based programs. One of its prime programs is in renewable energy development, -focused on solar-based rural electrification and, to a lesser extent, on biomass and small/mini hydropower. Its project activities include the integrated community-based energy/health /ecosystems management (ICBEHEM) project, improved biogas cookers/rural energy, and solar PV electrification to supply refrigeration for medications in rural healthcare centers and schools.

c) Energy/Environment/Gender Focus

A6.22 *UNDP* supports the following regional/country energy projects, most of which have a strong gender focus. The UNDP- *Energy and Atmosphere Program* (EAP) - has a project linking energy and women, as the entry point for advancing women and sustainable development. With cofunding from SIDA and the Sustainable Energy Global Program, also run by UNDP, the project's regional focus is Africa. Through advocacy, networking, training, and technical assistance, energy projects are designed and developed to benefit the lot of women.

A6.23 *Nepal Renewable Energy Development Program* (REDP), also funded by UNDP, is a comprehensive institutional development program for rural energy, focusing on community mobilization, decentralized energy planning, micro hydro, biogas, solar PV, improved cookstoves, and natural resources management. Its many activities include the installation and operation of rural energy schemes, and biogas plants attached to toilets. REDP projects promote community and small-scale private sector development, skills enhancement, technology promotion, environment management, and women's empowerment. REDP successes have been documented and disseminated.

A6.24 ENSIGN, which finances *Energy Services for Income Generating Opportunities for the Poor*, is a UNDP-sponsored program based in Kuala Lumpur, Malaysia. ENSIGN provides technological and financial intermediation to help microcredit institutions facilitate loans to the poor and to women, in Asia Pacific. An example of such a project is in Kerala, India with SEWA Bank and MAHITI.

A6.25 *United Nations Development Fund for Women* (UNIFEM) also supports gender-focused projects in the energy sector, in food processing and other cottage industries, globally.

A6.26 UNDP has other programs dealing with IAP, biomass fuels, and renewable energies, mostly of a conceptual and policy nature, which are not described here.

A6.27 *Grameen Shakti* is the renewable energy branch of Grameen Bank. It implements grassroots projects in PV electrification, biogas, and biomass energy. Soft financing and capacity-building in entrepreneurship are provided to the client base (many of whom are women) for cottage industries and small businesses.

d) Technology/Stoves

A6.28 *Yayasan Dian Desa* of Indonesia is the primary implementer of the *Asia Regional Cookstove Program* (ARECOP), which specializes in dissemination of improved household and institutional stoves, kitchen management, wood/charcoal/briquettes, and linkages between stove emissions and health. It also concerns itself with the broader issues of energy, the environment, and NGO development. ARECOP is operative in 12 Asian countries and is one of the foremost cookstove programs in the world, attempting to link appropriate stove technology with socioeconomic development and social change. It works closely with the FAO-RWEDP, and serves as a regional information network on stove-related development matters.

A6.29 *Integrated Development Association* (IDEA) of Sri Lanka is implementing the successful nationwide distribution of improved "ANAGI" stoves to the poorest rural villagers through a "Stove Commercialization Program." Through the use of revolving funds that enabled the commercial production, promotion, and marketing of the improved stoves, IDEA was able to upgrade the quality of work of the previously "pirate" stove-makers and link them with the poorest rural village users. IDEA is also capitalizing on the introduction of stoves as an entry point/mechanism for socioeconomic uplifting work of other types, targeted at the poorest segments of society, and with a gender approach.

A6.30 U.S.-based *Enterprise Works Worldwide* (EWW) focuses on capacity-building of small producers in low-income communities. Through its five focus areas, all related to farm commodities, EWW and its partners help micro- and small-scale farmers and entrepreneurs improve their livelihoods by adding value to basic commodities, safeguarding the resource base, and participating in profitable markets. EWW currently has three household energy projects in Africa where improved charcoal stoves developed by EWW are being reproduced and introduced for urban consumption. The portfolio focus has shifted from appropriate technology development to business and microenterprise development of its clients, more than half of whom are women. EWW has projects in 20-odd countries globally.

A6.31 Volunteers in Technical Assistance (VITA) is a small NGO, based in the U.S., working directly with communities in various aspects of development planning and implementation. They have good experience with household-level programs for improved stoves. Currently their portfolio covers biodiversity, micro-enterprise, and disaster relief, in line with priorities of their funding sources.

A6.32 The Renewable Energies Development Institute (REDI) has been involved in developing inexpensive but efficient and environmentally friendly cooking and heating devices which are to be manufactured or assembled at the local level in developing countries. Several models of stoves, adapted to different uses, environments, and cost levels have been developed. While many of its products are designed for use by poor communities, REDI is not itself involved in the dissemination or introduction of its products to the community.

A6.33 HANSI is a British NGO working in partnership with ROSE, the Rural Organisation for Social Elevation, based in the Kumaon Himalayan Hills of India. Both organizations are dedicated to supporting community development in this extremely remote, deforested, and poor area. Among their ongoing projects are improved stoves, reforestation, and water and sanitation.

2) Networks

A6.34 The Biomass Users Network (BUN) has a widely based membership from many developing countries. It facilitates scientific and technical cooperation, and funding for demonstration projects in biomass production and utilization BUN also promotes the socioeconomic development of rural economies through environmentally sustainable and innovative uses of bio-resources. BUN is focused on joint R&D, training, and activities which assist in developing diversified rural economies, through better access to energy and income, while protecting ecosystems. It maintains solid partnerships with community-based organizations and grassroots NGOs. Members include governments, NGOs, scientific and technical institutions, international experts, donor organizations, and the private sector. BUN has autonomous branches in Zimbabwe, Brazil, the United Kingdom, the U.S.A., Thailand, India, and Central America. Some of these regional bodies— BUN-Zimbabwe, BUN-Central America, and BUN-Thailand—are actively implementing community-level projects.

A6.35 The Household Energy Development Organization Network (HEDON) is a global consultative forum, dedicated to improving social, economic, and environmental conditions in the Southern countries. It promotes local, national, regional, and international initiatives in the household energy sector, and is very active in enhancing professional knowledge in this sector in both developing and developed nations. Many of its members (e.g., ITDG, BUN, SEI, ENERGIA, etc.) are involved in the forefront of IAP-related issues and activities.

A6.36 HEDON has a website portal which is linked to a wide variety of organizations working on energy issues—both household- and non-household-related. It is a very extensive and useful website portal. Many consultants and private companies advertise their services and hardware products at this site. A slightly higher percentage of the suppliers target developed economies.

A6.37 The International Network on Women and Sustainable Energy (ENERGIA) does research and development, and promotes and advocates the integration of gender issues into energy policies and plans, through networking and capacity-building. Supported by UNIFEM, Dutch Aid, RWEDP, and UNDP/EAP, ENERGIA's network of very active north and south women's groups is expanding. Its interests cover the entire spectrum of women's issues: health, income generation, micro-credit, empowerment, and the reduction of drudgery and poverty.

A6.38 The Future Action Network (OFAN), a networking organization and clearinghouse for information on gender, science, and technology, made its debut at the U.N.'s Fourth World Conference on Women, in Beijing. It supports people-centered and environmentally sustainable applications of science and technology, and also recognizes the contribution of women's knowledge (formal, informal, traditional, and indigenous) to science and technology. OFAN's current activities are focused on coalition-building and strategic partnerships for policy advocacy and capacity-building. It has regional focal points in Asia, Africa, Latin America, Europe, and North America.

A6.39 The Southeast Asia Policy Advisory Network (SEA-SPAN) for Global Change provides a forum in the region to identify and debate key policy issues related to global change, which are relevant to and affect Southeast Asia. Aided by sound scientific data and analysis, SEA-SPAN enables stakeholders (policy makers, businesses, and communities) to share their perspectives and views, and to come to common ground on how best to accommodate

local/regional public interests with those of the global community. SEA-SPAN provides capacity-building, and policy and technical support to relevant stakeholder communities, through commissioned studies, workshops, and regional and international networking capability.

A6.40 The Centre for Renewable Energy and Sustainable Technology (CREST, with offices in the U.K. and U.S.) promotes renewable energy technologies in biomass, hydropower, geothermal, photovoltaic, solar thermal, and wind power for both northern and southern countries. It undertakes in-house research projects, provides small grants to facilitate external research, and collaborates with professional associations and NGOs to advocate for and influence policy actions on renewable energy. It has a repository of key information on renewable energy and energy efficiency. The Consortium of Sustainable Energy Networks International (COSENI) in New Jersey and the Consortium for International Earth Science Information (CIESIN) in New York, have similar roles. CIESIN is also focused on the social dimensions of global environmental management and change.

A6.41 The International Network for Sustainable Energy (INFORSE) is a worldwide network of 200 NGOs in more than 60 countries, working to promote sustainable energy and social development. INFORSE actively engages in international awareness-raising through seminars and workshops on sustainable energy strategies, policies, and action plans. It develops regional capacity building programs for NGOs, and provides professional staff who participate in projects designed to reach the poorest population groups.

3) Operational Research and Policy Advocacy Groups

A6.42 The International Institute for Sustainable Development (IISD) is a Canadian think tank in the forefront of international decision-making on sustainable development. IISD contributes new knowledge and concepts, analyzes policies, and disseminates information about best practices, but has not worked specifically on IAP. However, due to its role and influence in advancing policy recommendations on climate change and natural resource management, its work can help to forward the IAP agenda among governments, businesses, and civil society. IISD's Community Adaptation and Sustainable Livelihoods program developed an "appreciative inquiry" tool, by which rural communities (1) can better define their livelihoods, focusing on their own strengths and capabilities; (2) are assured that interventions accurately reflect their views and vision; and (3) act as the primary agents of change, instead of aid workers. This method has been applied by CIDA with encouraging results in Ghana and Mauritania. In India, DFID is using the same model with subsistence farmers whose fuelwood consumption is aggravating deforestation.

A6.43 The Tata Energy Research Institute (TERI) of India conducts both scientific and policy research in the fields of energy, the environment, biotechnology, forestry, and a whole range of sustainable development issues. It has published extensively on the energy sector, renewables, IAP, and household biomass use in India. TERI's Environment and Technology Division carries out action-oriented research in rural energy, some of which have led to the direct implementation of community-based interventions with partner NGOs (e.g., the introduction of energy-efficient technologies (improved stoves and kerosene lamps, and biogas plants), coupled with village institution-building for self-sustenance and management

A6.44 The World Resources Institute (WRI) conducts operational research to assist governments, international organizations, and private businesses in helping communities and

societies to achieve economic growth without undermining the integrity of their natural resources and environment. WRI has put forth a number of position papers on the importance of IAP in the overall development context.

A6.45 The Center for Science and Environment (CSE) is one of India's leading environmental NGOs, well known for its strategy of *"knowledge-based activism"* to bring about sustainable environmental and natural resource management in the country. CSE activities in research, education, training, campaigns, and extensive publication reach a wide audience from political leaders to rural activists and young children. Its reputation in the field of environmental management and its belief in integrating traditional knowledge with modern science make it a worthy collaborator in the IAP agenda for India. CSE has hosted and participated in several workshops on indoor air pollution.

A6.46 The Energy and Development Research Center (EDRC) of South Africa is an African energy-policy research, consultancy, and capacity-building institution. Its research is cross-disciplinary, in engineering, natural and environmental sciences, economics, sociology, and anthropology, with a problem-solving orientation. EDRC's goal is to improve social equity, economic efficiency, and environmental sustainability in the energy sector through public-interest advocacy for better policy-making and implementation.

A6.47 One of EDRC's programs, Cooperative Assistance for Rural Energy and Development (Careda) addresses methods and strategies for off-grid electrification of rural areas, largely through renewable energy. An integrated approach is being adopted by this Program, connecting local communities with provincial planners, national energy-supply agencies, and other actors; improving linkages between energy supplies and other public services (health, education, water supply, and telecommunications) for equitable economic development in rural Africa. Sustainable Energy, Environment, and Development (SEED) is another local-action/community-based project implemented under EDRC for both rural and urban South Africa.

A6.48 The Technology and Development Group (T&D) at the University of Twente, in the Netherlands carries out operational research, information dissemination, and networking on renewable energy, the environment, and sustainable development, and it has a specialized unit devoted to gender isues. One of its research studies on fuelwood use and its impact on women's livelihood assessed how constraints in fuelwood affected rural African women, threatened their income-generating capability (and access to cash and family livelihoods) from popular cottage industries, such as beer brewing. In Zambia alone, beer brewing uses 410,000 m^3 of fuelwood, or 25 percent of its total annual consumption.

A6.49 The U.S. National Renewable Energy Laboratory (NREL) has, in its International Division, a Renewables for Sustainable Village Power (RSVP) program, which is currently operating pilot schemes in 13 countries. The program focuses on PV, solar and wind energy; the application of innovative technologies in renewables; the use of computer modeling; and the piloting of interventions with local and international partners. Currently, these schemes target entrepreneurial micro-enterprises, refrigeration, water pumping, lighting, the charging of batteries, and the powering of electronics—but nothing on cooking or space heating. NREL has a unit focused on gender.

A6.50 The Renewable and Appropriate Energy Laboratory (RAEL), based in Berkeley, California (U.S.A.), engages in research and development, project implementation, and community outreach. Under its Energy for Rural Development Division, RAEL has a variety of projects which examine the technical and economic feasibility of alternative energy schemes in PV, biomass, and wind power, and then pilots those with promise. In some of these projects, local government, businesses, community groups, and NGOs are closely involved in the implementation. RAEL often teams up with seasoned international or regional practitioners in its overseas projects in Africa, Asia, and Latin America.

A6.51 The Center for Science and Industrial Research for Australia (CSIRA) does operational research in all regions of the world, with a strong focus on the Asian Region. Its Climate and Atmosphere Unit, within the Environment and Natural Resources Division, is especially active in studying the effects of economic and social activities on climate and atmosphere, and vice versa.

Annex 7

Energy Sector Policy Documents

A7.1 In 1989, the Industry and Energy Department issued a working paper: "Energy Issues in the Developing World," which posed this issue in the summary: "Lower oil prices are raising doubts about the underlying assumptions and ambitious energy programs of the last decade. How—and how hard—do countries pursue the goal of energy efficiency in an uncertain market?" [107] The more recent priorities are described in the four reports described below.

"Fuel for Thought"

A7.2 The Sector Strategy Paper (SSP), Fuel for Thought: Environmental Strategy for the Energy Sector (1999 draft),[108] aims to bring about a better understanding of policy and lending priorities at the nexus of energy and the environment. It also serves as the basis for more detailed operational guidelines that will help shape country-specific assistance programs.

A7.3 The SSP takes stock of developing countries' efforts and of the support that the development community has provided in the rural energy sector in order to identify ways in which the World Bank Group can help its member countries address energy problems. The report looks at:

- The rural energy situation;
- Emerging practices and policies;
- Options for rural electrification;
- Innovations in renewable energy;
- Cooking fuels; and
- The role of the World Bank Group.

A7.4 The SSP describes the growing attractions of renewable technologies such as solar power. It argues that policy-makers, governments, non-governmental organizations (NGOs) and the private sector should concentrate on improving the use of traditional fuels, such as wood, and not just on promoting modern forms of energy, such as electricity. It stresses the importance of designing policies and projects with local people, rather than imposing schemes from above. The SSP concludes that through a combination of better technology and decades of experience, we are now able to tackle the problems of rural energy better than ever before.

[107] Mohan Munasinghe and Robert J. Saunders, eds., Industry and Energy Department, WPS No. 106, January 1989; cover page.

[108] http://wbln0018.worldbank.org/essd/kb.nsf/etc.

"A Brighter Future"

A7.5 The report, *A Brighter Future? Energy in Africa's Development*,[109] calls for a new strategy based on three objectives and a plan for change to:

- Refresh our awareness of the relevance of energy infrastructure and services to the major challenges of development, particularly human resource development, the fight against poverty, and care for the natural environment.
- Show how the Bank's work on energy forms an integral part of a balanced, coherent country assistance strategy for each country. A set of six important linkages are identified that interconnect the energy sector with the drivers of economic and social development (i) energy and the economy, to overcome a poorly functioning, vulnerable energy sector which is incompatible with economic stability; (ii) energy as an instrument to fight poverty and improve equity in growth; (iii) energy as a vehicle to mobilize private investment and assist private sector development; (iv) energy as a means for the development of markets and regional integration; (v) energy and the environment (health is mentioned); and (vi) energy and good governance. All too often these linkages have become constraints, and the purpose of the strategy is to help ease these constraints, so that the energy sector facilitates, rather than constrains, development.
- Show how the Bank, together with its partners, can plan innovatively and draw upon a wide range of tools and resources to formulate and deliver workmanlike contributions to country assistance strategies that can make a difference for Sub-Saharan African member countries.

Rural Energy and Development

A7.6 The report *Development in Practice: Rural Energy and Development—Improving Energy Supplies for Two Billion People* [110] recognizes that rural energy remains a major challenge for the Bank, i.e., two billion people do not have access to modern forms of energy. Around one-third of all energy consumption in developing countries comes from burning wood, crop residues, and animal dung. These fuels affect people's health (indoor air pollution from traditional fuels) and could damage the environment (deforestation). While the Bank can play a catalytic role, especially when developing the Country Assistance Strategy, this effort should be coupled with the adoption of policy and institutional reforms, the mobilization of entrepreneurial and NGO resources, and the development of innovative rural energy delivery and financing mechanisms.

A7.7 A new agenda is articulated, which recognizes a missing link and a time lag in the liberalization of energy markets: (i) access to affordable credit by the poor; (ii) the promotion of renewable forms of energy (solar and small-scale hydropower); and (iii) improved biomass stoves when using traditional fuels; and effective management of forest resources.

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[109] *A Brighter Future? Energy in Africa's Development*, Draft, 1999.

[110] *Development in Practice: Rural Energy and Development—Improving Energy Supplies for Two Billion People*, Washington, DC, 1996.

A7.8 An action plan for the Bank is formulated, which includes the following:

- Develop regional, country, and local ownership, and commitment to broaden energy access;
- Systematically operationalize rural energy in Bank assistance programs;
- Promote best practices and innovations in project design and implementation;
- Disseminate innovations and best practices;
- Develop partnerships with donors, NGOs, and other organizations;
- Create a special initiative for Africa;
- Improve the capacity of the Bank to deal with rural energy issues; and
- Monitor progress in achieving objectives.

Energy Services for the World's Poor

A7.9 The *ESMAP Energy and Development Report 2000: Energy Services for the World's Poor*[111] identifies and attempts to address the linkages between energy and poverty reduction. Lack of access to safe and reliable energy, coupled with high prices for poor-quality substitutes for millions of households in the developing world, poses a major challenge. Developing country governments together with all other players in the energy sector—private firms, financiers, regulators, non-governmental organizations, and multilateral donor agencies—need to understand the challenges which revolve around three main themes in this report:

- Formulating strategies and determining policy instruments to expand access to efficient and sustainable energy services for low-income households and communities in developing countries;
- Facilitating technological and commercial innovations in serving the poor, through market structure, regulatory reform, and the liberalization of the energy market; and
- Reducing financial, legal, regulatory, and tax barriers to better services for low-income households and areas.

A7.10 The report also reviews trends in private investment in the energy sector in 1990-99.

The Africa Energy Strategy

A7.11 The Africa energy strategy is derived from the report "Can Africa Claim the 21st Century" and follows the building blocks of the WDR 2001. From an environmental health perspective, health problems are recognized, but indoor versus outdoor abatement issues are not quantified and prioritized

A7.12 *Background.* Some 80 percent of the population in SSA lives on less than US$2 per day, and more than 40 percent lives on US$1 a day. Evidence shows that rises in national income are translated into better wellbeing (health, education, etc.), and a 7 percent GDP growth is required in SSA to cut poverty by one-half in 2015. Economic growth should, however, be accompanied by policies targeting the poor: creating opportunities (water and sanitation, education, health, electricity, jobs, etc.), facilitating empowerment (social and gender inclusion), and enhancing security (mitigating economic, social and natural disaster shocks).

[111] http://www.worldbank.org/html/fpd/esmap/energy_report2000/index.htm

A7.13 *Strategy for Developing Africa's Infrastructure.* Infrastructure plays a key role in poverty reduction. In addition to the tradition cluster of infrastructure interventions (water and sanitation, health care, etc.), an effort must be made to equip SSA with an information and communications technology infrastructure to benefit from a knowledge-based economy. The strategy revolves around: boosting investments (USUS$18 billion a year) especially on maintenance and rehabilitation, particularly in rural areas; development of public-private partnerships (depending on the market structure and the nature of the good); improving government credibility (effective policies and governance); increasing cross-border and regional cooperation (mainly road and electricity networks); and widening access to the poorest.

A7.14 *The Energy Sector*. No modern society has developed without providing access to modern, clean, and affordable energy services (for light, the "cold chain", i.e. chain of refrigeration needed for some medicines, communication, and information). However, over 85 percent of the population does not have access to electricity, and the latter is an essential asset among the physical assets to be provided to the poor. Lack of modern energy hurts the poor, who depend on polluting and sometimes more expensive traditional energy sources for cooking and heating. Improving access to modern energy sources can translate into a multitude of direct (light, cleaner burning fuels, reducing time and effort gathering biomass fuels, etc.) and indirect effects (enhancing service delivery for water, health, education, etc.)

A7.15 *Energy Strategies for Poverty Alleviation and Impact Pathways.* The energy sector's poverty alleviation should be embedded in the development strategy of the country concerned and include goals and priorities: improve markets and services for energy (quantity, quality and prices); increase rural transformation (increased access); reduce environmental impact; and initiate a paradigm shift (private provision and better regulation). More specifically, interventions should be articulated around electricity (markets, tariffs, first access, renewable development markets, and energy efficiency); rural transformation (commercially-oriented programs and decentralized energy services delivery); biomass and traditional fuels (sustainable supply and efficient use of biomass fuels and transition to modern fuels when possible); and hydrocarbons (sector reform and promotion of LPG).

A7.16 *Energy in the Poverty Reduction Strategy Paper.* Determining the right priorities and specific mix of energy interventions and cross-sectoral linkages appropriate for implementation in a given country and sectoral context, and identifying workable entry points as well as the timing and sequencing for implementation, represent the central part of our work program challenge. This will require upstream analysis and country dialogue leading up to the formulation of a country's PRSP. (Poverty Reduction Strategy Programs .Currently, no PRSP has included an environmental health analysis.)

A7.17 Other energy papers that were not summarized include:

- Alcohol Production from Biomass in the Developing Countries (1980).
- The Future Role of Hydropower in Developing Countries (1989).
- Hydropower Dams and Social Impacts: A Sociological Perspective. (1997)

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Joint UNDP/World Bank

ENERGY SECTOR MANAGEMENT ASSISTANCE PROGRAMME (ESMAP)

LIST OF TECHNICAL PAPER SERIES

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	Phase-Out of Leaded Gasoline in Sub-Saharan Africa	04/02	028/02
	Energy and Poverty: How can Modern Energy Services Contribute to Poverty Reduction	03/03	032/03
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Senegal	Regional Conference on the Phase-Out of Leaded Gasoline in Sub-Saharan Africa	03/02	022/02
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	Technology Assessment of Clean Coal Technologies for China Volume I—Electric Power Production	05/01	011/01
	Technology Assessment of Clean Coal Technologies for China Volume II—Environmental and Energy Efficiency Improvements for Non-power Uses of Coal	05/01	011/01
	Technology Assessment of Clean Coal Technologies for China Volume III—Environmental Compliance in the Energy Sector: Methodological Approach and Least-Cost Strategies	12/01	011/01
Thailand	DSM in Thailand: A Case Study	10/00	008/00
	Development of a Regional Power Market in the Greater Mekong Sub-Region (GMS)	12/01	015/01
Vietnam	Options for Renewable Energy in Vietnam	07/00	001/00
	Renewable Energy Action Plan	03/02	021/02
	SOUTH ASIA (SAS)		
Bangladesh	Workshop on Bangladesh Power Sector Reform	12/01	018/01
	EUROPE AND CENTRAL ASIA (ECA)		
Russia	Russia Pipeline Oil Spill Study	03/03	034/03
	MIDDLE EASTERN AND NORTH AFRICA REGION (MENA)		
Regional	Roundtable on Opportunities and Challenges in the Water, Sanitation And Power Sectors in the Middle East and North Africa Region. Summary Proceedings. May 26-28, 2003. Beit Mary, Lebanon. (CD)	02/04	049/04

Region/Country	*Activity/Report Title*	*Date*	*Number*
	LATIN AMERICA AND THE CARIBBEAN REGION (LCR)		
	Regional Electricity Markets Interconnections — Phase I Identification of Issues for the Development of Regional Power Markets in South America	12/01	016/01
	Regional Electricity Markets Interconnections — Phase II Proposals to Facilitate Increased Energy Exchanges in South America	04/02	016/01
	Population, Energy and Environment Program (PEA) Comparative Analysis on the Distribution of Oil Rents (English and Spanish)	02/02	020/02
	Estudio Comparativo sobre la Distribución de la Renta Petrolera Estudio de Casos: Bolivia, Colombia, Ecuador y Perú	03/02	023/02
	Latin American and Caribbean Refinery Sector Development Report – Volumes I and II	08/02	026/02
	The Population, Energy and Environmental Program (EAP) (English and Spanish)	08/02	027/02
Ecuador	Programa de Entrenamiento a Representantes de Nacionalidades Amazónicas en Temas Hidrocarburíferos	08/02	025/02
Guatemala	Household Fuel Use and Fuel Switching	06/03	036/03
Mexico	Energy Policies and the Mexican Economy	01/04	047/04
Nicaragua	Aid-Memoir from the Rural Electrification Workshop (Spanish only)	03/03	030/04
	GLOBAL		
	Impact of Power Sector Reform on the Poor: A Review of Issues and the Literature	07/00	002/00
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	Key Factors for Private Sector Investment in Power Distribution	08/01	014/01
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	Monitoring and Evaluation in Rural Electrification Projects: A Demand-Oriented Approach	07/03	037/03
	Household Energy Use in Developing Countries: A Multicountry Study	10/03	042/03
	Knowledge Exchange: Online Consultation and Project Profile from South Asia Practitioners Workshop. Colombo, Sri Lanka, June 2-4, 2003	12/03	043/03
	Energy & Environmental Health: A Literature Review and Recommendations.	03/04	050/04

Last report added to this list ESMAP Technical Paper 050/04.