Energy, Development and Gender: Global Correlations and Causality[1]

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List of acronyms

ASTAE	Asia Technical Unit for Alternative Energy, World Bank
DfID	United Kingdom Department for International Development
EDI	Energy Development Index of the IEA
EnPoGen	Energy, Poverty and Gender Project of ASTAE, World Bank
GDI	Gender-related Development Index of the United Nations
GEP	Gender-Energy-Poverty Index
GDP	Gross Domestic Product
GEM	Gender Empowerment Index of the United Nations
HDI	Human Development Index of the United Nations
HPI-1	Human Poverty Index of the United Nations
IEA	International Energy Agency
MDG	Millennium Development Goal
OECD	Organisation for Economic Cooperation and Development
USAID	United States Agency for International Development

Executive Summary

The Millennium Development Goals and the UN Millennium Project reports give a new impetus to linking energy access with gender and poverty. This is one of a series of research papers being published under an ENERGIA/DfID research project on "Gender as a key variable in energy". Case studies have been carried out in a number of countries collecting field data on linkages between gender and energy. An empirical review of evidence from past studies on linkages between energy and poverty, from a gender perspective, is also part of the research. As part of the empirical review, papers are being prepared exploring the empirical and especially the quantitative evidence on the impact of energy access by gender on each of the UN Millennium Development Goals.

The present paper specifically explores global statistical studies and their evidence on correlation and causality in the linkages among energy, development and gender. There is a strong relationship between energy and economic growth, and some evidence that energy can be a driver of economic development, especially at the industrial stage for developing countries. There is also a strong correlation between per capita energy consumption and human development indicators such as life expectancy, literacy and school enrolment used in the UN's Human Development Index (HDI), though whether this is causal or simply linked by rising incomes, has not been demonstrated. HDI also correlates strongly with the new IEA composite indicator, the Energy Development Index (EDI).

None of these correlations have addressed the question of a relationship between energy, and gender equity and empowerment, however. This study does so by looking first, at some available statistical analyses of energy access versus some key human development indicators of particular importance to women; and secondly, by carrying out some simple correlations between energy consumption and United Nations gender-related development indices.

Commercial energy access has been plotted by the IEA and found to be correlated with the UN indicators of extreme poverty: life expectancy, probability of not surviving to age 40, school enrolment, and underweight in children. A significant positive relationship was found by another study between traditional biomass fuel use and infant and child mortality, life expectancy (with a larger effect for females), fertility rates and crude birth rates, independent of both income per capita and income equality in a country. Indoor air pollution exposures have been related with child and adult morbidity and mortality, though globally there has been no disaggregation of effects on girls and boys, most impact on adults is assumed to be on women cooks. An eight-country study finds that the fuel transition to hydrocarbon cooking fuels is strongly correlated in these countries with access to other infrastructure represented by variables for education, urbanization, and electrification. Access to clean water, especially important for reducing women's work burden, has been plotted against electrification, but the curve shows considerable diversity; other factors may be significant.

Access to energy does appear to correlate with a number of these key social and economic indicators of special importance to women. However the lack of gender disaggregation in many of the statistical studies limits the usefulness of these correlations in determining impacts on women and men, or girls and boys, separately, and particularly in assessing their relationship with gender equity and empowerment.

For this reason, an attempt is made in this paper to use UN gender-related indices to explore whether energy access is related to gender equity and empowerment. Per capita energy consumption does correlate closely with the UN's Gender Development Index (GDI), in a similar non-linear relationship as HDI. It appears that even modest increases in energy and electricity consumption could be associated with much larger improvements in gender-related development in terms of women's life expectancy, literacy and school enrolment. This is consistent with what is known about the effects of energy access on women's "practical" needs to reduce work burden.

However the relationship between energy consumption and the UN's Gender Empowerment Index (GEM), which measures gender inequality in economic and political spheres of activity, is much less clear. Gender empowerment likely depends more strongly on other factors, such as legal, social and policy frameworks. Other conditions in addition to energy access are necessary to meet "strategic" needs including the transformation of gender roles and relations.

Further, an attempt is made to develop a Gender-Energy-Poverty Index (GEP) based on data available for 57 countries. Such an index could be used to measure gender-energy-poverty vulnerability and identify priority countries for action, and to compare progress across countries and regions as well as shifts over time. The GEP here identifies "hot spots" which need priority attention, particularly in parts of Africa and South Asia.

Finally, some suggestions are made for consideration in future statistical studies on energy access and development indicators, to ensure a gender perspective: MORE HEREmost importantly and simply, the disaggregation of data collection and analysis by women and men, and girls and boys.

1. Introduction

The adoption of the Millennium Development Goals by world leaders in 2000 gave a new impetus to the recognition of the importance of linking energy access with poverty and gender, launched most notably by DfID's *Energy for the Poor: Underpinning the Millennium Development Goals* in 2002. Energy was firmly placed on the MDG agenda in January 2005, when the independent advisory body the UN Millennium Project published its report to the UN Secretary-General, *Investing in Development: A Practical Plan to Achieve the Millennium Development Goals*, a comprehensive operational framework and investment strategy that would allow meeting the MDGs by 2015. Energy is notably integrated into each MDG in the report. Energy, including both electricity and safe cooking fuels, is identified as an essential infrastructure service and part of the "means to a productive life." Investing in core infrastructure, together with human capital and good governance, is viewed as a means to convert subsistence farming to market-oriented farming, establish the basis for private sector-led diversified exports and economic growth, enable a country to join the international division of labour in a productive way, and set the stage for technological advance and eventually an innovation-based economy.

Most notably, the UN Millennium Project proposes that countries adopt the following specific targets for energy services to help achieve the Goals by 2015:

- Reduce the number of people without effective access to modern cooking fuels by 50 percent and make improved cook-stoves widely available.
- Provide access to electricity for all schools, health facilities, and other key community facilities (this target is also included in the list of "Quick Wins" for rapid action).
- Ensure access to motive power in each community.
- Provide access to electricity and modern energy services for all urban and periurban poor.

The Millennium Project report emphasises that energy investments need to be included in MDG-based country poverty reduction strategies, and estimates that out of total MDG investment needs of $80 per capita in 2006 (rising to $124 in 2015), energy costs would need to be about $13 per capita in 2006 (rising to $18 in 2015).

Energy appears explicitly in the report of the UN Millennium Project Task Force on Gender Equality on *Taking Action: Achieving gender equality and empowering women* (2005), a focus of Beijing+10 review in New York in March 2005[2]. Energy appears

2 The task force sets seven strategic priorities to ensure that Goal 3 on gender equality is met by 2015:

1. Strengthen post-primary education opportunities for girls while meeting universal primary education commitment
2. Guarantee sexual and reproductive health and rights
3. Guarantee women's and girls' property and inheritance rights
4. Invest in infrastructure to reduce women's and girls' time burdens
5. Eliminate gender inequality in employment by decreasing women's reliance on informal employment, closing gender gaps in earnings, and reducing occupational segregation

explicitly in strategic priority 3, where investment in energy infrastructure is seen as an important means to reduce women's and girls' time burdens in fuelwood collection and transport. One of the 12 (expanded from 4 previously) indicators proposed for monitoring progress towards Goal 3 on gender equality is the hours per day women and men spend fetching water and collecting fuel.

Energy is important in meeting basic human welfare needs and as a factor in economic development. For most people in developing countries, cooking and heating are the main use of energy, using wood, charcoal, animal and plant wastes, and candles or sometimes kerosene for lighting. Transport and most agricultural, food processing and cottage industry work is carried out by human energy. Women's role in this energy system is central, and access to modern forms of energy could make a crucial difference in their ability to participate in development. While investing in energy infrastructure is an important means of reducing women's and girls' time burden, energy's linkages with gender issues go beyond just supply of capital infrastructure or relieving the time burden, though this is important. The relationship between energy and production, energy-related health issues such as indoor air pollution, and improvements in traditional biomass energy are all part and parcel of whether increasing energy access will also improve gender relations and the welfare of both women and men.

This is one of a series of research papers being published under an ENERGIA/DfID research project on "Gender as a key variable in energy" (see **Annex 2**). Case studies have been carried out in a number of countries collecting field data on linkages between gender and energy. An empirical review of evidence from past studies on linkages between energy and poverty, from a gender perspective, is also part of the research. As part of the empirical review, papers are being prepared exploring the empirical and especially the quantitative evidence on the impact of energy access by gender on each of the UN Millennium Development Goals. **Table 1** lists some indicators of energy as a key variable from a gender perspective, for each Goal, that are being used to assess the empirical evidence for gender and energy linkages with the MDGs in these papers.

The present paper specifically explores global statistical studies and their evidence on correlation and causality in the linkages among energy, development and gender. First explored is the relationship between energy and economic growth, and between per capita energy consumption and human development indicators such as life expectancy, literacy and school enrolment used in the UN's Human Development Index.

Next, the question of a relationship between energy, and gender equity and empowerment is addressed by looking first, at some available statistical analyses of energy access versus some key human development indicators of particular importance to women; and secondly, by carrying out some simple correlations between energy consumption and United Nations gender-related development indices. Evidence on traditional fuel use, poverty, and demographic and health indicators; on fuel switching to modern cooking

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6. Increase women's share of seats in national parliaments and local governmental bodies
7. Combat violence against women and girls

Table 1: Indicators of Energy as a Key Variable from a Gender Perspective for the Millennium Development Goals

Millennium Development Goals	**Gender & energy perspective indicators relate energy access with:**
Goal 1. Eradicate extreme poverty & hunger by 50%	1. Time & effort savings (M/F, B/G) and their use 2. Income generation (M/F): agriculture, workday extension, income activities, energy entrepreneurs 3. Savings in household expenditures 4. Food processing, cooking & nutrition
Goal 2. Achieve universal primary education of boys and girls	1. Primary, middle & secondary education (B/G)
Goal 3. Promote gender equality and empower women	1. Literacy (M/F) 2. Media & telecommunications 3. Leisure time (M/F) 4. Control over & access to energy services (M/F) 5. Transformation of gender roles 6. Violence against women in energy sector 7. Voice and participation 8. Representation of women in the energy sector
Goal 4. Reduce child mortality (by 2/3 the <5 mortality rate) Goal 5. Improve maternal health (reduce mortality by ¾) Goal 6. Combat HIV/AIDS, malaria, other	1. Indoor air pollution exposures, respiratory diseases and other health effects of biomass fuel use (M/F, B/G) 2. Burns and kerosene poisoning 3. Fuelwood collection health costs incl violence 4. Health costs of lack of modern energy for daily survival tasks – work burden 5. Fuel scarcity, diet & nutrition 6. Modern energy services benefits – household level 7. Health service delivery
Goal 7. Ensure environmental sustainability incl safe drinking water and slum dwellers	1. Deforestation & fuel collection 2. Climate change & traditional biomass 3. Access to clean water & sanitation

Source: E. Cecelski, "Energy, Gender and the Millennium Development Goals: Empirical Evidence," DfID/ENERGIA "Gender as a key variable in energy interventions" Review Meeting, Nairobi, 17-20 May 2005 fuels and electricity and access to other infrastructure; and on electrification and access to clean water, is presented and assessed.

Due to the absence of gender disaggregation in many of these statistical studies, however, another approach is then taken, to use UN gender-related indices to explore whether energy access can be statistically related to gender equity and empowerment. Per capita energy consumption is correlated with the UN's Gender Development Index (GDI), and then with the UN's Gender Empowerment Index (GEM).

Further, an attempt is made to develop a Gender-Energy-Poverty Index (GEP) based on data available for 57 countries. Such an index could be used to measure gender-energy-poverty vulnerability and identify priority countries for action, and to compare progress across countries and regions as well as shifts over time. The GEP here identifies "hot spots" which need priority attention, particularly in parts of Africa and South Asia.

Finally, some suggestions are made for consideration in future statistical studies on energy access and development indicators, in order to ensure a gender perspective.

2. Energy, Economic Growth and Human Development

Linkages between energy and development have been posited since the first oil crisis in 1973 called into question the easy availability of affordable fossil energy to fuel economic development. At that time, the major concern was whether energy efficiency could decouple the almost one-to-one relationship between energy and economic growth; and indeed, for OECD countries, a successful effort has been made to reduce the amount of energy needed to produce a unit of Gross Domestic Product. For developing countries, at a more energy-intensive level of agricultural and industrial development, decoupling appears more difficult, but technological leapfrogging to more energy efficient technologies and lower energy intensity is also leading to a common lower pattern of energy use per unit of GDP (UNDP/UNDESA/WEC, 2004).

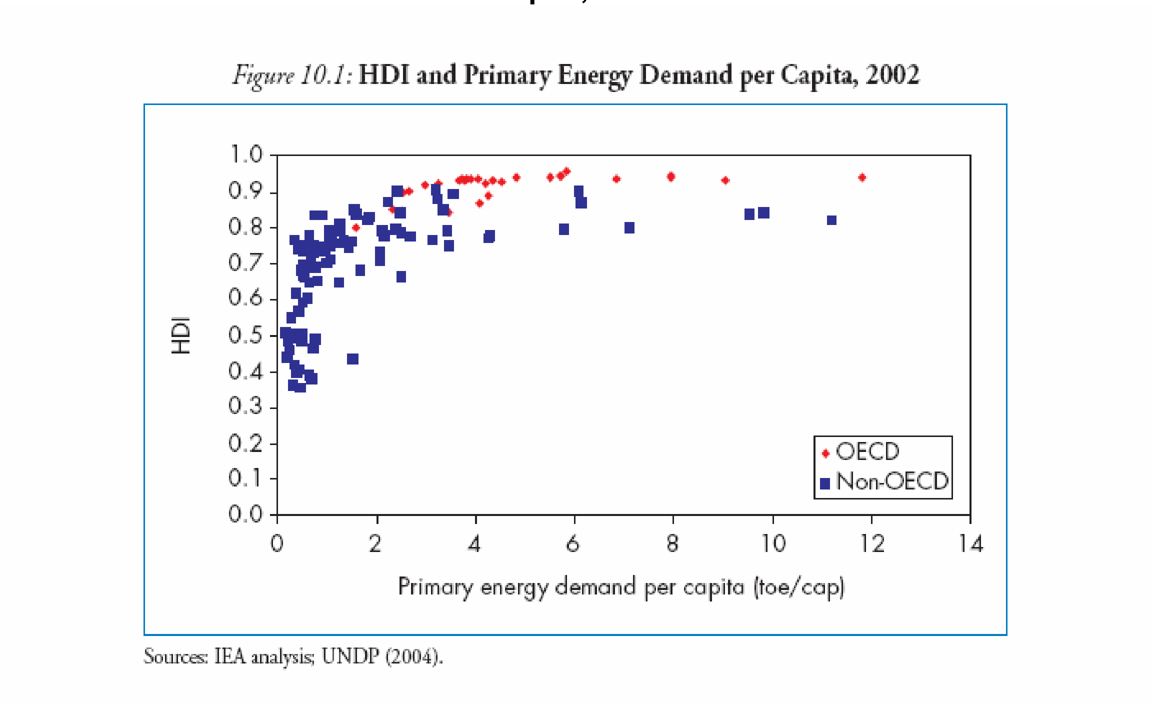
While there is no doubt that energy is necessary for economic and social development, the exact relationship is complex. Global statistical correlations and indices can be rightly criticized for over-simplifying these relationships. But they can be a useful corroboration and generalization of relationships suggested by case studies and household field data in some sites, and are presented as such in this paper.

Whether energy actually *causes* increases in human welfare and economic growth is more difficult to assert than simple association. Certainly, energy is required for all sorts of economic activities to take place, but the direction of causation could be that increasing economic growth and human development cause more energy to be consumed. Logically, of course, it makes sense that the causation would flow both ways: higher energy use for production (together with other inputs) would promote economic growth, and this in turn would make possible higher energy consumption and human development.

One would expect this effect to be strongest in the early stages of development, with the shift from human and animal energy and low-efficiency biomass sources, to mechanical, fossil fuel, and electrical sources of energy. The International Energy Agency (IEA, 2005) did find, in its analysis of energy as a variable in the neoclassical production function, that energy (as compared with capital and labour) contributed significantly to GDP growth in a number of countries, and was the leading driver in Brazil, Turkey and Korea. The effect was strongest at the intermediate (industrial) stage of economic development. In any event, whether causal or associated, the IEA suggests that investment in energy infrastructure and economic development are a "virtuous circle" that will need to be repeated in poor countries.[3]

[3] Andrew Barnett was the first to suggest a diagram showing that "Large numbers of people suffer from a "vicious circle" of energy poverty where they are "energy poor" because they do not have the means to buy improved energy services, even if they have access to them (in the sense of being in close proximity to a supply[3]). But there are opportunities for breaking this cycle by combining improved energy services with productive end uses. This is the so-called virtuous circle." Andrew Barnett, "Energy and the Fight Against Poverty," Lecture at the Institute of Social Studies, The Hague, 2000.

Figure 1: The Human Development Index (HDI) and Primary Energy Demand Per Capita, 2002



Source: IEA, 2004.

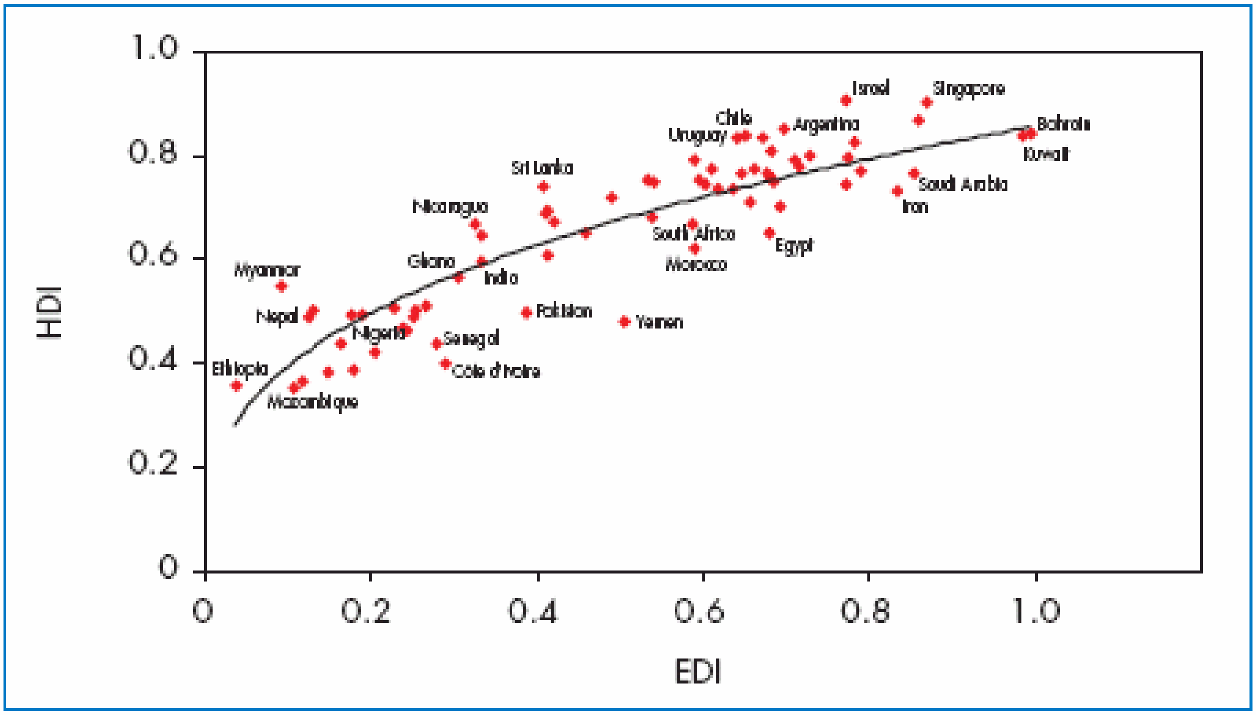
The IEA finds a very strong correlation between per capita energy consumption (both commercial and non-commercial) and the UN's Human Development Index (HDI)[4], especially below an HDI of 0.8. Very few countries with a per capita energy use of less than 2 tonnes of oil equivalent have an HDI over 0.7. **Figure 1** from the *World Energy Outlook 2004* shows the correlation between energy consumption and HDI in a number of developing countries. The correlation is even stronger if only commercial energy, or only electricity, is considered.

Importantly, these correlations are non-linear: the increase in HDI scores at lower levels of levels of energy and electricity consumption is more rapid than at higher levels. This means that for poor countries, even modest increases in energy and electricity consumption are associated with much larger improvements in human development. As Modi (2004) points out in relationship to energy and the Millennium Development Goals, an increase from 30 to 300 kgoe in primary energy consumption does have a strong association with dramatically improved living standards.

[4] The Human Development Index (HDI) is a composite of social and economic indicators for all countries that takes into account human welfare, not only economic growth as measured by GDP. HDI data is updated annually and published in the *Human Development Report*. It is composed of life expectancy at birth, adult literacy and school enrolment, and per capita GDP (adjusted for purchasing power parity).

Figure 2: Energy Development Index (EDI) and Human Development Index (HDI), 2002

Figure 10.7: EDI and HDI in Developing Countries, 2002



Sources: IEA analysis; UNDP (2004).

Source: IEA 2004.

The close relationship between human development and energy consumption is illustrated in **Figure 2** as well, using the IEA's new Energy Development Index (EDI), a composite of per capita energy consumption, *access* to modern energy, and *access* to electricity. EDI is a more accurate measure of energy development than per capita consumption alone, since it takes into account possible inequalities in access to modern energy and electricity by higher income groups compared to lower.

These statistical analyses do demonstrate a correlation between energy consumption, economic growth, and human development overall, but they tell little about the results for the welfare or agency of women and men separately, or for gender relations. Dev Nathan (2005) suggests that energy effects on both production and human well-being are gendered, both in terms of the end uses of energy, and the manner in which both energy and the resulting income from growth are controlled. In energy as in other sectors, women face distinct challenges and opportunities related to their traditional roles, household responsibilities, and low social and economic status. Energy poverty is experienced differently by women and by men and may have different causes and consequences. And energy projects impact women and men in different ways (Clancy, et.al., 2003; Cecelski, 1995; Parkih, 1995). A number of efforts are seeking both to ensure that energy projects help achieve goals of gender equity; and that attention to gender differences can be harnessed to improve the outcomes of energy projects (UNDP, 2004a). For this reason, the remainder of this paper seeks to explore global correlations between energy and development indicators, from a gender perspective.

3. Energy and Gender-Related Human Development Indicators: Global Analyses

One way to examine the global relationship between energy and gender equity is by looking at statistical correlations at the global level, between energy access and key social and economic indicators of particular relevance to women. Women, especially poor women, in virtually all rural areas of all developing countries, have the principal responsibility and burden of cooking and associated fuel collection. Water collection is also a primary responsibility of women. Together, these two activities represent a major portion of women's (and often children's) time and effort, and this human energy effort can be replaced or made more efficient and convenient by modern sources of energy. Some global comparative studies are available on the linkages between traditional fuel use and poverty, on the association of fuel-switching to modern cooking fuels with various infrastructure indicators, and on the relationship between electrification and access to drinking water; and these are discussed below.[5]

Traditional biomass fuels and poverty

Traditional fuel consumption, mainly in cooking, is a particular concern for women cooks who suffer from indoor air pollution from smoky stoves and are burdened by time-consuming fuel collection. Traditional "biomass" fuels include wood, charcoal, animal dung, and agricultural residues. In poor countries, most traditional fuels are gathered by women and children. As income rises, even traditional fuels may become commercialized and a "fuel transition" to modern cooking and heating fuels such as kerosene, LPG and even electricity gradually takes place. However traditional biomass fuels may continue to be used even in higher income households and developing countries, especially where the value of women's labour and their status remain low. Poor households may continue to use lower-cost biomass fuels and appliances, while higher income households switch to modern fuels. This traditional fuel use has important implications for household labour allocation, health and nutrition.

According to recent IEA analysis, modern (=commercial) energy consumption closely (negatively) correlates with the indicators of extreme poverty developed by the UN as HP-1, as shown in **Table 2**. Total energy consumption is composed of modern + traditional fuel consumption, so it is also shown that traditional fuel consumption correlates positively with the human poverty indicators.

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[5] A further major area of women's work that can be replaced or improved with modern energy sources, is food processing (milling grains, pounding, threshing, crushing, expelling oils, etc.) However no global studies of relationships between energy access and these activities were found, so this area is not included here. There is considerable anecdotal evidence of grain mills reducing women's drudgery and time, at the micro level, however. Country and project studies on the impacts of improved energy sources on women's food processing activities. are analysed in a separate paper on MDG 1 on reducing extreme poverty and hunger (Dutta, 2005, forthcoming).

Table 2: Commercial Energy Use and Human Poverty Indicators, 2002

	Commercial energy as share of total energy consumption		
Indicator	0-20%	21-40%	41-100%
Average life expectancy at birth (years)	59.8	69.0	69.5
Probability at birth of not surviving to 40 (%)	21.7	9.4	9.1
Gross school enrolment ratio	52.4	65.4	76.9
Children underweight (% of population)	40.9	15.1	11.9
Population without access to improved water (%)	20.9	22.9	12.8
Number of countries in sample	*30*	*7*	*27*
Per cent of total sample population	*42%*	*39%*	*17%*

Note: Indicators are averages weighted by population based on 64 developing countries for which data are available.
Sources: IEA analysis; UNDP (2004) in IEA, 2004.

These confirm similar findings in the *World Energy Assessment (2000)*. Gender differences in these indicators are not given in either the IEA or the WEA analysis, however.

Traditional biomass use may be correlated with demographic factors as well. In an analysis of the impact of biomass fuel use in developing countries from a demographic point of view, Zaidi and Bloom (2004) find a significant positive relationship shown in **Table 3** below, between traditional fuel use and: infant and child mortality; life expectancy (with a larger effect for females); fertility rates and crude birth rates. These relationships are independent of both income per capita and income equality. The authors speculate that indoor air pollution is the reason for the link between traditional fuel use and health as well as fertility.[6] These demographers insist that "continued dependence on wood for fuel helps to depress income and maintain rural poverty by (a) ensuring that time and money resources are devoted to collecting fuelwood, (b) harming the health of those who use it, and (c) abetting high birth rates. These conclusions are strongly buttressed by recent research on the economic consequences of demographic change." (p. 18) From a demographer's point of view, reliance on biomass used in traditional ways by rural populations of developing countries impedes the demographic transition and thereby impedes economic growth.

[6] In fact, though not noted by these authors, the entire biomass fuel supply and use cycle could be contributing to these effects.

Table 3: The Effect of Using Traditional Biomass Fuel on Various Demographic Indicators (Regression Results)

Dependent Variable	Constant	Percent Traditional Fuel Use	Log GNP Per Capita	Inverse log GNP Per Capita	R Squared	N
Crude Death Rate	-227.919**	0.007	13.247**	1044.726**	0.54	108
Infant Mortality Rate	-795.305**	0.247**	37.945**	4203.384**	0.83	108
Under 5 Mortality Rate	-1377.804**	0.494**	67.613**	7066.313**	0.82	108
Life Expectancy	213.215**	-0.088**	-5.453*	-816.024**	0.86	108
Male Life Expectancy	195.649**	-0.076**	-4.708	746.366**	0.84	108
Female Life Expectancy	213.647**	-0.102**	-6.234*	-889.108**	0.86	108
Life Expectancy Gap (F-M)	35.998	-0.026**	-1.526	-142.741	0.35	108
Crude Birth Rate	66.412	0.176**	-5.336	-6.581	0.77	108
Total Fertility Rate	-0.011	0.025**	-0.213	37.326	0.78	108
Population Growth Rate	3.031	0.021**	-0.184	-3.546	0.43	108

* indicates significance at 10% level. N is the number of observations.
**indicates significance at the 5% level; Data from 1993 and surrounding years. Traditional Fuel includes fuelwood, bagasse, charcoal, animal wastes, vegetable wastes, and other wastes. Traditional Fuel use is expressed as a percentage of total fuel use.
Source: Zaidi and Bloom, 2004, based on *UN Energy Statistics Yearbook 1993* and *World Development Indicators 1998*.[7]

Women's need to command labour in fuel collection is identified by Zaidi and Bloom as an important factor in valuing children's labour and hence higher fertility rates. However it should be noted that women's need to command labour extends well beyond fuel collection to cooking (as or more important a time use as fuel collection) and indeed more broadly to water collection, transport, food processing, and other human energy activities that can potentially be replaced by mechanical, electrical, or other forms of modern energy. One wonders indeed whether the correlations identified with demographic factors are primarily with the use of biomass energy, or in fact are due to the high use of human energy, which likely is associated with biomass energy use as well.

The relationship between indoor air pollution exposures from the combustion of traditional biomass fuels and both child and adult morbidity and mortality in developing countries has received warranted attention recently; estimates of impact are succinctly summarized in a recent World Bank study (Dasgupta, et.al, 2004):

"Indoor air pollution from burning wood, animal dung and other biofuels is a major cause of acute respiratory infections (ARI), which constitute the most important cause of death for young children in developing countries (Murray and Lopez, 1996). Acute lower respiratory infection (ALRI), the most serious type of ARI, is often associated with pneumonia (Kirkwood et al.,

[7] Given the improving quality of data on biomass energy consumption, it would be of interest to repeat the Zaidi and Bloom analysis using current IEA and UN data.

1995). ALRI accounts for 20% of the estimated 12 million annual deaths of children under five, and about 10% of perinatal deaths (WHO, 2001; Bruce, 1999). Nearly all of these deaths occur in developing countries, with the heaviest losses in Asia (42% of total deaths) and Africa (28%) (Murray and Lopez, 1996). Through its effect on respiratory infections, indoor air pollution (IAP) is estimated to cause between 1.6 and 2 million deaths per year in developing countries (Smith, 2000). Most of the dead are in poor households and approximately 1 million are children (Smith, 1993; Smith, et al., 1993; Smith and Mehta, 2000)."

Table 4: Annual Disease Burden from Indoor Air Pollution (Early 1990's)

Region	Deaths ('000)	Illness Incidence ('000,000)	DALYs[8] ('000,000)
China	516.5	209.7	9.3
India	496.1	448.4	16.0
Sub-Saharan Africa	429.0	350.7	14.3
Other Asia & Pacific Islands	210.7	306.4	6.6
Mid-East and North Africa	165.8	64.2	5.6
Latin America & Caribbean	29.0	58.2	0.9
Total	1,800.0	1,400 .0	53.0

Source: Dasgupta, et.al. 2004, from World Bank (2002), drawing on Smith and Mehta (2000) and Von Schrinding, et al., (2001).

Dasgupta also cites other studies that estimate the health damage from indoor air pollution by region, in **Table 4** above. More than half of the deaths are in India and China. The one million deaths estimated to be of children have not been disaggregated between girls and boys in this estimate, however the remainder of 800,000 can be assumed to be largely women cooks.[9]

Fuel switching to modern cooking fuels and access to other infrastructure services

Fuel switching from traditional biomass to modern fuels for cooking such as kerosene and LPG gas could reduce women's work burden and improve health. A 2003 ESMAP multi-country study used a database consisting of household surveys from eight very diverse developing countries – Brazil, Ghana, Guatemala, India, Nepal, Nicaragua, South Africa, and Vietnam – to assess the extent to which hydrocarbon cooking fuels can displace traditional solid cooking fuels (ESMAP, 2003). A number of variables were found through regression analysis to affect fuel choice and fuel switching: household expenditures, education, urbanization, electrification status, and water source. [10] Uptake of modern cooking fuels correlated with access to other infrastructure services and

[8] DALYs, or disability-adjusted life years, combine life-years lost from premature death and fractional years of healthy life lost from illness and disability (Murray and Lopez 1996).
[9] A separate DfID review on energy links with a gender perspective on child mortality and maternal health is under preparation.
[10] Education by gender of the respondent does not appear to be analysed however.

specifically with per capita expenditures on energy, with electrification of the household, with having tap water inside the house, and with education.

These findings lead the authors to conclude that due to the lower levels of all of these correlating variables in rural areas – as well as the greater accessibility of biomass – the prospects for introducing modern fuels will be better in urban than in rural areas, and other interventions such as improved stoves or better ventilation of kitchens may be more appropriate for rural areas.

Table 5: Electrification Status and Modern Cooking Fuels Use, 8 Countries

Table 4.1: Electrification Status and Modern Cooking Fuels Use

(in % of households)

	Electrified	*LPG for Cooking*	*Kerosene for Cooking*	*Electricity for Cooking*	*All Nonsolid Cooking Fuels*
Brazil	92.3	92.3	0.1	1.6	92.8
Nicaragua	68.7	29.0	1.8	1.0	31.7
South Africa	53.6	7.9	43.2	45.8	85.8
Vietnam	78.5	22.3	8.0	13.1	33.0
Guatemala	73.1	44.9	5.5	2.0	50.1
Ghana	41.0	5.4	1.1	0.4	6.9
Nepal	14.1	1.6	7.1	0.3	9.0
India	59.4	16.0	7.9	0.2	24.3

Notes: Row shares of individual nonsolid fuels may not sum to the total for all nonsolid fuels because of multiple fuel use by households.
[a] The Brazil questionnaire does not allow distinction between LPG and other types of gas (piped gas).

Source: ESMAP 2003.

Though a causal link cannot be established, one could speculate about reasons for this, centering around changes in gender roles and the opportunity costs of women's time as a result of electrification, education, etc. What is clear is that affordability is not the only factor that shapes household choice of cooking fuel.

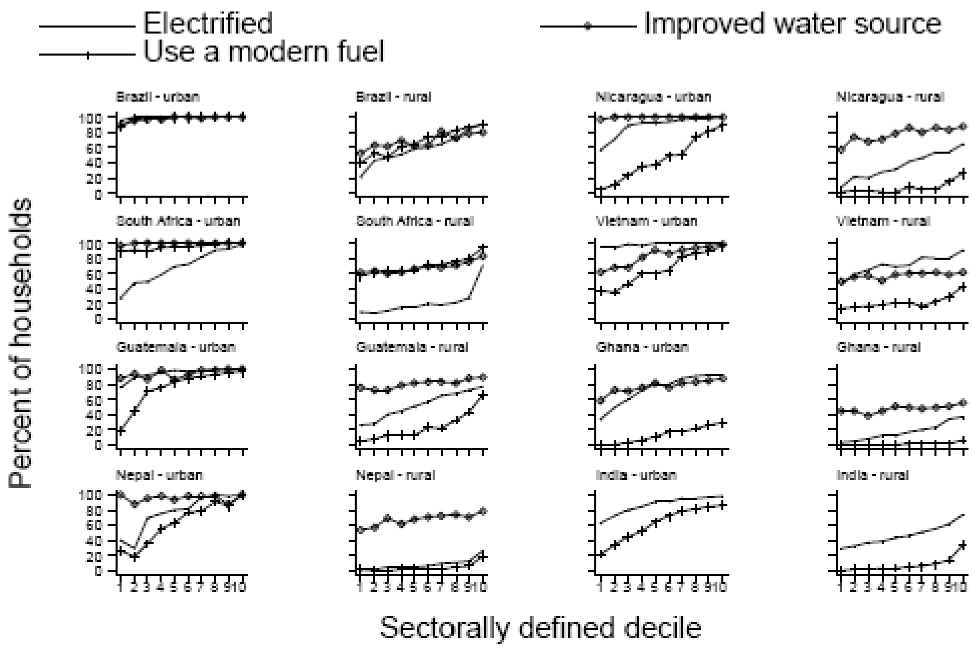
Electrification and access to clean water

Access to clean water is especially important for reducing women's work burden and to the ability to provide healthy and clean environment to families. In sub-Saharan Africa, a 1999 review of studies (Rosen and Vincent, 1999) showed an average per household of 134 minutes per day spent on water collection. Difficult access to clean water has implications not only for the time spent by women in collection, but for their ability to provide basic hygiene, cleanliness and health to their families.

In the multi-country ESMAP (2003) study described in the previous section, correlation was found between electrification and access to improved water supply in these eight countries.

Figure 3: Electrification, Use of Any Improved Water Source, and Modern Fuel Use by Country, Sector and Decile

Figure 8.2: Electrification, Use of Any Improved Water Source, and Modern Fuel Use by Country, Sector, and Decile



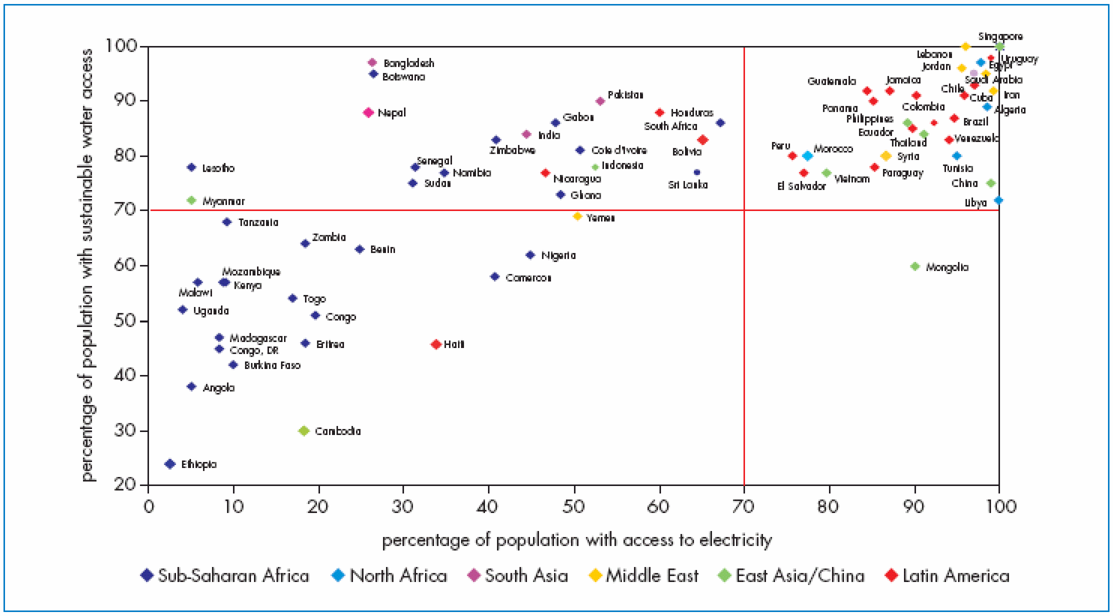
Note: Water source not available for India

Source: ESMAP, 2003.

Figure 4 from the IEA shows that the correlation of access to electricity with access to clean water is not always very clear in all countries though. The IEA analysis admits that among countries with high level of access to clean water, access to electricity varies enormously, and the figure also shows quite a bit of divergence among countries with low access. It would be useful to know whether this is the case due to the fact that electricity is not the main fuel used for pumping drinking water (rather diesel pumps, hand or animal pumps), or whether other factors are at play here concerning, for example, access to electricity for drinking water pumping as compared to its access for other services.

Figure 4: Electricity and Improved Water Access, 2002

Figure 10.5: Electricity and Improved Water Access*, 2002



* "Improved water access" is defined by the UN as the share of the population with reasonable access to any of the following types of water supply for drinking: household connections, public standpipes, boreholes, protected dug wells, protected springs and rainwater collection. "Reasonable access" is defined as the availability of at least 20 litres per person per day from a source within one kilometre of the user's dwelling.

An interesting question is whether electricity or water "lead the way" in infrastructure development. In a recent ground-breaking cross-country study on slum electrification in India, Brazil and South Africa, electricity often came first in sectoral development, with water and sanitation following. Households could take electricity connections off others much more easily than they could get clean water; slum-lords would provide access to illegal electric connections but not to water (Wendy Annecke, personal communication, and USAID, 2004).

The typical order of arrival of basic infrastructure services to poor people in the eight country ESMAP study was first electricity, then either tap water or a modern cooking fuel, depending on country. However if improved water sources outside of the household are included, in these countries improved water often arrives before electricity, particularly in rural areas. In any event, modern cooking fuels typically follow quite a bit later.

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The above studies show that access to modern energy does appear to correlate with some socio-economic indicators of particular importance to women. Energy access does appear to be linked with women's health, fertility, and even life expectancy, even apart from income. Fuel switching to modern cooking fuels, in a sample of eight countries, is linked at all income levels to access to other infrastructure services, including electrification, though causality cannot be demonstrated. Access to clean water is also associated with electrification, though the dimmer relationship between electrification and access to water shows however, that the direction of causality is not always clear, and there may be other factors involved.

4. Energy and Gender-Related Indices

Can gender-related indices be used to relate energy access with gender equity and empowerment? In 1995, the UN created two gender-related indices[11] that so far are the most used to classify countries based on their level of gender equity: The Gender-related Development Index (GDI), and the Gender Empowerment Index (GDI). Gender equity and empowerment are complex concepts that involve multiple qualitative and quantitative dimensions and an index will always have limitations.[12] Still, although data is not available for all countries, the GDI and the GEM can be plotted against per capita energy consumption to give some idea of whether there is any relationship at all.

Energy and the Gender-related Development Index (GDI)

The UNDP's GDI (Gender-related Development Index) measures the same variables as the HDI (life expectancy, literacy and gross enrolment, and income), except that the GDI adjusts for gender inequalities in the three aspects of human development. A comparison of country ranking by the HDI of a country and its ranking on the GDI shows the level of gender discrepancies in a country. GDI coverage is limited to 143 countries since not all UN member countries have sufficient data to calculate the index. No country has a GDI as high as its HDI, suggesting that all countries have a gender gap in at least one of its components (Bardhan and Klasen, 1999).

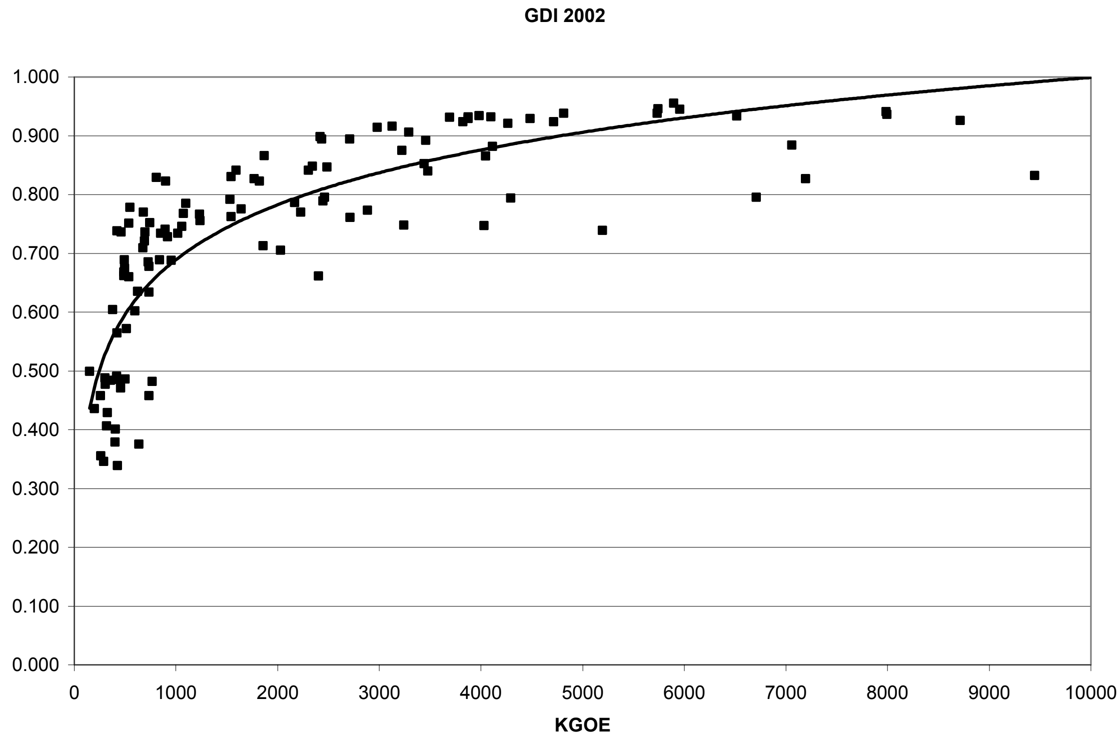
To show that gender equality does not depend on income, it is useful to compare relative rankings on the GDI and level of national income. For example, Peru with GDP per capita of $5,260 is ranked 67 in GDI, below the Philippines, with GDI of 63 and GDP per capita of $4,321. Italy is ranked 18th, Belgium 9th, and Iceland 2nd in GDI, even though all three countries have a per capita GDP of around $37,000.

Figure 5 shows the correlation between per capita energy consumption and GDI. The curve is not too dissimilar to that of HDI but is not identical.

[11] In addition to the well-known Human Development Index (HDI), and two Human Poverty Indices, HP-1 and HP-2. A specifically African GDI has been developed by the Economic Commission for Africa as a monitoring tool.

[12] Both GDI and GEM have been criticized on the one hand, for female bias; and on the other, for over-emphasising income and ignoring poverty, inequality and patriarchy as key elements: for an example of the latter critique, see e.g. R. S. Mathur, "Development of Gender Development Indices – Indian experience", Working Group of Statistical Experts, 11th Session Bangkok, 23-26 November 1999. Bardhan and Klasen (1999) critique the GDI on statistical grounds, i.e., it is largely driven by gaps in one component, the earned-income component, which is inconsistently applied to countries; while other indicators such as gender bias in mortality, are as or more significant aspects of gender bias in the developing world. The latter authors suggest that a limitation of the GEM is its focus on representation at the national government level and in the formal sectors of the economy, missing much of the participation and involvement of women at local political and administrative levels, in grassroots mobilization at the community level (including within political parties), and in many non-governmental organizations active in development.

Figure 5: Gender-related Development Index (GDI) versus per capita energy consumption (kgoe), 2002



Source: World Development Indicators, 2004; personal communication, Henry Lucas, IDS/Sussex. [Need to figure how to label with some countries]

It is important to note that gender equality rankings and HDI rankings are not the same, so that improving energy access will not automatically correlate with improved gender equity even if overall HDI does. Still, it does seem that the non-linear relationship between HDI and per capita energy consumption prevails for GDI as well. This would imply that small increases in energy consumption at low levels of GDI, are associated with relatively larger increases in gender equality. In other word, improvements in energy access in poor countries might benefit gender-related development disproportionately. This would make sense, from what we know about energy's contribution to women's "practical" needs of reducing work burden.

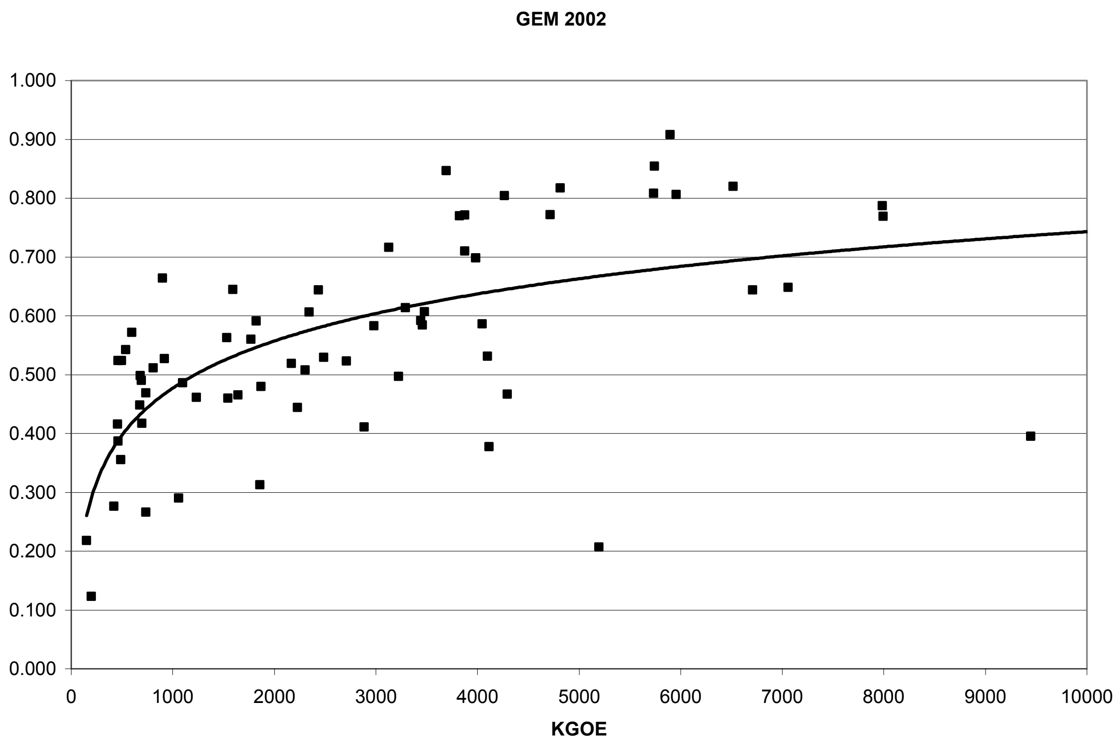
Energy and the Gender Empowerment Measure (GEM)

UNDP's Gender Empowerment Measure (GEM) measures gender inequality in economic and political spheres of activity. It is made up of economic participation and decision making (percent female administrators and managers, and professional and technical workers); political participation and decision making (percent seats in parliament held by women) and power over economic resources (women's estimated earned income). GEM attempts to measure not achievement in well-being, but equity in *agency*[13] (Bardhan and Klasen, 1999).

GEM diverges from GDP even more strongly than does GDI. For example:

• Poland ranks 24nd in the GEM, just behind Japan, in 23rd place, yet income per person in Poland is about one third that of Japan's ($9,051 vs. $26,755).
• The UK and Finland have very similar income per person ($23,509 and $24,996) yet in the GEM Finland ranks 5th, the UK 16th.

Figure 6: Gender Empowerment Measure (GEM) versus per capita energy consumption (kgoe), 2002



Source: World Development Indicators, 2004; personal communication, Henry Lucas, IDS/Sussex.

For GEM, the correlation with per capita energy consumption is not as strong as that of GDI, as shown in **Figure 6**. GEM also does not show a strong non-linear relationship, i.e., a small increase in energy availability is only weakly associated with an increase in gender empowerment. Women's empowerment likely depends much more strongly on other factors in addition to energy access, such as legal, social, and political frameworks. This would be in line with current thinking about women's "strategic" needs, i.e., for change in gender relations, agency and power as an explicit objective of policy.

[13] Agency can be defined as people's ability to make and act on their own strategic life choices, and to help determine the conditions under which these choices are made. Agency means actively exercising choice, and in ways that challenge power relations. Access to resources from a strong bargaining position is what makes it possible to actually achieve good outcomes with agency.

5. A Gender-Energy-Poverty Index

Neither GDI nor GEM address energy vulnerability directly. Can we apply an index at the global level, to identify gender-energy-poverty vulnerable regions where the Gender-related Development Index, the Energy Development Index, and the Human Development Index are all low; as well as not very vulnerable areas where the GDI, EDI and HDI are high? Other regions would fall in-between.

This concept draws on an analysis of inter-relationships between gender, poverty and *environmental* change in rural India by Bina Agarwal (1995). Agarwal specified a GEP index, for measuring gender-environment-poverty vulnerability, and focused on variations in this index across regions and shifts over time during the previous two decades. She found a number of class-gender effects such as an increase among poor households in women's and female children's time and energy spent in fuel, fodder and water collection; a decrease in women's incomes from non-timber forest products and agriculture; and an adverse effect on the health and nutrition of household members in general, and female members in particular. These effects varied in form and in intensity across India, due to geographic differences in gender bias, in environmental risk, and in poverty incidence. Importantly, the Agarwal index showed that "rural women are worst off in regions where all three forms of disadvantage are strong and reinforce each other, as in many parts of northern India, and especially Bihar. They are best-off where all three types of disadvantage are weak, as in southern and northeast India, and especially Kerala."

Table 6 performs a similar analysis focusing on energy, rather than environment. It makes use of the well-known UN indices for human development to measure poverty[14] and gender development to measure gender equality, as well as the new IEA index for energy access. GDI, EDI and HDI are given for the 57 countries for which all three indices were available, and their rankings within each indicator.[15] A simple composite GEP indicator is developed by adding the three indicators together, and countries are then ranked by GEP. This produces some interesting observations.

First, some countries clearly rank low for all three indicators; in some poor countries such as Mozambique and Ethiopia, gender-energy-poverty vulnerability is high and women are likely to be the worst off, where all three types of disadvantage reinforce one another. As Agarwal asserts for similar regions in India, these countries probably warrant special attention in terms of schemes which give poor women greater control over economic resources in general, and – in this case - energy resources in particular. Women's active participation in energy development will be especially important not only for improving

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[14] It could be argued that HP-1 or HP-2 would be better indices of poverty, but these are not available for all countries.

[15] These rankings cannot be compared directly with the UN rankings for GDI and for HDI, because these include only the 57 countries for which data was available for all three indicators, not the full 175 UN countries. Oil-rich countries are also excluded.

Table 6: Gender-Energy-Poverty (GEP) Index in 57 Countries

Country	GDI	Rank	EDI	Rank	HDI	Rank	GEP	Rank
Costa Rica	0.823	8	0.896	3	0.995	1	2.714	**1**
Israel	0.906	1	0.773	7	0.908	2	2.587	**4**
Singapore	0.884	2	0.608	23	0.902	3	2.394	**5**
Argentina	0.841	3	0.698	12	0.853	5	2.392	**6**
Trinidad&Tobago	0.795	9	0.728	9	0.801	9	2.324	**8**
Uruguay	0.829	6	0.640	18	0.833	8	2.302	**10**
Malaysia	0.786	10	0.711	11	0.793	10	2.290	**11**
Iran	0.713	28	0.834	5	0.732	27	2.279	**12**
Venezuela	0.770	12	0.716	10	0.778	12	2.264	**13**
Tunisia	0.734	24	0.772	8	0.745	22	2.251	**14**
Brazil	0.768	14	0.609	22	0.867	4	2.244	**15**
Algeria	0.841	4	0.693	13	0.704	29	2.238	**16**
Thailand	0.766	15	0.677	17	0.768	16	2.211	**17**
Lebanon	0.755	16	0.683	15	0.758	17	2.196	**18**
Jordan	0.734	25	0.686	14	0.750	21	2.170	**19**
Panama	0.785	11	0.589	26	0.791	11	2.165	**20**
Colombia	0.770	13	0.609	21	0.773	13	2.152	**21**
Philippines	0.751	17	0.594	25	0.753	18	2.098	**22**
Ecuador	0.721	27	0.635	19	0.735	26	2.091	**23**
China	0.741	19	0.603	24	0.745	23	2.089	**24**
Dom. Rep.	0.728	26	0.617	20	0.738	25	2.083	**25**
Paraguay	0.736	22	0.541	29	0.751	20	2.028	**26**
Peru	0.736	23	0.532	31	0.752	19	2.020	**27**
Egypt	0.634	37	0.679	16	0.653	36	1.966	**28**
El Salvador	0.709	29	0.489	32	0.720	28	1.918	**29**
South Africa	0.661	34	0.588	28	0.666	35	1.915	**30**
Bolivia	0.674	32	0.538	30	0.681	32	1.893	**31**
Sri Lanka	0.738	21	0.409	37	0.740	24	1.887	**32**
Morocco	0.604	38	0.589	27	0.620	38	1.813	**33**
Indonesia	0.685	31	0.412	36	0.692	30	1.789	**34**
Vietnam	0.689	30	0.409	38	0.691	31	1.789	**35**
Honduras	0.662	33	0.420	34	0.672	33	1.754	**36**
Guatemala	0.635	36	0.458	33	0.649	37	1.742	**37**
Nicaragua	0.660	35	0.326	41	0.667	34	1.653	**38**
Namibia	0.602	39	0.414	35	0.607	39	1.623	**39**
India	0.572	40	0.332	40	0.595	40	1.499	**40**
Ghana	0.564	41	0.304	42	0.568	41	1.436	**41**
Pakistan	0.471	50	0.387	39	0.497	46	1.355	**42**
Bangla Desh	0.499	42	0.267	45	0.509	42	1.275	**43**
Cameroon	0.491	43	0.253	46	0.501	45	1.245	**44**
Zimbabwe	0.482	48	0.251	47	0.491	49	1.224	**45**
Sudan	0.485	46	0.229	50	0.505	43	1.219	**46**

Haiti	0.458	51	0.244	48	0.463	52	1.165	**47**
Nigeria	0.458	52	0.238	49	0.466	51	1.162	**48**
Togo	0.477	49	0.176	54	0.495	47	1.148	**49**
Senegal	0.429	53	0.280	44	0.437	53	1.146	**50**
Nepal	0.484	47	0.131	55	0.504	44	1.119	**51**
Kenya	0.486	45	0.124	56	0.488	50	1.098	**52**
Ivory Coast	0.379	55	0.290	43	0.399	55	1.068	**53**
Congo	0.355	57	0.189	52	0.494	48	1.038	**54**
Benin	0.406	54	0.205	51	0.421	54	1.032	**55**
DR of Congo	0.488	44	0.118	57	0.365	57	0.971	**56**
Zambia	0.375	56	0.179	53	0.389	56	0.943	**57**
Mozambique	0.339	59	0.107	58	0.354	59	0.800	**58**
Ethiopia	0.346	58	0.037	59	0.359	58	0.742	**59**

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Source: Calculated from IEA, 2004; World Development Indicators 2004.

family welfare but for ensuring the success of energy interventions and meeting gender equality goals in these countries.

Second, some countries such as Costa Rica, Malaysia and Tunisia rank relatively high for all three indicators, and needs for intervention may not be as pressing – though one must remember that the sample only includes developing countries and traditional biomass fuel use in cooking may still be widespread in spite of high rates of rural electrification and the availability of fossil fuels.[16]

It is apparent that gender-energy-poverty vulnerability often varies from HDI and in some countries HDI may not reflect the urgency of gender-energy problems. For example, Sudan, Togo, Kenya, and Congo have considerably lower rankings for GEP than for HDI, possibly indicating that the gender-energy situation needs urgent attention. Differences in policy in these countries may account for the differences, despite similar incomes to others in the region.

[16] In Tunisia, for example, though energy access is rated high and rural electrification is approaching 100%, it is not uncommon to observe women cooking on open fires outside fully electrified homes.

6. A gender perspective in statistical analyses of energy and development?

This paper has reviewed global statistical comparisons and analyses of linkages between energy and development, from a gender perspective. Strong correlations have been found in global analyses between per capita energy consumption and the UN Human Development Index indicators, but differential indicators for women and men have not been used in these. Examining access to energy and some development indicators of special importance to women shows a number of positive correlations. Since women are the main cooks and providers of fuelwood, estimates of the effects of traditional fuel use on socio-economic indicators are of special concern. These include respiratory health effects but probably others related to the biomass fuel cycle as well, that show significant positive statistical relationships globally with infant and child mortality, life expectancy, and fertility. On the other hand, use of modern cooking fuels is found to correlate with access to other infrastruture such as education and electrification. Electrification has an impact on clean water access as well, another primary concern of women. A major gap in global correlations between energy and socio-economic indicators of relevance to women's welfare, is in the area of energy and food/agricultural processing, where no global studies were found.

Good data on energy use by households that would permit more detailed analysis of linkages among gender, energy, and development indicators are limited. Gender bias has been suggested as one reason for lack of attention to household energy (Cecelski, 2004). Indeed, the amount and quality of energy information collected by standard national surveys is small, compared to the detailed questions on other aspects of household welfare such as education, water, santitation, and health, the ESMAP (2003) multicountry study concluded. It proposed two key indicators for household energy: first, the rate of household electrification, and second, household adoption of modern cooking fuels. Both of these are judged feasible to measure and compile from household surveys for a substantial number of countries, and suitable for official adoption as quantitative development targets to draw more attention to household energy among governments, civil society, development practitioners, and academics. We can only second that recommendation here.

However not only data collection on energy in households is necessary; the relevant indicators need to be available by gender if the impact on gender relations and empowerment is to be shown. Future research needs to better understand the gendered nature of energy and economic growth and human well-being in terms of choices about energy end-uses and economic development paths. The relationships among gender relations and differences in opportunities and agency for men and women, and access to energy sources, especially modern cooking fuels, need to be explored. Global correlations with socio-economic indicators are not enough, and better "stories" with empirical support at the national and field level are required in order to explain causation and suggest more effective intervention strategies.

An examination of correlation between the UN Gender-related Development Index (GDI) and per capita energy consumption shows that a close relationship exists, and that small increases in energy access in low income countries are associated with larger increases in gender related development. Energy access is not necessarily associated with gender empowerment, though, as shown by the weaker correlations between energy and the UN Gender Empowerment Measure (GEM), where legal, social and policy frameworks are likely to be more important in transforming gender relations and empowerment. It might be of interest to experiment with relationships with other indices and indicators, for example, substituting HP-1 for HDI; or testing the correlations of biomass energy use or per cent electrification wiwth GDI and GEM. Also, how does energy access compare with that to clean water or transport, in terms of a linkage with GDI and GEM?

A Gender-Energy-Poverty (GEP) Index, based on data for 57 countries, has been developed here as a possible tool for identifying priority countries especially in need of a gender perspective on energy interventions, and of action on energy as a way to reduce poverty for both women and men. It shows possible "hot spots" for priority attention to women's energy needs, in Africa and South Asia.

Such an index is no substitute for the routine disaggregation of linkages and effects by women and men, girls and boys, in data collection and analysis, however. Some guiding principles for gender-sensitive energy research are given in **Annex 1**, as developed under another part of this research project. Global studies are dependent on national and project level data. Today in the 21st century, it should no longer be necessary to justify the need for collection of gender based data.

Bibliography

Agarwal, B. (1995), "Gender, environment and poverty interlinks in rural India: Regional variations and temporal shifts, 1971-1991," Discussion Paper 62, United Nations Research Institute for Social Development (UNRISD), Geneva.

Bardhan, K. and Kalpana, S. (1999), "UNDP's Gender-Related Indices: A Critical Review," *World Development* Vol. 27, No. 6, pp. 985-1010.

Barnes, D.F., Krutilla, K. and Hyde, W.F. (2005), *The Urban Household Energy Transition: Social and environmental impacts in the developing world*, Resources for the Future/ESMAP, Washington, DC.

Barnett, A. (2000), "Energy and the fight against poverty," Lecture at the Institute of Social Studies, The Hague.

Cecelski, E. (1995), "From Rio to Beijing: Engendering energy policy," in *Energy Policy* 1995 Vol 23 No 6, pp 561-575.

Cecelski, E. (2004), "Re-thinking gender and energy: Old directions, new directions," ENERGIA/EASE Discussion Paper, ETC, Leusden.

Clancy, J., Skutsch, M. and Batchelor, S. (2003), "The gender-energy-poverty nexus: Can we find the energy to address energy concerns in development", Report to DfID, University of Twente, The Netherlands.

Dasgupta, S., Huq. M., Khaliquzzaman, M., Pandey, K. and Wheeler, D. (2004), "Who suffers from indoor air pollution: Evidence from Bangladesh," Development Research Group, World Bank, Washington, DC.

Department for International Development (2002), United Kingdom, *Energy for the Poor: Underpinning the Millennium Development Goals,* DfID, London.

Energy Sector Management Assistance Programme (ESMAP) (2003), "Household Energy Use in Developing Countries: A Multicountry Study," ESMAP Technical Paper 042, World Bank, Washington, DC.

Ezzati, M. and Kammen, D.M. (2002), "The health impacts of exposure to indoor air pollution from solid fuels in developing countries: Knowledge, gaps, and data needs," *Environmental Health Perspectives* (11:1) pp. 1057-1068.

International Energy Agency (IEA) (2004), *World Energy Outlook 2004*, OECD/IEA, Paris.

Mathur, R.S. (1999), "Development of gender development indices – Indian experience," Working Group of Statistical Experts, 11th Session, Bangkok, 23-26 November 1999.

Modi, V. (2004), “Energy services for the poor”, Commissioned paper for the Millennium Project Task Force 1, Draft November 9, 2004, Earth Institute and Department of Mechanical Engineering, Columbia University, New York.

Nathans, Dev, Email of 15 August, 2005, Peer review of Empirical review of evidence on gender/energy and MDG linkages.

Parikh, J. (1995**),** “Gender issues in energy policy,” *Energy Policy* (23:No. 9) pp.745 - 754.

Rosen, S. and Vincent, J.R. (1999), “Household water resources and rural productivity in Sub-Saharan Africa: A review of the evidence,” Development Discussion Paper No. 673, Harvard Institute for International Development, Harvard University.

United Nations Development Program (UNDP) (2004a), *Gender and Energy for Sustainable Development: A Toolkit and Resource Guide,* UNDP, New York.

United Nations Development Program (UNDP) (2004b), *Human Development Report 2004*, UNDP, New York.

United Nations Development Program (UNDP), United Nations Department of Economic and Social Affairs (UNDESA), and World Energy Council (WEC) (2000), *World Energy Assessment: Energy and the challenge of sustainability*, UNDP, New York.

United Nations Millennium Development Project (2005), *Investing in Development: A practical plan to achieve the Millennium Development Goals*, Report to the UN Secretary-General, UNDP, New York.

UN Millennium Project Task Force on Education and Gender Equality (2005), *Taking Action: Achieving gender equality and empowering women*, Report to the UN Secretary-General, Earthscan, London.

USAID, Innovative *Approaches to Slum Electrification*, Bureau for Economic Growth, Agriculture, and Trade, USAID, Washington, DC, December 2004.

World Bank (2005), *World Development Indicators 2005*, World Bank, Washington, DC.

Zaidi, A.K.M. and Bloom, D. (2004), “The demographic impact of biomass fuel use,” Department of Population and International Health, Harvard School of Public Health, Boston.

Annex 1 Guiding principles for gender and energy research

The absence of an accepted framework for gender and energy research and analysis has been noted in several fora (Cecelski, 1995; Clancy, Skutsch and Batchelor, 2001; IDS, 2003). There are several guiding principles for gender and energy research that can be proposed, based on recent gender and poverty thinking:

1. *Gender should be treated as a separate category of analysis, not as a subset of poverty.* While it is true that the majority of the poor are women, gender inequalities are due to the subordination of women, not to poverty (though they may be intensified by poverty). Specific gender analysis is needed therefore.

2. *Gender analysis methods should be used systematically not incidentally.* Both participatory and quantitative methods can be useful, but gender critiques of both of these need to be taken into account. Researchers at all levels need to be capable of using and interpreting gender analysis, and basic principles of gender-sensitive research (e.g. interviewing women as well as men, use of female as well as male enumerators) need to be followed.

3. *Gender analysis should go beyond women's practical welfare needs and project efficiency concerns, and address women's strategic needs and the transformation of gender relations.* The gender division of labour, access to and control over resources and benefits may be the starting point for research on women's practical needs. But women's strategic needs and the potential for transformation in gender relations should also be addressed.

4. *Women should not be treated as a homogeneous category*, rather differences in age, race, ethnicity, labour command, and income should be used to identify different groups that experience poverty (and wealth) differently, for policy intervention.

5. *A bargaining model of the household should be assumed*, rather than a unitary model with identical interests. Both conflict and cooperation can be important forces within the household.

6. *Gender relations as well as roles should be analysed*: property relations, social relations, labour relations, decision-making relations (at household, community, national levels).

Source: Cecelski, 2003.