Energy, Poverty, and Gender

A Review of the Evidence and Case Studies in Rural China

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Preface

This report was carried out under contract to the World Bank's ASTAE program with funding from the Government of the Netherlands.

The project has taken place in four phases:

- A wide-ranging review of existing material relating to the links between energy, poverty and gender was undertaken. This review included proposals as to the components of a general framework for research and analysis.
- The review was used as a basis for the development of specific plans and instruments for fieldwork in China.
- Gender-balanced teams of Chinese and European researchers in two provinces undertook fieldwork.
- The findings of the fieldwork were summarized and combined with a revised version of the initial review.

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Comments on earlier stages of the work have been received from a panel of reviewers and these have been considered in the preparation of this final report; however any errors or omissions that remain are the responsibility of the main authors alone.

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Acronyms and Abbreviations

ASTAE	Asia Alternative Energy Program of The World Bank
CRED	Centre for Renewable Energy Development
CREIA	China Renewable Energy Industry Association
DFID	Department for International Development (U.K.)
ETC	ETC Energy
ESMAP	UNDP/World Bank Energy Sector Management Assistance Programme
GDP	Gross domestic product
GEF	Global Environment Facility
GNEI	Gansu Natural Energy Institute
GNP	Gross National Product
GTZ	Deutsche Gesellschaft für Zusammenarbeit
hh	Household
IDS	Institute of Development Studies
LGPR	Leading Group for Poverty Reduction
NRECA	National Rural Electric Cooperative Association
NGO	Nongovernmental organization
OED	Operations Evaluation Department (World Bank)
OECD	Organisation for Economic Co-operation and Development
PAO	Poverty Alleviation Office
PRSP	Poverty Reduction Strategy Paper
PV	Photovoltaic
SETC	State Economic and Trade Commission
SL	Sustainable Livelihoods
tce	Ton coal equivalent
UNDP	United Nations Development Programme
WDR	World Development Report
WEC	World Energy Council

Units of Measure

1 mu	0.07 hectares
1 jin	0.5 kg

Currency Equivalents

1 yuan (¥ 1)	US$0.12

Executive Summary

This study is one of a number undertaken to "identify the linkages between access to energy-electricity, poverty alleviation and gender equity." Related exercises were undertaken linked to fieldwork in Indonesia and Sri Lanka. Based on an extensive review of existing documentation and evidence from fieldwork in the People's Republic of China, general conclusions are drawn about "the lessons learned that may improve the impact of projects of the World Bank and the Asia Alternative Energy Programme (ASTAE) on poverty alleviation and gender equity in China and possibly in other countries."[1]

The first section of the report is based on the above-mentioned review. Following it is a general discussion of current approaches to poverty and gender issues, existing evidence on links between energy, poverty, and gender. The discussion centers on the "vicious circle" of energy poverty: The inability to buy improved energy supplies or equipment results in low productivity, low quality of outputs and an inability to release reproductive[2] labor for economic activity, leading to low returns to investment and labor inputs, again limiting possibilities for energy investments.

The discussion of gender in the report takes as its starting point the empirical fact that women and children form not only the majority of poor people in most communities in developing countries, but are universally the major users and suppliers of energy resources in marginalized households. Women (together with their children) collect much of the biomass, and women manage most of the energy used by poor households. It is argued that a focus on productive, often male-dominated energy services, has neglected the complementary nature of productive and reproductive activities in rural households and leads to interventions that are not only gender-biased, but also less effective in terms of poverty reduction.

The review underlines the methodological difficulties of establishing rigorous quantitative relationship between energy inputs and poverty-gender outputs at the project level. This is particularly so in the absence of time series data and the large volumes of data necessary for a general equilibrium approach. However there would appear to be clear and long-standing "associations" between energy and human well-being at the macro level of whole countries.

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[1] Terms of Reference; see appendix 1.

[2] The human resources and labor time required to enable households to reproduce themselves both between generations and on a daily basis.

The review confirms the following:

- The impact on poverty and gender relations of energy interventions are strongly affected by "complementary inputs" such that the "bundling" of a number of interventions, together with improved energy services, appears to have more than proportionate effect.
- The choice of energy end-use technology plays a large part in determining, the nature, scale and distribution (between women and men) of energy interventions.
- The patterns of impacts of energy interventions are often complex, involving both direct and indirect linkages to the reduction of poverty of women and men.
- The vicious circle of energy poverty will often be broken only by combining improved energy services with end uses that generate cash income.

Among the specifically gender-related issues, the report notes the following:

- Disaggregated data (for example, on needs, uses, and technologies,.) are of considerable importance because the different and unequal roles in the division of labor mean that women and men have different needs and priorities, and these are reflected in their different energy needs.
- Given the importance of energy end use in determining impact, women's energy needs will not be met until they have a "voice" in determining options and priorities.
- In order to improve women's access to the energy services they need, programs will need to address their unequal access to the necessary "livelihood assets," including credit, extension, and training.

The insights gained from the review are related mainly to a perspective rather than some finite set of energy-poverty-gender linkages. There is not likely to be a set of rules or fixed input-output relationships that provide a "magic bullet" to solve energy poverty. There is a new situation in which poverty reduction is seen as the main objective of development and agencies no longer consider huge "energy sector loans" as part of their arsenal. The key to the new situation is the need to increase awareness across the development community that energy interventions may have an important role in removing potentially binding constraints on poverty reduction strategies. The primary concern must be that at present energy issues are often not even considered when policy is being formulated.

A number of possible analytical frameworks for the exploration of energy, poverty and gender links are considered in the review. It is proposed that the most appropriate course of action would be to build on two existing frameworks, the Sustainable Livelihoods (SL) approach and the Poverty Reduction Strategy Papers (PSRP). In practice these exhibit considerable convergence. However, it is pointed out that both are still under development and do not yet deal adequately with either energy or gender.

The report extends these approaches and contributes insights that are specific to energy systems and recent changes in the institutional arrangements characterizing the energy sectors of developing countries. Proposals are made as to the areas that need to be considered in the development of a general framework through which poverty, gender and energy linkages can be viewed.

In the second section of this report, a simplified version of this framework is used to select and record empirical evidence on the nature of these linkages in the Peoples' Republic of China. Field research was conducted in selected poor rural counties in two Chinese Provinces, Gansu and Hubei. This was based around a series of case studies, using both qualitative and quantitative methods.

In considering the findings of this fieldwork it must be emphasized that China is in many respects a special case:

- The sheer size of the population has implications for data interpretation. For example, although only a very small proportion of people now rely on batteries or small diesel generators for electricity, they amount to a population of some 77 million people in 30,000 villages.
- China has experienced exceptional economic growth during the last two decades, associated in part with an astonishing growth of "Township and Village Enterprises" that have bought relative prosperity to many rural areas.
- There has been a strong commitment to poverty reduction (in the traditional sense of reducing the number of people with incomes below the poverty line) with the result that there are effective institutions and delivery mechanisms not available in many other developing countries.
- Approximately 96 percent of villages and 94 percent of households are reportedly served by large or small electricity grid systems, leading to a strong sense of exclusion for people who do not have access.
- The political and administrative system is unlike that in any other country and is constantly evolving. The distinction between "private" and "public" sectors is often difficult to determine.
- The country is in many respects highly decentralized. Provincial and county governments are largely self-financing and have a great deal of autonomy. Central government may issue policy directives and provide financial support, but the nature and extent of policy implementation will often be determined locally.

Again, although the study areas in Gansu and Hubei provide important insights into the relationship between energy, gender, and poverty in China, it is evident that they represent only a part of the varied reality in China. It should also be noted that in the two years prior to the field research, both areas had suffered from serious periods of drought that had a major detrimental effect on their largely agricultural economies.

Allowing for the above, the analytical framework, and the associated empirical work, suggest the following:

- Electric lighting is of great importance for promoting social inclusion, well-being, and social capital in China. Lack of electricity is viewed as an indicator of extreme poverty. This has implications for the sustainability of poor rural communities in that it encourages out-migration and adversely affects the marriage eligibility of men who choose to remain in villages without access to electricity.
- A general view is that the major impact of electricity on livelihoods arises from its capacity to reduce general workloads and lengthen the working day, thereby increasing the possibilities for diversification of activities. Electricity is used for smaller domestic equipment and viewed mainly as a consumption item. Its importance lies in its less tangible benefits, allowing women to do tasks in the evening, allowing children to do their homework and read after dark, and providing access to television.
- There are direct impacts of energy services on production. A clear correlation exists between powered production and transport equipment and living standards. Diesel is the primary fuel associated with production activities.
- Electricity does not seem to have made serious inroads into the time spent by women on onerous and health harming reproductive tasks. Women tend to identify the labor they have to expend on human-energy-intensive basic reproductive tasks, especially fuel gathering and water carrying, as one of the main characteristics of a life spent in poverty.
- There is little evidence from any of the villages that women have an effective input to decisions on equipment purchases. They report that expenditure on the purchase of items that reduced reproductive toil would always come second to productive expenditures that will generate income.
- The links between productive and reproductive activities are complex. For example, temporary out-migration is an important livelihood strategy that in some cases is only possible where improvements in women's access to energy services allow them to take on greater workloads, releasing their male family members to seek work outside the village.
- Richer (often salaried) people obtain and then hire out end use devices at what appear to be relatively low prices.
- Attempts to introduce ad hoc energy services, such as photovoltaic (PV) home systems, have often failed. This is partly a function of remoteness, but more fundamentally because the delivery of spare parts and maintenance is not embedded in a proper system of "intermediation."
- Energy services have numerous indirect impacts on poverty and gender. Perhaps one of the most important is that relating to irrigation pumping. This can clearly

greatly reduce vulnerability to drought. However, dependence on powered irrigation systems has attendant risks, both in term of possible technical failures (expenditure on maintenance may be very limited in poorer regions) and because poor households may have little influence at times when there are competing demands for water resources.

At a more general level, it was found that:

- Research based on a sustainable livelihood approach worked well in generating a rich set of insights about the energy situation in Western China, and its gender dimension.
- There are multiple interactions and synergies between energy inputs and the other complementary inputs associated with poverty reduction. Energy provides a necessary but not sufficient (enabling) input, probably in the same way as other infrastructure services, such as water supplies, education, and health.
- There are two distinct perspectives to consider in assessing the role of energy services in poverty reduction in China. Although there may be instances in which it is reasonable to ask about the impact of energy interventions, a more appropriate question will typically relate to the potential for improving other interventions by a more energy-sensitive approach.
- Where, as in China, access to electric lighting and communications becomes commonplace, even among poor communities, the sense of exclusion of those people who do not have access may imply that lack of access can reasonably be defined as a component of the newer, multidimensional view of poverty.

Although only a small proportion of Chinese people are without access to modern energy services, the absolute numbers are large and are concentrated in the more remote areas. Remoteness increases the costs of all energy supply options, but not all options equally. Clearly those with low fuel transport costs are likely to be favored (for example, microhydro, wind, biogas, PV, and so forth). However the example of PV systems suggests that the distance-related costs of installation, maintenance, and spare parts can be severe. Lack of integration with the external market, because of remoteness and lack of transport infrastructure, severely limits the range of income generating options (and technology supply options) necessary to break the cycle of energy poverty.

Section 1:
A Review of Energy, Poverty, and Gender Links

1 Introduction

There was a time when it was taken for granted that "development" required energy. Indeed the history of the European Industrial Revolution is inextricably linked with increasing access to more convenient and cheaper sources of energy. But in recent times energy has fallen off the agenda of mainstream development thinking and action. For example, World Bank lending to the energy (mainly electricity) sector has declined rapidly from being one of the largest programs in the 1980s to one of the smallest in 2002. This is partly as a result of refocusing on sector reform, and partly on the related assumption that the private sector would provide the bulk of the finance to the sector. Many other financial institutions have adopted similar approaches.
This review addresses these issues, not with the intention of raising the energy sector to its "former glory," but rather with the intention of understanding the following:

- How poverty reduction strategies will be more effective if they are both energy- and gender-sensitive.
- How particular energy interventions can be designed to have a larger impact on poverty by considering the role of gender.

The review is intended primarily for nonenergy specialists who have an interest in understanding the role energy plays in reducing poverty and its importance in the lives of poor women.

The review begins with chapter 2, which considers why energy issues appear to have fallen so far down the development agenda in recent times and examines some of the evidence as to whether this decline is justified in terms of the current concern with poverty reduction. It also reviews the arguments for a detailed gendered analysis of energy-poverty links and considers how such an analysis might contribute to the development of an analytical framework.

Chapter 3 illustrates the pervasiveness of energy in the lives of poor women and men and considers recent developments in the debate around energy supply systems. The initial discussion centers on the "vicious circle" of energy poverty. The inability to buy improved energy supplies or equipment results in low productivity, low quality of outputs, and an inability to release reproductive labor for economic activity. These in turn lead to low returns to investment and labor inputs, again limiting possibilities for energy investments. Breaking out of this circle implies finding improved energy services that generate cash incomes allowing a "virtuous circle."

One key starting point for this discussion is the observation that women and children form not only the majority of poor people in most communities in developing countries, but they are the major users and suppliers of energy resources in marginalized

communities. Women and children of poor households collect much of the biomass used by households, and women manage most of the energy used by households.[3]

Chapter 4 considers the appropriate methodology framework for studies on the links between energy, poverty, and gender. In recent times, much of the debate on poverty reduction has focused around two main analytical frameworks. These can be broadly identified with work on Sustainable Livelihoods and Poverty Reduction Strategy Papers. This chapter outlines the main features of these two approaches and considers their relevance to energy issues. An initial synthesis is attempted and a general framework for future research suggested.

Finally, chapter 5, attempts to summarize what we know and what we do not know about energy, poverty, and gender linkages.

[3] Unusually, in the case studies in China, which form the accompanying section of this report, the task of collecting firewood appears to fall largely to men.

2 Energy, Poverty, and Gender: An Overview

This chapter will begin by considering why energy issues appear to have fallen so far down the development agenda in recent times. It will then examine some of the evidence, both at the macroeconomic and project levels, as to whether this decline was justified in terms of the current concern with poverty reduction. Finally, it will review the arguments for a detailed gendered analysis of the energy-poverty links and consider how such an analysis might contribute to the development of an analytical framework.

Energy and the Current Development Agenda: The Historical Context

From the 1950s until relatively recent times, increased energy production and consumption was accepted as integral to the development process. Economic growth was seen as the engine of development and it was taken for granted that growth in output implied growth in energy inputs. In particular, increased generation and distribution of electricity were regarded by many as essential components of modernization. In Bangladesh, for example, rural electrification was seen as so crucial that it was written into the constitution (*Constitution of the People's Republic of Bangladesh* 1996, Clause 16).

The concern with energy issues was reflected in the considerable share of development assistance provided for energy projects, particularly to expand the capacity of electricity generation. During the Cold War, donor funding of dams or other large-scale generating plants had the major additional advantage of providing highly tangible symbols of strategic political alliances. The situation has now changed radically. Donor funding to the energy sector has declined substantially in recent years and the major international development debates in the post Cold War environment seldom mention energy at all.[4] It

[4] The World Bank's recent *World Development Report* on poverty (World Bank 2000) has no mention of energy. Despite publishing a large amount of material on energy and development, and undertaking significant research on energy and poverty, this does not appear to be reflected in the core of the World Bank's business. Similarly the United Kingdom's Department for International Development is developing a "Livelihood Approach" to development, but it contains no mention of energy, and their "Target Strategy Papers" contain only passing references to energy. A glance at some of the leading develop research institutions, such as the Institute of Development Studies and the Overseas Development Institute in the United Kingdom, and a number of similar institutions in Europe shows that they do almost no work on any aspect of energy and development.

can be argued that the gradual shift in focus from growth to poverty reduction as the overriding development concern for donor agencies is a major explanatory factor for this decline.

Changing Development Priorities

In the 1950s, when modernization, which to many economists meant industrialization, was the primary objective, the importance of the energy sector was almost self-evident. The gradual recognition in the following decade that agriculture was not a backward sector that could be ignored, but was fundamental to growth in most countries, resulted in a shift of emphasis in terms of energy strategy but did not diminish its importance. Integrated rural development projects almost always included a major energy component, often in the form of rural electrification. Energy issues remained central to the growth agenda, which was the primary policy focus. Poverty was mainly regarded as a human or social development issue, to be addressed through poverty alleviation projects implemented by ministries of labor or social development.

The "Redistribution-with-Growth" paradigm of the early 1970s attempted to bring issues of income and wealth distribution into the debate around growth strategies. It argued that a more integrated approach to growth and public investment that included all sectors and recognition of the distributional implications of alternative strategies, could achieve a synergy between growth and a more equitable distribution of benefits. In the late 1970s, poverty issues were more directly addressed by the "Basic Human Needs" approach, which urged, in language often mirroring current discussions, that ensuring an acceptable level of living to all members of society, including the poorest, should be the primary task of any government. Growth, it was asserted, should be seen as a means to achieve this objective, not an end in itself.

Whatever the merits of these arguments, they were largely swept away in the 1980s with the debt crises and the resurgence of neo-liberalism. Economic growth was once again very much center stage. Short run financial stabilization and longer-term structural adjustment policies dominated the agenda. Debates on poverty reduction revolved mainly around the possible consequences of stabilization (particularly in terms of reduced public expenditures), the extent to which adjustment policies promoted growth, and whether that growth had a direct impact on poverty.

The 1990s brought a gradual acceptance that it was not sufficient, even in growth terms, to focus exclusively on economic issues. Many countries that appeared to have got the macroeconomic fundamentals right, including those following standard IMF prescriptions relating to public expenditure, deregulation, exchange rates, and improving revenue collection, were not experiencing the expected returns in terms of growth rates. It was certainly evident that the measures followed were not translating into poverty reduction. Multilateral donors were put under pressure to justify their existence and come up with a coherent aid strategy, particularly given the increasing evidence of the wastage of money on ineffective projects.

In recent years, there has also been a fundamental shift in the aid agenda in response to the end of the Cold War. Now that development assistance cannot be readily justified in terms of support for strategic alliances, the case has to be argued on other grounds. Basic humanitarian concerns are the most frequently cited. It is simply seen as intolerable that such a large proportion of the world's population lives in conditions of desperate poverty, lacking what would be regarded as the most essential elements of a reasonable life. This position is sometimes reinforced by reference to the implications of large-scale poverty for social stability, particularly in terms of the costs of social instability and the potential effects of poverty-induced large-scale migration. It is also possible to argue that there are considerable potential benefits for industrial countries if developing country growth leads to an expanded global market in goods and services. Whatever the merits of these positions, they do not appear to have reversed the steady decline in aid funding experienced in the 1980s. All major donors reduced aid relative to their GNP between 1991 and 1997 (World Bank 1998a), and total DAC aid declined by one-third.

The humanitarian argument naturally focuses attention on the needs of the poorest. The 1998 agreement on Core Indicators for the OECD Development Assistance Committee (OECD Development Assistance Committee 1998) identified the key target indicator of economic well-being as "Reduce extreme poverty by half." The primary growth indicator, GNP per capita, was listed among "other selected indicators of development." The priority given to extreme poverty reduction creates a much more complex environment for discussion of the role of the energy sector. As suggested above, the link between energy and output growth, or between electrification and modernization, needs little justification. But to argue that any specific energy intervention should be seen as a priority in terms of extreme poverty reduction, particularly given the more limited funds available, is a much more demanding undertaking.

Energy, Growth, and Poverty Reduction

Notwithstanding the points mentioned above, does the existing empirical evidence suggest that investment in energy services should retain a central role in poverty reduction strategies? Relevant literature exists at both the macro and micro levels. The macro approach relates aggregate national or energy consumption by sector to aggregate outputs. The micro approach, in contrast, examines specific energy interventions and attempts to model the impact on targeted population groups.

The Macro Picture

It has been established for many countries over many years that there is a strong empirical association between Gross National Product (GNP) and energy use. Typically for each additional percentage of GNP growth in "all market economies" there is a 0.85 percent growth of primary energy demand. In "developing market economies" the

elasticity is likely to be one-to-one.[5] These relationships are not fixed by natural laws and it is clear (and of vital importance, given environmental trends) that energy efficiency could in principle be increased to allow growth in production without necessarily increasing energy demands. However, these relationships have proven remarkably stable. Breaks have frequently been mere temporary "blips," for example those associated with the oil crises of 1973, 1974, and 1979.

In the poorest parts of the world the relationship between energy and output appears to be even more crucial. For instance it has been shown that for Indian agriculture in the 1980s, a one percent increase in agricultural output was associated with a 3.5 percent increase in the use of modern fuels (Hurst and Barnett 1990). This is caused by the fact that increases in agricultural productivity were associated with mechanized land preparation and harvesting, and the pumping of irrigation water. Although increased access to improved energy supplies will not necessarily initiate rural development, a major element in agricultural growth is clearly associated with the replacement of "sweat intensive" human labor with more convenient and efficient sources of energy and the technology (often capital equipment) that enables more to be produced with less.

Similar associations hold for the relationship between per capita energy consumption and changes in the Human Development Index (HDI). A recent example is *Energy Needs for Sustainable Human Development* by Professor Carlos Suarez.[6] This shows a very strong association between increases in commercial energy consumption and increases in the HDI.

However these associations cannot be interpreted as showing that increasing energy consumption necessarily *causes* increases in well-being. It is likely that the direction of causation operates in both ways, namely that the richer people become the more commercial energy they consume, and the more energy they use the richer they can become. However, such research does highlight the extent to which use of energy services are intimately linked to other aspects of well-being. Indeed, energy services have the potential to impact on almost every area of human activity, from increased economic activity through improved child literacy and safer drinking water to lower rates of domestic violence. It further suggests that although increased access to more convenient energy supplies may not be a sufficient condition for development, it may well be a necessary condition.

This is important because, as discussed at length in chapter 4, one central characteristic of the current poverty debate has been to move away from a focus on

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[5] World Energy Council 2000, page 30. WEC estimates of Primary Energy are about 15 percent higher than those of the International Energy Agency, because IEA data exclude all noncommercial fuels whereas World Energy Council data do not.

[6] Suarez 1995. Gerald Leach has argued strongly against the use of these "associations" on the grounds that they divert attention from the other major aspects of development including other infrastructual development, social and political development.

aggregate income measures. Current descriptions of poverty will typically focus on a lack of adequate food, clean water, shelter, basic education, healthcare, and so forth. Indicators of the various dimensions of poverty will typically not move in tandem. Even when rapid economic growth has the desired impact in terms of income poverty reduction, in the short to medium term only specific interventions are likely to combat other aspects of deprivation, such as illiteracy or incidence of particular diseases.

Although energy in one form or another will almost certainly be required as an input to the production of all these needs, the essentially intermediate nature of energy services, as with other infrastructure investments, such as roads and communication systems, makes it extremely difficult to estimate the poverty reduction potential of a given energy sector investment. Perhaps the most that can be expected is a carefully argued subjective assessment using a mixture of quantitative and the qualitative information.

The Micro Picture

At the micro level the relationship between energy and poverty becomes less clear. There seems to be general agreement that it is empirically difficult to attribute measurable poverty impacts to relatively small investments, such those associated with improving access to modern energy services. This is because in such cases there are a host of other factors, including climatic variation and macro economic change, which affect the measurable poverty status of particular communities during any particular period. These large effects can swamp the effects of the planned intervention.

Similar problems arise in trying to prove the causal links between any small development project and overall reductions in poverty. It is even difficult to be certain of such links in the case of specific sectoral inputs, such as the effect of a potable water supply on improved health status. However it can usually be asserted that there are strong underlying reasons to believe that such inputs are likely to produce positive benefits.

Ideally, some form of general equilibrium approach could be adopted that would track not only the first round impacts of a given energy intervention, but also the secondary and "nth round" effects, possible over a considerable number of years, such that macroeconomic effects and other causes of increased well-being (such as rainfall) could be normalized. Such a general equilibrium approach would (potentially) be able to catch the various positive and negative effects as they ripple through the system. Relying on direct and first-round changes can be very misleading, as shown in the following examples:

- The positive improvement in the productivity of an enterprise that gains access to (say) electricity (a first round effect), has to be matched with the displacement of labor and consequential reduction in incomes from the non-energy-using enterprises that may become unprofitable in the new situation. (a second-round effect). The mechanization of agroprocessing has certainly displaced women's

labor, and whether this is beneficial will depend on how different socioeconomic groups of women view the situation and what else they do with their labor.

- Improved energy services to productive enterprises can raise the incomes of employees, and they in turn may then be able to afford better energy services in their own homes.
- Improved stoves may initially reduce the cost of using fuelwood (people need less wood to obtain the same amount of heat) leading to a rise in the use of fuelwood as it becomes cheaper than other fuels.
- If biogas plants are introduced, this may well have benefits for the owner and the owner's family. However such plants have been shown to increase the value of dung to the point that landowners prevent poor people (usually women) from collecting dung for their own use.
- Increases in fuel availability (or reductions in its cost because of better distribution) can reduce the cost of transport, which allows more of certain products into the village (at lower cost) thus reducing local consumption, while at the same time increasing the market for village products. The net effect may be uncertain.

However such general equilibrium approaches, which take both direct and (possibly lagged) indirect effects into account, are very demanding, particularly in terms of the cross-section and time series data that are required. Given the current state of knowledge, understanding of energy, poverty and gender linkages would probably benefit more from additional detailed qualitative studies, (particularly with men and women living in poor households), than from a further round of questionnaire-based surveys.
Such studies may be better suited to interpreting the difficult issues relating to causality, determining the sequence of events by which people gain increased income through access to improved energy services or access to improved energy services because they have increased income. The effectiveness of such an approach will depend on obtaining a clear idea of the range of possible interventions and their consequences, and comparing this, through sensitive and skilled questioning, with people's perceptions of past experiences and future expectations.

Energy Impact Mediated by Complementary Inputs

Many studies were carried out in the 1970s and 1980s that looked at energy and development in rural areas (where at the time most poor people lived). Initially these studies were concerned with electrification, and at the time this almost invariably involved extensions to the main electricity grid. Subsequently there was a growth in studies looking at the impact of domestic energy systems, primarily cooking fuel systems. Here the main concerns were on the impacts of deforestation. It was assumed (wrongly in both cases) either that the oil crises experienced in the modern economies in 1973, 1974, and 1979 would have a major impact on poor people, or that the use of fuelwood was the

major cause of deforestation, and that this fuel source was being mined rather than harvested.

Studies on the impact of electrification showed very mixed results. The schemes were often very costly, often using ludicrously inappropriate technical standards imported uncritically from snow prone areas of Europe and North America, and the benefits were very often uncertain. A recent summary of this type of work is the 1995 World Bank Operations Evaluation Department (OED) report. This states the following:

> All the evidence to date, including that from Bank-financed RE [rural electrification] projects in Asia, shows that RE does not directly reduce poverty by helping the poorest rural people. Most of the direct benefits from rural electricity go to wealthier people. …Once connected, the amount of electricity consumed, and therefore the benefits obtained, depend on the ability to buy electrical equipment, whether light fixtures, televisions, fans, water pumps, or motor-driven machines…. RE reduces rural poverty only through a general rise in rural income obtained by productive uses. And—again with the exception of irrigation pumping—these productive uses of electricity appear to come about only when other factors are already raising rural and national per capital income.[7]

As a consequence of these and earlier findings of a similar kind, many donors stopped programs of grid-based rural electrification, in part because the sites considered best (those with the highest density of demand) had been dealt with, but also because they felt that such programs were a bottomless pit of expense, which frequently added to the insolvency of state run utilities.[8]

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[7] "One of the most persistent claims for RE is that it can induce industrial growth in otherwise lagging low-income rural economies. The evidence from developing countries does not support this claim; RE has not, by itself, triggered industrial growth or regional development…. The study found that where other prerequisites of sustained development were absent, demand for electricity for productive uses did not grow…. RE is economically justified only when the emerging uses of electricity are strong enough to ensure sufficient growth in demand to produce a reasonable economic rate of return on the investment. RE may be in a unique position to promote a paradigm shift in agricultural production, by making possible irrigation and associated modern technology and practices." (World Bank 1955)

[8] There are a number of notable exceptions. For instance, the National Rural Electric Cooperative Association (NRECA) has continued to provide support to rural electrification schemes, most successfully perhaps in Bangladesh. Similarly in the richer countries, such as Chile and Thailand, grid extensions have continued to provide by far the most cost effective means of providing rural people with access to electricity. (See, for instance, Jadresic 2000.)

There have been a number of other studies that showed that major impacts on poverty could *not* have been achieved without improved energy services. For instance, the evaluation of DFID's huge investment to upgrade the Greater Power Distribution System states the following:

The projects made a decisive contribution to a wide variety of benefits of different social groups. Where these benefits reached disadvantaged groups they were often fortuitous or indirect and had rarely been explicitly so targeted at the project's inception. The most dramatic indirect benefit has been the financial emancipation of thousands of women employed in the

Energy analysts largely ignored the use of biomass energy until the 1970s. This was in part because it was a largely nonmonetized source of energy, involved the invisible labor of women and children, and was not captured in conventional energy statistics produced by governments.[9] The early studies established that biomass fuel systems were often complex, involving multiple fuels and different appliances, and difficult to quantify, not least because of important seasonal variations. The margins of error in estimates of biomass energy use and the production often overlapped, making it difficult to determine the sustainability of the systems. Gradually a clearer picture emerged in which sites of overconsumption were identified, women and children were revealed as the main collectors and users, and it was realized that such fuels could inflict a huge health burden, again particularly on women and children. These issues are discussed further in chapter 3 under the heading *Environmental Aspect of Reducing Energy Poverty*.

The importance of these studies is that they showed why the impacts of energy projects were are so variable at the micro level. It became clear that as energy is a derived demand the impacts (for example of electrification schemes) were likely to be a function of the complementary inputs that are associated with it (Fluitman 1983). For example the benefits of supplying electricity to water pumps is likely to be far greater if a system of irrigation channels is already in place than if it is not.

In recent years staff at the World Bank has further developed this idea of complementary inputs (Peskin and others 2000).[10] These studies found that the "bundling" of services like water, sanitation and education with electricity has disproportionate welfare benefits for local populations—the whole was substantially greater than the sum of the parts. In Peru, for example, the effect of bundling of a number of social services is said to be such that the impact of adding a fourth service for rural households is about seven times greater than the addition of the second service. In the Philippines, combining electricity with education similarly resulted in an increased impact on a family's earnings.

These finding suggest a most important conclusion: The impact of poverty reducing energy interventions will be a function of the existing complementary inputs (production equipment or other "livelihood assets"), and if these inputs are not in place, the impact will not be achieved unless additional investment is made.

It also suggests that, as no human activity is possible without the use of energy, all studies purporting to show an impact on poverty from one or more inputs (for example,

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mushrooming garment factories in Dhaka. The lives of large numbers of poor people were also significantly improved by the use of very modest amounts of electricity for lighting, fans and (less so) even in cooking. See http://www.dfid.gov.uk/.

[9] The exception to this was often charcoal, which was usually produced by men and sold for cash either as a primary source of employment or as a casual source of extra income.

[10] In the Philippines, the study finds that one year of education increases, on average, annual income by about 13,000 pesos. However, this increase is augmented by an additional 2,000 pesos if the household has electricity.

land reform, irrigation, microcredit, women's education, agricultural improvement) are necessarily also affected by the use of energy (and probably many other inputs). Therefore a prima facie case can be made that these interventions owe at least part of their success to the presence of these energy services, or that they would have had a greater impact had they been associated with greater access to effective energy services.

This in turn means there will be poverty benefits from considering how, and at what additional cost, improved access to energy services might add value in terms of poverty impact to other leading poverty reduction interventions. Or, to put it another way, the key energy issues relating to the development of any poverty reduction strategy are whether that strategy would be improved or worsened by adding an energy perspective to the diagnosis of the problem, and whether the effectiveness of specific interventions would be enhanced significantly if they had access to improved energy services.

A large evaluation of the energy and development projects carried out by the European Union in its first 25 years of operation concluded that energy activities needed to be integrated into development projects and therefore agencies need to design administrative procedures to ensure that this happens (Hurst and Barnett 1990). It was suggested that it would be relatively easy to identify those development activities likely to have a significant energy dimension. These would include the following:

- Projects that use considerable inputs of inanimate energy (such as agricultural mechanization, pumped irrigation, rural transport).
- Projects that are highly dependent on small but secure supplied of energy (medical supplies, telecommunications).
- Projects that are known to have large indirect effects on local energy systems (such as land clearance, changes in land use, and projects increasing the density of populations).

For these projects it was suggested that the people involved in designing such interventions should be required (through their terms of reference) to do the following:

- Examine how robust their suggested intervention was to changes in the cost or availability of energy supplies.
- Examine whether the value (or where appropriate the profitability) of the planned intervention could be increased by additional investments to improve or secure adequate energy supplies.
- Examine whether the planned intervention was likely to have effects that would indirectly affect the local energy situation.[11]

[11] Hurst and Barnett 1990, p. 17.

Energy, Poverty, and Gender Links

Women carry a disproportionate burden in terms of both of both poverty and energy systems in developing countries. There comes a point, therefore, when an ungendered aggregate approach, whether at macro or project levels, hides more than it reveals. Analysis has to take account of the fact that there are substantial differences in the way women, men, and children contribute to and are affected by energy systems.

To explore the theoretical and conceptual relationships between energy, poverty, and gender two related sets of arguments can be distinguished: gender-poverty linkages, and gender-energy linkages. First, it is necessary to consider the relationship between poverty and gender. The following discussion provides a brief summary to current thinking.

Poverty and Gender

Work on poverty has increasingly recognized that the social processes and trajectories by which people fall into poverty are differentiated by gender. That is, poor women and poor men do not necessarily become poor in the same ways through the same processes. They also have different capacities for accumulation. The impact of migration on poor rural areas is a particularly clear example of this in China. Migration is usually gendered. Although able bodied men may move to work in other rural or urban areas, women may be left as the majority of the population managing both food production and household-based reproductive[12] work. Remittances may or may not flow to individual households. In many rural areas, households are increasingly female headed, lacking in labor and other resources, and prone to greater vulnerability from income fluctuation and shocks.

As a consequence of these differences, poor women and poor men may have different livelihood strategies. Thus, asset interventions that benefit poor men do not necessarily benefit poor women. This is because women and men are positioned differently in relation to the "productive" and "reproductive" economies.[13] This in turn affects their assets and entitlements.

Poor women (and often also girls) spend a disproportionate amount of their time on unpaid household and farming tasks. This time use pattern places gender specific limits on the capacity to accumulate resources through value added economic activity.

Intrahousehold relations tend to determine members' access to utilities and resources. Intrahousehold data may reveal hidden gender- or age-differentiated discrimination. For example, inheritance patterns mean that women's ability to act fully in relation to property may be less than that of men and is usually mediated through male kin. Intrahousehold decisionmaking reflects this imbalance of resources. Men are more likely

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[12] The human resources and labor time required to enable households to reproduce themselves both intergenerationally and on a daily basis. In many households much of this burden is borne by female labor.

[13] These terms are common in gender analysis and are further explained in the *Gender and Energy* section of this chapter.

to take decisions on behalf of households and in terms of their own economic and social priorities.

Measures of poverty and well-being have tended to focus narrowly on income and basic needs. A fuller understanding of poverty should take into account the ways in which both women and men experience poverty. This means considering social autonomy, power, and agency as dimensions of poverty reduction strategies and acknowledging gender differences in the capacity to exercise these.

There has been a tendency to equate men with production-based needs and women with welfare-based needs. A gendered analysis of poverty is not just concerned with welfare needs but also addresses women's as well as men's capacity to access productive resources.

Gender and Energy

A second set of arguments links gender and energy. These arguments focus particularly on the relationship between the sexual division of labor and the reliance of the poor on traditional energy sources.

Women and men, boys and girls are situated differently in the division of labor. Women generally work in both the productive and reproductive economies, bearing most of the reproductive tasks associated with child-rearing, food processing and cooking, care of the sick, and management of the household's physical environment. Girls are more likely than boys to provide support in these tasks. The poorer the household, the greater the time, physical, and health burdens associated with these tasks. The absence of basic labor saving and "clean" technologies, such as fuel-efficient stoves, not only burdens poor women in these ways, it also has high opportunity costs, as it diminishes their capacity to undertake other productive activities. The disproportionate health impacts of traditional energy use on women, girls, and young children are a further consequence of the division of labor.[14]

Women and girls also work in production, often as unpaid family labor in physically arduous or time-consuming tasks, such as food processing for local markets. The greater the degree of gender segregation in rural divisions of labor, the greater the association of women and girls with traditional low technology, low value added tasks using mainly human energy. A similar pattern is found in income generating activities. Gender inequalities mean that women generally have less access to productivity enhancing resources, such as labor, collateral, credit facilities, information and training. These inequalities stem from household-based discrimination (see above) and from broader societal and cultural constraints. For instance, women may need permission from senior men, there may be ideologies of appropriate and inappropriate roles for women, female

[14] See the subsection below, *Wood energy, cooking and health*.

literacy rates are often lower and so forth. Hence, their capacity to increase their labor productivity and improve their incomes is limited.[15]

The division of labor between productive and reproductive tasks has a strong parallel with energy use. Household requirements, such as cooking and lighting are commonly referred to as "energy for consumption." In practice there is often no clear distinction between production and consumption activities in poor households. It may well be, for instance, that lighting allows both men and women to undertake productive work for longer hours within the household, and that "cooking" might including the processing of food for sale.

Electric lighting appears to be particularly important for creating a sense of inclusion and well-being (see chapters 2 and 3). However the most important energy end uses in terms of directly contributing to a reduction in income poverty are likely to be those that enhance the major production activities, either by increasing productivity, extending the range of outputs or improving output quality (see chapter 3). However, women's employment can be threatened by the introduction of more efficient forms of energy (see chapter 2).

Because of their different and unequal roles in the division of labor, women and men have different needs and may have different priorities. This means that they may make different tradeoffs between time and energy. For example, Dutta found in her studies of biogas that women valued smoke reduction on health grounds and to reduce the drudgery entailed in cleaning smoky pots. Men, on the other hand, valued fuel savings above other considerations. Community level interventions need to take particular note of this. Communities are differentiated in a number of significant ways, including gender. It is important to look at who speaks for communities, how decisionmaking takes place, and whether the voices of minorities and women have been heard.

The critical conclusion that emerges from combining the gender perspective with the energy perspective at is that the poverty impact of improvements in energy services is largely determined by the choice of end use[16] to which the energy is put, and by implication, by who chooses what the energy will be used for (and how it is obtained).[17] Women are less likely to benefit from energy interventions unless they are involved in the choice of energy end use technology and can capture the benefits of the improved energy service.

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[15] Cecelski (personal communication, February 16, 2001) estimates that only 10 percent of households will use household energy technologies for income generation. This is important to the arguments that follow.

[16] The choice of energy end use will also often determine the type of energy and conversion technology required.

[17] This was shown in Thumim 1999. In this case only one quarter of the households were electrified, with the richer households consuming more power than the poorer ones. Thirty households were interviewed (of which some 30 percent of the interviews were with women). The data are not disaggregated by gender.

Even though this appears so self evident as to be almost trivial, it is surprising how little attention is given by analysts and policymakers to these choices. If energy services are directed to tasks that are traditionally considered in the woman's domain (in many societies this will include agroprocessing, textiles, pottery, and soap making), or to new activities not yet dominated by men, it can have a considerable (targeted) impact on women's lives. However there are clearly circumstances in which the introduction of improved energy services results in the task (and the surplus) being taken over by men. For example, in Bangladesh, the replacement of traditional paddy huskers operated by women with small-scale mechanized milling has displaced significant amounts of female employment. Men have largely taken over the jobs in milling. This underlines the need to produce gender disaggregated analyses of energy-related impacts on the poor.

But perhaps equally important, in the case of electricity, even the impact upon people in unconnected households can be greatly affected by the choice of energy end uses. For example, it has been suggested that the addition of one type of mill (such as for chili) can produce more benefits to an excluded group (a group of women) than the addition of a battery charging station. Furthermore unconnected households have been shown to benefit from access to TV.[18] In one case it was found that the advent of television had a significant cultural impact in that women said they could see they "don't have to remain as second class citizens" (Thumin 1999).

Elements of the Energy-Gender Framework

Until relatively recently, energy issues have not had much attention from gender analysts. This has begun to change. There have recently been a number of energy studies taking gender as a significant variable, and in the last year at least two important conceptual and synthesizing papers have appeared, providing an excellent basis for further empirical investigation and for the development of an analytical framework.[19] Their approaches are summarized and commented on here.

Cecelski provides a comprehensive review of current thinking in the field. Her approach is characterized by a concern with broadening the relationship between poverty and energy to encompass recent thinking on poverty reduction. She challenges the technocratic, infrastructure-focused approach to thinking about energy and poverty and asks what it means to introduce concepts, such as empowerment and security, to the energy-poverty question. This is highly relevant to thinking about gender in relation to energy. Many of the issues that surface connect to access to and control of technologies

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[18] This is illustrated in a path-breaking piece of research on the gender-related impact of micro hydro, which was carried out in Sri Lanka in the mid-1990s (Dhanapala 1995). The benefits of the schemes were largely at the household level (lighting, TV and battery charging) for connected households, but unconnected households benefited by access to TV and the possibility of hiring lights for special occasions. See also Khennas and Barnett 2000.

[19] See, for instance, the work of Energia (http://www.energia.org/), papers by Elizabeth Cecelski (for example, Cecelski 2000a and Cecelski 2000c).

within households, communities, and so forth, rather than about technologies per se. This is a reiteration of findings from other studies of gender and technology. Technologies are rarely gender neutral; because of the sexual division of labor, women and men have different relationships to a given technology and therefore derive different utilities from it.

Cecelski notes that the main focus in the gender and energy literature so far has been on poor rural women, wood energy, and the microeconomic project level. In the context of rural electrification schemes, she picks out four key issues that are central to a gender and poverty analysis.

Data needs and analysis: separation of energy use, supply, and impacts by gender as bases for applying methods and tools for incorporating gender in project design and implementation. As she points out, lack of data ties in with the absence of a gender perspective in macro level energy policies. A particular area of relevance is the pricing of fuels that are also used for cooking. Extrapolating gender data collected is thus a first, essential step in understanding the connections between gender and energy. A further implication lies in the kinds of methodologies that are needed for this. Particularly for information on demand side use and needs, a range of methods will be appropriate. This will include qualitative forms of enquiry, which can elicit information on examples of how hierarchies and relationships within households affect access to technologies.

Wood energy, cooking, and health: seeking integrated approaches and solutions (including fossil fuels and electricity) that recognize the importance of these. In poor rural areas, cooking is usually the most intensive use of inanimate energy by women, often requiring long hours in fuelwood collection as well as the cooking process itself. High levels of use of traditional fuels can contribute to environmental problems and is a leading cause of respiratory infections and early deaths among women and children. The poorer the household the greater the use of these fuels. Actions to reduce this reliance would have a major impact on the health of poor rural women and children.

It has taken the world a long time to realize just how much the smoke that results from cooking with solid fuel (often woody biomass) kills people and produces life long health problems. Careful and persistent work by Professor Kirk Smith and other researchers during the past 30 years has quantified the causes and scale of the problem. A recent example of his work suggests that cooking with solid fuel (mainly woody biomass) is the third largest cause of death and disease in solid fuel using households in developing countries.

> Acute respiratory infections in children under five years of age are the largest single category of deaths [and disease] from indoor air pollution, apparently being responsible for about 1.2 million premature deaths annually in the early 1990s.[20]

[20] See Smith and Mehta 2000. See also Smith, Corvalan, and Kjellstrom 1999.

Women's specific electricity needs: Women and men use electricity differently in water pumping, agricultural processing, security, work productivity, and health. They may also have conflicting priorities (for instance, productivity-related uses of electricity taking precedence over domestic uses, or the location of light fixtures inside a house). But energy policy also needs to recognize women's specific time and labor needs to enable them to make more effective tradeoffs between their domestic and income-generating activities. Women also have greater needs for certain kinds of community-based energy resources, such as street lighting, which improves security. Also, at a community level, women are the most affected by the potentially health enhancing effects of water purification, refrigeration, and so forth as they tend to be the main informal carriers. Although the emphasis here is on electricity, women's energy needs should be looked at as a whole. This is particularly and obviously the case with food processing technologies and cooking. However women have important energy requirements related to transport where women are restricted in their use particular forms of transport (not using bicycles, or being required to travel only in closed taxis).

Equal access to credit, extension and training: to assure energy supplies for women's domestic tasks and microenterprise needs. Poor women have particular difficulties in gaining access to these resources. Credit is already on the agenda for improving access to energy in poor rural areas, but gender differences in access must also be addressed. This needs to take into account both women's domestic and income generating activities. The experience from microcredit schemes geared particularly to women users is relevant. However, the extent to which credit alone can greatly improve access by the poor and women without other supporting poverty reducing measures must be approached cautiously.

Other gender-related access issues that need to be considered are the following:

- The modalities and timing of any payments. The poor, and especially women, tend to have irregular income flows.
- The potential for "overloading" microcredit with yet another demand on limited resources.
- Household-level decisionmaking and entitlements. Women are often not able to make decisions independently, needing to consult with and defer to male household members.
- Community level demands and who voices them. A number of studies point to the absence of women's voices and concerns, in community consultations on energy use and resources.

The United Nations Development Programme (UNDP) Energy and Atmosphere Programme derives its remit from the 1992 UN Conference on Environment and Development. It is particularly concerned with the balance to be struck in the "tradeoff triangle" between economic growth, social equity, and environmental protection. The UNDP Initiative for Sustainable Energy regards energy as a means of achieving its key

human development goals, including gender equality. The Programme coordinates a project on "Energy and Women: Generating Opportunities for Development," which is concerned with the linkages between sustainable energy and improving women's situation in the three areas identified as of particular relevance: time, health, and income generating activities. The project has an African focus and supports sustainable energy pilot projects to create income generating opportunities and other benefits for women. They have produced a briefing paper called "Gender and Energy: How is Gender Relevant to Sustainable Energy Policies?"[21] This paper makes the following additional key points.

Impoverished women and girls bear heavy time and physical labor burdens acquiring traditional fuels, such as wood. These burdens are not accounted for in calculating national energy needs and expenditures. It could also be added that this burden of unpaid labor, which is highest among the very poor, is not accounted for in national productivity and employment statistics, thereby making it appear a "free" good. Furthermore, this low value added activity reduces time for higher value added tasks and for important social investments, such as education.

Women in poor households are "traditional energy managers" and can play a major role in the adoption of less polluting fuels and technologies, particularly renewable energy resources, such as small hydropower, wind, and solar power. This argument resonates with some current environmental discourses that see women as guardians or conservators of the environment (for example, Shiva). This association between energy and the environment is taken up further in the next chapter (chapter 3).

Women have been largely excluded from participation in energy policy and in processes of decisionmaking. They lack access, or equivalent access to men, to the resources needed for economic or political participation. Yet they are key stakeholders in producing sustainable, equitable development policies. There is a need for gender specific data to inform policy on gender, poverty, and energy linkages. Women also need to be included in the design of energy interventions. Evaluations of solar cooker projects in poor countries have found that successful projects have been ones where women users were involved in the design stage.

Gender-Poverty-Energy Links: Some Reflections

Both of the above papers break new ground in spelling out the links between gender, poverty, and energy. They make a major contribution to thinking through the methodological needs for better informed energy policy. Cecelski focuses more on the gender aspects of the microeconomic determinants of access and their link to macroeconomic policy. The UNDP paper places stronger emphasis on environmental links. In keeping with its mandate on gender equity it also flags more centrally the

[21] Cecelski 2000c.

importance of enabling women's voices to be heard in data collection, consultation, and program design.

Both papers focus centrally on women's relationship to energy-electrification. This is not altogether surprising, as evidence is emerging that poor women in particular experience specific disadvantages, such as their high degree of reliance on inefficient, human energy-intensive and health-harming energy technologies. A focus particularly on the lives of individual poor rural women brings dramatically into vision the drain on women's time, energy, and health. An approach centered on individual women and their burdens, however, does also have some limitations.

What is apparent from the literature is the essentially synergistic nature of energy interventions with other interventions in successful poverty reduction strategies. Concentrating on one element or one technology is insufficient in evaluating the impact of programs to improve energy access. A parallel argument applies in assessing gender impacts. Taking gender into account means adopting a relational approach as well as focusing on women as a specifically affected group. This is important in two particular respects:

It is useful to disaggregate possible direct and indirect gender benefits mentioned earlier. Some interventions, such as fuel-efficient cooking stoves, may directly benefit women and their households. Others may have an indirect benefit. For instance, interventions to improve infrastructure may benefit children's education, the health of household members (such as through cold chain improvements), or provide greater household income security. Any of these may have benefits for women, even though they are not the direct beneficiaries.

Improvements in the lives of poor people will always involve tradeoffs. Although women and men may have different perspectives and priorities, they also have common interests, particularly in relation to longer term survival and well-being strategies. A gendered approach needs also to take this into account. For example circumstances may arise where there are conflicting priorities in energy use or acquisition. An obvious case would be the possible introduction of technologies, which enable men to gain more income but place a higher workload on women. In China, for example, it seems likely that improved energy services have released men from the heavier work and enabled them to migrate, as women can perform more tasks that were previously more labor-consuming. It is important to uncover these effects and their potential implications for poverty reduction. At the same time, researchers cannot make judgments about the desirability of these tradeoffs. That is a matter for those making them.

3 Energy Services and Energy Poverty

This chapter illustrates the pervasiveness of energy in the lives of poor women and men by considering the standard list of energy services and the fuels that are used by different income groups to obtain these services. This provides a first step in the process of understanding the pathways by which increased access to energy services can contribute to poverty reduction and sustainable livelihoods. It also offers an initial insight into the gender dimension by indicating the energy inputs associated with particularly gendered activities. The concept of energy poverty is introduced and linked to the notions of vicious and virtuous circles linking energy services and poverty. The special issues associated with provision of energy services to remote areas and the environmental concerns relating to reducing energy poverty are then addressed. Finally, the chapter considers recent development in the debate around energy supply systems.

As will become clear through the discussion that follows, the benefits derived from energy services are often diverse and complex. They range from the direct benefits of contributing to increased production and reducing sweat energy, through the contribution that energy can make to health and human capital (for example in terms of pumping water or provision of lighting and other services to health facilities[22] and schools), through to more intangible benefits of security (via street lighting, back-up energy supplies, or pumped water reducing risks from drought) to a sense of inclusion in the modern economy (via communications media). Table 1 shows the ways in which these energy services are obtained by different income groups.

[22] The difficulty of measuring the impact of improved energy service on health facilities is noted by GTZ, which suggests that "to really measure the impact, these different preconditions have to be taken into account. Some suggestions to precisely define possible impacts [are]:

Better working conditions because of electricity lead to more motivated medical personnel.

Better diagnostic possibilities lead to better medical treatment.

Better hygienic conditions from hot water and sterilization lead to a reduction of infections."
Comments provided to EnPoGen by GTZ in letter dated April 20, 2001.

Table 1: Typical End Uses by Energy Source in Developing Countries

	Income level		
Household	***Low***	***Medium***	***High***
Cooking	Wood, residues and dung	Wood, charcoal, residues, dung, kerosene, biogas	Wood, charcoal, kerosene, LPG, coal
Lighting	Candles, kerosene, none	Candles, kerosene	Kerosene, electricity
Space heating	Wood, residues, dung, none	Wood, residues, dung	Wood, residues, dung, coal
Other appliances: radio/television	None	Grid electricity and batteries	Grid electricity and batteries
Space cooling and refrigeration	None	Electricity (fans)	Electricity, kerosene, LPG
Agriculture			
Tilling	Human labor	Draft animals	Animal, gasoline, diesel,
Irrigation	Human labor	Draft animals	Diesel, grid electricity
Processing	Human labor	Draft animals	Diesel, grid electricity
Industry			
Milling/mechanical	Human labor	Human labor, draft animals	Grid electricity, diesel, gasoline
Process heat	Wood, residues	Coal, charcoal, wood and residues	Coal, charcoal, wood, kerosene, residues
Cooling/refrigeration	None	None	Grid electricity
			LPG, kerosene
Services			
Transport	Human labor	Draft animals	Diesel, gasoline
Telephone	None	Batteries	Grid electricity

Source: World Bank 1996, p. 25.

Energy Efficiency and the Idea of "Energy Services"

Wide ranges of devices convert these primary sources of energy into the various services. The use of energy entails its conversion from one form to another and this always has a cost (both in terms of conversion processes, such as engines, and in terms of efficiency losses). The cost of useful energy can be quite different from the cost of the primary energy or fuel. Therefore energy specialists increasingly refer to the provision of energy services rather than merely the supply of energy (energy service plus energy supply or fuel plus conversion equipment). Energy conversion efficiencies are illustrated in table 2. This shows in particular how much more efficient electricity is for lighting than candles and kerosene, and how much more efficient gas is for cooking than wood.

Table 2: Relative Energy Conversion Efficiencies (typical values)

Cooking		Lighting		Appliances	
Energy Source	**Efficiency**	**Energy Source**	**Luminous Efficiency**	**Energy Source**	**Efficiency**
Electricity	1.00	Electricity	1.00	Grid electricity	1.00
Propane	0.77	Candles	0.02	Dry cell battery	0.90
Fuelwood	0.15	Kerosene	0.01	Car batteries	0.90

Source: Foster 2000.

If these data are combined with typical energy price data (in this case from Guatemala), the impact on people's lives becomes stark. Table 3 shows that nominally high-cost fuels, such as LPG (propane), can be as cheap per meal as fuelwood when providing energy for cooking. It can also be seen why people have a very strong desire to switch from kerosene to electricity for lighting. There is also a strong motivation for people to switch from solid to liquid or gaseous fuels.[23] The replacement of traditional sources of energy with commercialized fuels of increasing efficiency is known as the *energy transition.* The balance between the various sources of primary energy has changed for all countries as their economies developed. In Europe the transition has been from wind and water, to coal and steam, through to oil and gas. This transition parallels (and is in part caused by) changes at the level of individual energy users. As people acquire more assets, they move up the energy ladder to more efficient or more convenient energy sources, while at the same time moving up to end-use technologies that better suit their needs.

[23] Comparable data for kerosene as a cooking fuel was not included in the original table.

Table 3: The Cost of Useful Energy (excluding appliance costs)

Energy source	Gross cost ($/kWh)	Cost of useful energy ($/kWh)
Fuelwood	0.01	0.06
Propane	0.05	0.06
Electricity	0.08	0.08
Dry cell batteries	0.59	0.53
Car batteries	2.57	2.31
Kerosene (for lighting)	0.05	5.87
Candles	0.26	13.00

Source: Such figures are available from many sources. These are taken from Foster 2000.

Multiple Fuels and Many Appliances

It is important to note that as people become richer and proceed through the energy transition they introduce new, more convenient and efficient sources of energy into their lives, they may well continue using the traditional energy sources as well. This is in part for cultural reasons (for example, the taste of food cooked on a particular fuel) and in part to minimize the risk of interruption in supply (for example, back-up diesel generator to cover the risk of cuts in power from the electricity grid). This multiple fuel use means that the impact of fuel switching and efficiency improvements is often not as dramatic as more simplistic models and policies might predict. This is perhaps at its most extreme with cooking, where households may graduate to LPG but women still use wood and charcoal to cook certain types of food (note that the relatively rich also behave in this way, continuing to cook with charcoal over "primitive" stoves in their gardens despite having lavishly equipped kitchens, although in this case cooking often becomes a predominately male task). Even very poor households may retain a variety of options to reduce the costs or risks associated with a particular fuel-technology system. For example, in poor rural China it is not difficult to find households with a solar water boilers, biogas rings, and both coal and residue burning stoves.

The Unique Attractiveness of Electricity

The energy transition is also driven by the fact that each end-use needs to be matched by an appropriate energy source. Electricity is not only the most efficient source of lighting by far, but it is also frequently the only energy source that can drive many modern technologies, such as telecommunications, radio (clockwork radios remain expensive), and television. People really want electricity for lighting and will go to extraordinary

lengths (and expenditures) to get it.[24] This contributes strongly to the equation of electricity with modernization and frequently results in voters asking for, and politicians promising, electricity connection.

However, it is important to recognize the great diversity in the nature of electricity supply technologies. For example, batteries and photovoltaics, which can produced very small amounts of electricity, cannot be used to supply the electrical power required by modern machinery, refrigerators, heaters, or ovens. All too often policymakers interpret the word *energy* as *electricity*. Providing poor people with access to tiny amounts of electricity may improve their lives, sometimes significantly, but it will not meet their energy needs for cooking, motive power, heating, and cooling. Conventional modern forms of energy (predominantly from fossil fuels) will remain the fuel of first choice for most poor people for many years to come, whereas biomass fuels will remain the main fuel of necessity.

Capital and the Conversion of "Renewable" Energy

It is also important to note in this context that all modern renewable energy technologies share a particular characteristic that often limits their use by poor people: They have high initial capital costs and low recurrent (fuel) costs relative to fossil fuel-based technologies. This is particularly so for photovoltaic electricity, hydropower, and wind energy. The poorer the people, the less likely it is they can afford this kind of renewable energy (technically because the opportunity cost of capital increases with lower incomes so they are forced to value the present more highly than the future). For this reason, poorer people often pay more per unit of energy used simply because they cannot afford the initial (front-end) costs of supply options that have the lowest lifetime cost.

Similarly, where generating utilities have very severe limits on capital expenditures, their opportunity cost of capital at the margin rises to very high levels. They will then commonly opt for technologies with a lower initial capital cost, such as diesel generators, over an apparently preferable renewable option, such as microhydro.

The Central Problem of Increasing the Ability to Pay for Improved Energy Services

Large numbers of people in effect 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). Furthermore, even people who can afford improved energy supplies still may not be able to afford the conversion technology that makes that energy useful (for example, a stove, radio, light bulb, or motor). This can be illustrated diagrammatically (figure 1).

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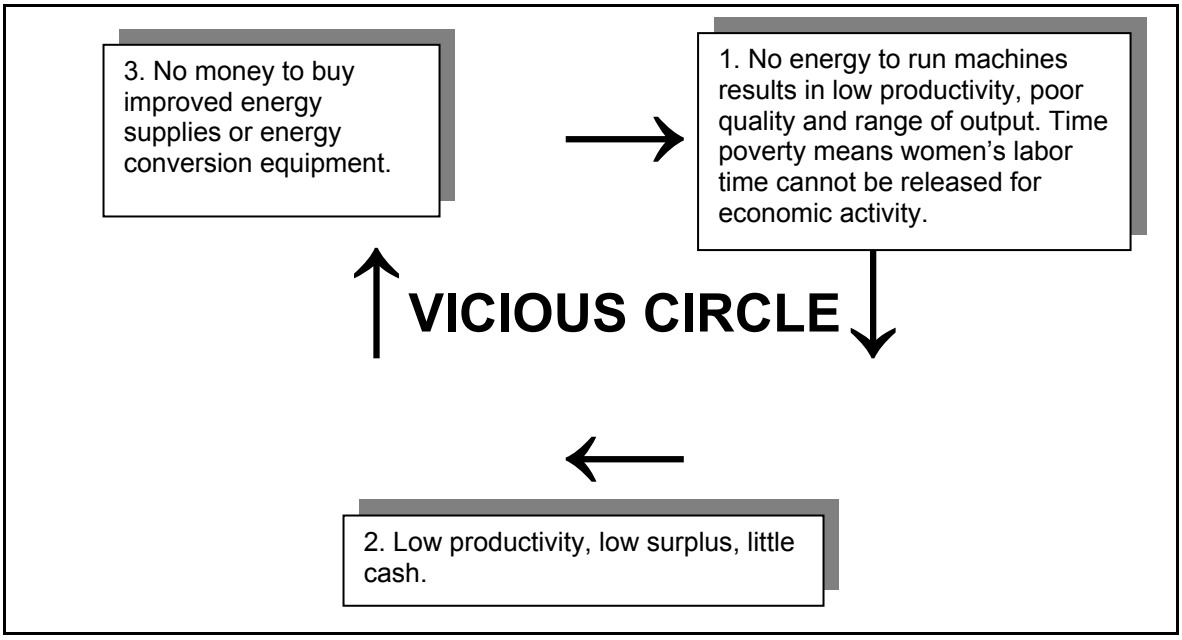
[24] Although the capital cost of dry cell (flashlight) batteries may not be very high, they represent a very expensive way of buying electricity. In terms of energy supplied, such electricity probably costs more than US$40 per kilowatt-hour. See SGA Energy Limited 1998.

Figure 1: The Vicious Circle of Energy Poverty



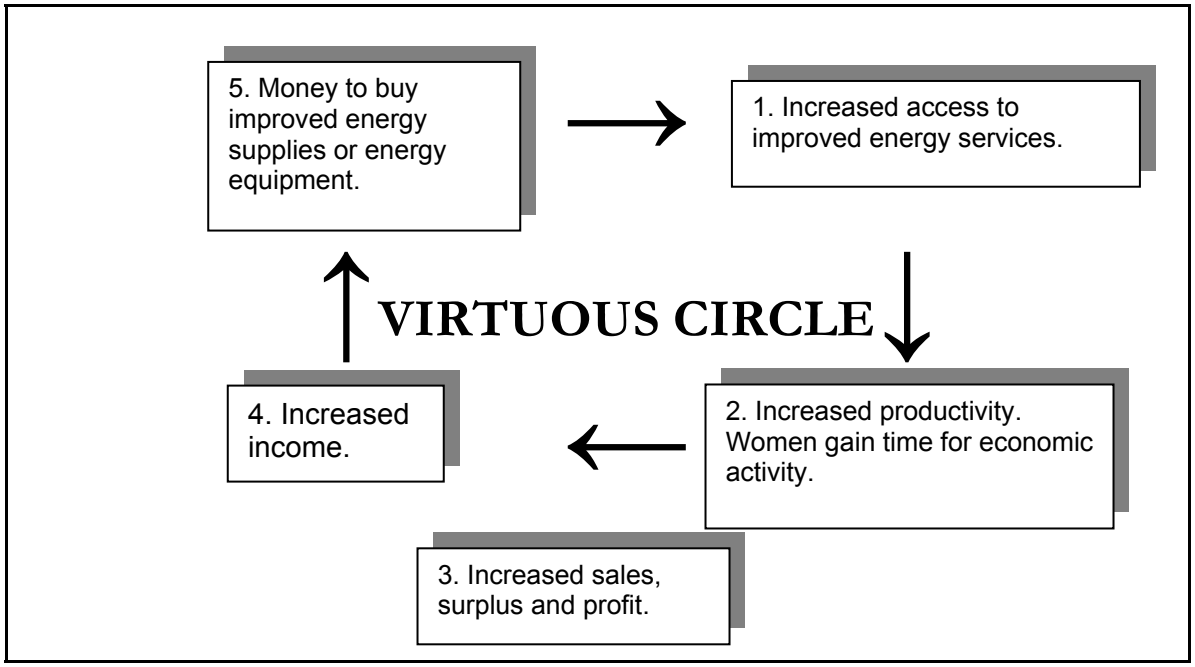
Increased access to cash becomes crucial both for poverty reduction and for acquiring improved energy services. Improved energy services at the household level frequently necessitates switching to an energy technology that costs money from one that does not, particularly in relation to stoves and cooking fuels. But this is critical to release women from the constraints of time poverty. Even where improvement in lighting results in cash savings because the new source replaces more costly but less effective supplies (such as batteries and candles), there is frequently a net increase in money expenditures because people make more use of the improved energy services.

This means that attempts to reduce energy poverty, particularly using electricity supply technologies, face a difficult issue in terms of the stated preferences of intended beneficiaries. When rural people express their needs for improved energy services they often give high priority to lighting, a perfectly understandable position for those forced to live much of their lives in the semidarkness provided by candles or kerosene. But the most financially sustainable decentralized electricity supply options are likely to be those that provide power to productive enterprises that can sell their output profitably.[25]

An important conclusion follows from this. The cycle of energy poverty will often be broken only by combining improved energy services with end uses that generate cash income. These are likely to be the productive energy end uses that enhance production activities, either by increasing productivity, extending the range of outputs or improving output quality. This might be labeled a *virtuous circle*, and is illustrated in figure 2.

[25] Generally village wealth will not increase unless goods and services can be sold outside the village. This implies that roads and transport are likely to be necessary "complementary inputs."

Figure 2: A Virtuous Circle to Break Out of Energy Poverty



Clearly the vicious circle of energy poverty (as with other forms of poverty) can be broken through the redistribution of wealth by means of grants and subsidies. But the level of funding available from government, aid donors, and nongovernmental organizations (NGOs) is likely to be far below those required to provide all people with adequate energy services.

There is a further corollary to this central conclusion. Experience suggests the dictum that when undertaking rural energy projects "it is easier to make the profitable social, than to make the social profitable." That is, when planning propoor energy interventions it is important to consider means of using the energy to secure cash income at an early stage of the development process, and only subsequently to see how the impact of improved energy services can be extended to the other aspects of sustainable livelihoods. It has proven extremely difficult to produce financially sustainable results with energy projects if they are started with the mind set of social development (akin to feeder roads, clinics, and schools) that are free at the point of service.[26] Such projects often fail when the governments, aid agencies, and NGOs who finance such schemes initially cannot sustain their support for recurrent expenditures.

The Issue of Remoteness

Even if improved energy services were affordable to poor people with easy access to equipment, advice and credit, these options are certainly likely to be more expensive and

[26] Although it is clear that in recent years attempts have been made to place such services on a more financially sustainable basis.

more difficult to obtain for people in isolated rural communities. Such people are likely to have more difficulty in obtaining sufficient information and contacts to identify credit sources, credit terms, existing technical alternatives, and so forth. Development activities with such populations result in high transaction costs for both financial institutions and for the suppliers of equipment and technical assistance, making them unattractive to customers and suppliers alike. Consequently, this section of the population is likely to be most excluded from both market and state delivery systems.

Remoteness adds to the costs of all energy supply options, but not necessarily in the same way or to the same degree. Thus, remoteness is likely to increases the attractiveness (comparative advantage) of energy supply options that do not require the transportation of fuels relative to those that do. This will tend to favor options that rely on local energy resources (such as biogas, gasification, hydro, wind, passive solar, and photovoltaic systems) rather than fossil fuel-based systems. However this transport cost advantage may be offset by the cost of imported spare parts and the high cost of frequent visits from urban-based technicians required to maintain novel or delicate systems.

Policymakers face difficult choices in terms of the tradeoff between providing improved energy access to the most people or to people in specific locations. There is an ongoing argument between the advocates of decentralized (often renewable) energy systems and Ministries of Energy and their conventional utilities. Proponents of decentralized systems are often disappointed that utilities will not take them seriously. Certainly small, decentralized systems often face unfair competition from highly subsidized grids, and from subsidized fossil fuels. But there is a genuine tradeoff between maximizing the access of people to efficient and affordable energy, and doing so in those places where a particular technology (such as photovoltaic, wind or microhydro) provides the least cost option.

Indicative of this tradeoff are the statements in evaluations of renewable energy technologies that they "are the least-cost options in the areas investigated" (to repeat the careful phrase used in many recent World Bank evaluations). These locations are likely to be remote sites or where there is a low load density.

The scarce resource in most countries is not energy but the capital to make energy accessible and useful. Therefore if the objective is, for instance, to provide electricity to as many people as possible, the most cost-effective way of achieving this may well be through extensions of the existing grid, or more likely, intensification of the use to which the grid is put rather than to distribute electricity evenly across the country.[27]

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[27] Where utilities have very severe limits on capital (or where the private sector requires a high return on its investment), the "opportunity cost" of capital at the margin rises to very high levels, explaining perhaps why they then opt for diesel generators rather than hydro with its higher initial capital cost. There has been a marked reduction of investment in medium- and large-scale hydro as utilities have been "corporatized" or privatized. See evidence for this "perverse" shift away from "economically justifiable hydro dams toward...less environmentally friendly, thermal plants" (World Bank 1998b, page 58; see also page 57).

On the other hand, if equity consideration forms part of the objectives of energy policy, for example between regions or population groups, then small-scale decentralized technologies, such as diesel engines, photovoltaics, and microhydro, are likely to have an important role, even if the intended users cannot meet the full cost. A review of recent microhydro programs in Peru, Nepal and Sri Lanka suggest that they have been explicitly motivated by ideas of social justice and fairness (Khennas and Barnett 2000). Certainly people in remote rural areas in many countries can be expected to ask why they should not be entitled to at least the same levels of subsidy on energy services as those often provided to urban dwellers.

Environmental Aspects of Reducing Energy Poverty

Environmental impacts are both a driving force in raising awareness of issues of energy and poverty but they also form a major constraint to action. The huge impact of indoor air pollution caused by the burning of solid fuels, particularly biomass, on the health of women and children has been mentioned already. Similarly, the collection and burning of woody biomass can have effects on ground cover, and the burning of dung can affect the level of nutrients being returned to the soil. But the link between the energy uses of biomass and deforestation varies from location to location. In principal biomass can be a renewable energy resource, but there are areas of fuel pressure where the use of the biomass is more akin to nonrenewable mining.[28]

In a significant number of cases the energy options that best meet the needs of poor people will involve fossil fuels,[29] and their use can have a negative effect on the local and global environment. There are very few alternatives to fossil fuels for transport (although animals are extensively used) and the cheapest electricity for most people will come from large power stations fuelled by gas, coal, or oil. Even in remote rural areas, diesel engines will provide the optimal solution for providing both shaft power and electrical power for machines.

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[28] The FAO (which is probably best placed to know) has asserted for many years that the main cause of deforestation is the clearance of land for agriculture. This truth was largely disregarded by "rural energy specialists" for a long time. The more balanced view is that, although changes in land use are the major cause of deforestation, there are areas of "fuelwood stress," usually surrounding urban areas and refugee camps where the demand for fuel exacerbates the balance between the production and consumption of the biomass.

[29] Such a view is clearly open to misinterpretation. It is not a simple argument against renewable energy. Clearly renewable energy will be the "best solution" for some people, at some locations, at some times. Indeed it is clearly the case that renewable fuelwood is already the least cost energy solution for very large numbers of people. It does suggest, however, that more might be achieved by focusing both on those options that best increase energy access and on those options that best reduce the environmental costs of energy conversion and use. Neither objective is likely to be effectively achieved if both have to be pursued with only one rather limited weapon, namely "new renewable sources of energy."

There is therefore an evident tradeoff between the objective of tackling energy poverty and the objective of improving the environmental problems linked to energy conversion and use. In the medium term and certainly under current prices and other incentives, actions to reduce energy poverty can harm the environment.

However, a great deal of the interest and funding in rural energy is driven by concerns over global environmental issues (the Global Environment Fund, the Clean Development Mechanism, and the Group of 8 Renewables Fund are three examples). This means these new initiatives often are forced to limit the range of options for meeting the energy needs of poor people to *new* renewable options.

If the primary objective is meeting the energy needs of the not-served and underserved populations, neither the optimal solutions nor the most equitable solutions will be found if their energy options are restricted just to renewable sources (either old renewables, such as biomass, or new renewables, such as photovoltaics). The move toward empowerment as a development objective implies that people in power should allow the excluded majority to make informed choices from the full menu of energy options, so they can select the option that best meets their needs. They certainly cannot be expected to restrict their options willingly while northern industrial countries are not doing enough to reduce the pollution burden of their current and past energy consumption.[30]

The complexity of the arguments over renewable and nonrenewable energy options is well illustrated by a particularly important finding from recent empirical research. This suggests that if the people who are currently cooking by inefficiently burning renewable fuelwood were to switch to nonrenewable gas (LPG) there would be a strongly positive environmental impacts and a massive reduction in green house gases per person meal.[31] Simplistic assumptions as to the relative merits and demerits attaching to renewable and nonrenewable energy sources can be very misleading, and lead to damaging policy responses.

The UNDP's Initiative for Sustainable Energy (1996) goes some way in making the tradeoff between poverty reduction and the environment more explicit. It shows why the tradeoff exists and what can be done to reduce it. The UNDP report argues in particular that "poverty eradication and improved living standards cannot be achieved sustainably

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[30] It is also clear that if the poorer countries of the world were to consume per capita as much energy as industrial countries currently do, global warming would be severe and probably irreversible. There is no longer much doubt that global warming is likely to exacerbate the problems of those parts of the world that are already deeply stressed, economically and environmentally. The question remains, however, whether the poorest people on earth should carry this burden, as well as all the others they carry.

[31] This is because of the considerably greater efficiency with which liquid and gas fuels can be converted into heat for cooking. Burning fuelwood in a normal cooking fire or traditional stove is not "green house gas neutral" because of the products of incomplete combustion. See Smith and others (2000).

without major changes in the current energy system," including bringing energy prices in line with their full cost[32]. This results in a strong argument for energy sector reform from the points of view of both environment and social efficiency. The World Bank's "Fuel for Thought" (1998b) similarly identifies the need for more analytical work to develop pragmatic ways of "internalizing the externalities" associated with the environmental impact of energy conversion and use.[33]

Recent Developments in Energy Supply Systems

It was suggested in chapter 1 that energy has recently fallen off the agenda of mainstream development thinking and action. But at the same time fundamental changes have also taken place that make the energy sector of today quite different from that of even 10 years ago. In addition to the widespread efforts at energy sector reform, two changes in particular have had a bearing on the poverty, gender, and energy framework. One in what is technically possible in the conversion of primary energy into useful energy, particularly at the small scale; and the other in the realization that even poor people already pay significantly for energy services.

Policy thinking in the energy sector has been significantly affected by massive technical changes in recent years. A great deal of the change has been in the large-scale industrial sectors (effectively removing a major element of utilities' natural monopoly). But advances in small-scale technology have also increased efficiency and reduced costs, opening up a wide number of options for profitable small-scale, decentralized energy supply. This was most apparent in improvements to diesel and small petrol engines, but there have also been promising developments with photovoltaic cells (where prices have fallen dramatically), wind generators, microhydro (particularly with the introduction of electronic load controllers), biogas, and gasification.

Although energy poverty is clearly a function of more general poverty, it has recently become clear that many rural people, and the urban poor, already pay significant amounts of cash to meet their energy requirements. In many cases the amounts they pay for energy will be a much higher proportion of total cash income than is the case for richer people.[34]

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[32] UNDP 1996. It goes on to say that "the transition to this new paradigm will inevitably take many decades" (page 18). "Improvements in end-use efficiency and greater use of renewables have long been discussed as major hopes for the future. They have not yet, however, made the substantial contribution to increased energy services for which they have potential." However, the UNDP is unequivocal in its belief that it is "technically possible to meet all of the environmental changed associated with energy while increasing the supply of available energy and the living standards of billions of people" (page 34). However it notes a great deal of uncertainty about performance and cost characteristics in more environmentally benign options—but this will only be known if the world puts in place "strong and sustained investment in R and D" (page 40).

[33] World Bank 1998b.

[34] This is the case, for instance, in Hyderabad. See ESMAP 1999.

And in some cases, the poor will pay more in absolute terms than their richer compatriots.[35]

Evidence of what poor consumers are paying for energy is coming from a wide range of countries across the globe. One type of evidence is provided by data on the widespread use of 12-volt (car) batteries for lighting, radio and TV where alternative sources of electricity are unavailable. Recent survey data from Uganda show that in 1996, 94 percent of households not connected to the grid used dry cell batteries and were thought to spend about US$6 per household per month on them.[36]

This discovery of significant cash payments for improved energy services, even among relatively poor people, means that in principle it may be possible to meet their needs with market-based solutions. Such people do not necessarily have to wait for the state, aid agencies, or NGOs to extend energy services to them. Although the supply of improved energy services to poor people is by definition unlikely to be the most profitable area for private sector investment, there is a new optimism that modest profits can be earned from such businesses, particularly if the relevant social, legal, and physical infrastructures are in place.

The Role of Intermediation

Experience during the past 25 years demonstrates that at the heart of the problem of developing decentralized energy supply options are the very high costs—often described as the "the transaction costs"[37]—associated with putting together the various elements of technology, finance, community development, and management required to make such schemes work

For many of the larger schemes, many hundreds of tasks are necessary to get them off the ground and running sustainably. A number of analysts have found that the idea of intermediation offers a convenient way to group and understand these activities. The approach extends the idea of financial intermediation and considers three additional

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[35] This situation arises partly because it is the richer people who tend to benefit most from existing energy subsidies to both electricity and to kerosene, but it is also a function of the greater amounts of primary energy that poor people have to buy because of the low efficiency with which they can convert primary energy into useful energy.

[36] The same survey found that there were at least 44,000 lead acid batteries in use among the 550,000 households represented in the 12 districts. It is estimated that some 100,000 periurban and rural households in Uganda use lead acid batteries for electrification. The total expenditures on these batteries (including charging, transport, and capital depreciation) could be as much as US$10 million per year. Households that use both lead acid batteries and dry cell batteries for rural electrification (approximately 4.3 percent of rural households) spend US$16 per month, or approximately US$192 per year, on these sources of electricity. Similar World Bank data are available in other countries as diverse as India and Zimbabwe. In Sri Lanka comparable expenditures are implied by the fact that several thousand electric generators of less than 75 kVA are regularly imported into the country at an annual cost of more than US$10 million (1996 data).

[37] See "social overhead investment" in Barnett 1990.

forms of intermediation: technical intermediation, social intermediation, and organizational intermediation.

Financial Intermediation involves putting in place all the elements of a financial package to build and operate a decentralized energy supply company in place. A process sometimes referred to as *financial engineering*. It covers the following:

- The transaction costs of assembling the equity and securing loans.
- Obtaining subsidies.
- The assessment and assurance of the financial viability of schemes.
- Assessment and assurance of the financial credibility of borrower.
- The management of guarantees.
- The establishment of collateral ("financial conditioning").
- The management of loan repayment and dividends to equity holders.

Financial intermediation can also be used to cover whole schemes rather than just investment in an individual plant. In this way projects can be bundled together in a way that:

- Makes them attractive to finance agencies.
- Establishes the supply of finance on a wholesale basis from aid agencies, governments, and development banks.
- creates the mechanisms to convert these flows into a supply of retail finance (equity and loan finance at the project level).

Technical intermediation involves improving the technical options by undertaking research and development activities, and importing the technology and know-how down through the development of capacities to supply the necessary goods and services. These goods and services include: site selection; system design; technology selection and acquisition; construction, and installation of civil, mechanical and electrical components; operation; maintenance; trouble shooting; overhaul; and refurbishment.

Organizational intermediation involves not only the initiation and implementation of programs, but also lobbying for the policy change required to construct an environment of regulation and support in which the energy technology and the various players can thrive. This involves putting in place the necessary infrastructure and getting the incentives right to encourage owners, contractors, and financiers. Organizational intermediation must include the development of regulatory support and incentive structures that can specifically address the energy needs of the poor and women, particularly in rural areas.

Organizational intermediation may be usefully distinguished from a related activity, social intermediation. This involves the identification (by socioeconomic status and gender) of owners and beneficiaries of projects and the community development necessary to enable a group of people to acquire the capabilities to take on and run each individual investment project. It includes measures for enabling poor people and

specifically women to obtain a voice in project identification, design and management of programs.

The Role of Subsidies

In addition to overall poverty, the number and range of intermediation tasks, low density of demand, and remoteness of location, raises the costs and reduces profitability of energy supplies to rural areas. Furthermore a certain amount of social overhead investment almost always has to be put in place to support such schemes (for example, training, technical assistance, and capacity building within communities). The burden of these overheads will be particularly high for innovative schemes, although they may eventually be spread across a large number of enterprises.

A recent report from The World Bank confirms the view held by many people involved in the practical implementation of rural energy schemes when it says that:

> It is illusory to expect that increasing access to electricity for a significant part of the population traditionally excluded from grid-based electricity can be financed only by the private sector. [38]

If the cost of energy is too expensive for poor people who need it, then the issues of subsidies and grants cannot be avoided. The political acceptability of subsidies has undergone wild fluctuations in recent years. All governments provide subsidies, and it is clear that some have done more harm than good by destroying markets and benefiting people who are already better off. However, the essential question that has emerged from the ideological posturing of recent years is less about the rights and wrongs of subsidies in principle, but rather as to whether a particular form of subsidy is actually likely to achieve its intended purpose.

The arguments for using money that is supplied at less than full commercial rates of interest (soft money) are overwhelming if large numbers of people are to be given access to improved energy services. This soft money will be required to enable people with insufficient purchasing power to gain access to electricity and to other, more convenient, forms of energy.

If the case can be made for subsidies, experience suggests that the use of soft money can both help and harm the expansion of decentralized energy supply options. As always, the "devil is in the details," and in the specifics of each context. Hence the phrase "smart subsidies"[39] has been coined to put some distance between current forms of subsidy and the earlier forms, such as subsidies on grid-based electricity, kerosene and diesel, that have been shown to stultify innovation, destroy markets, and support the already rich.

A large number of technology-driven schemes currently adopt a strategy of trying to increase sales through subsidy. This is particularly the case with photovoltaics. It is

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[38] Floor, Massé, and Girdis 2001, page 10.

[39] The term *smart subsidies* was first coined by Charles Feinstein at the World Bank; details of what is involved can be found in Floor, Massé, and Girdis 2001.

argued that increased sales will reduce the cost of production and, more importantly, enable the overhead costs of providing technical support and supplying retail credit to be spread over a larger number of unit sales. The evident danger of such an approach is that "soft" money intended for social investment is often used to subsidize the costs of these supply options for those who could readily afford to pay the true cost if they genuinely regarded this as a priority area of expenditure. Furthermore, the use of subsidies linked to a particular supplier can make matters difficult for other entrants to the market.
In essence, smart subsidies should:

- Follow preestablished rules that are clear and transparent to all parties.
- Focus on increasing access by lowering the initial costs (technical advice, capital investment) rather than lowering the operating costs.
- Provide strong cost minimization incentives, such as retaining the commercial orientation to reduce costs.
- Remain technologically neutral.
- Cover all aspects of the project including end-use investments, particularly to encourage propoor end uses.
- Use cross-subsidies within the project to pay for life line charges, tariffs, and other propoor, recurrent cost subsidies (for example, enable transfer from richer sections of the community, and commercial users to marginal connections).

The Enabling Environment

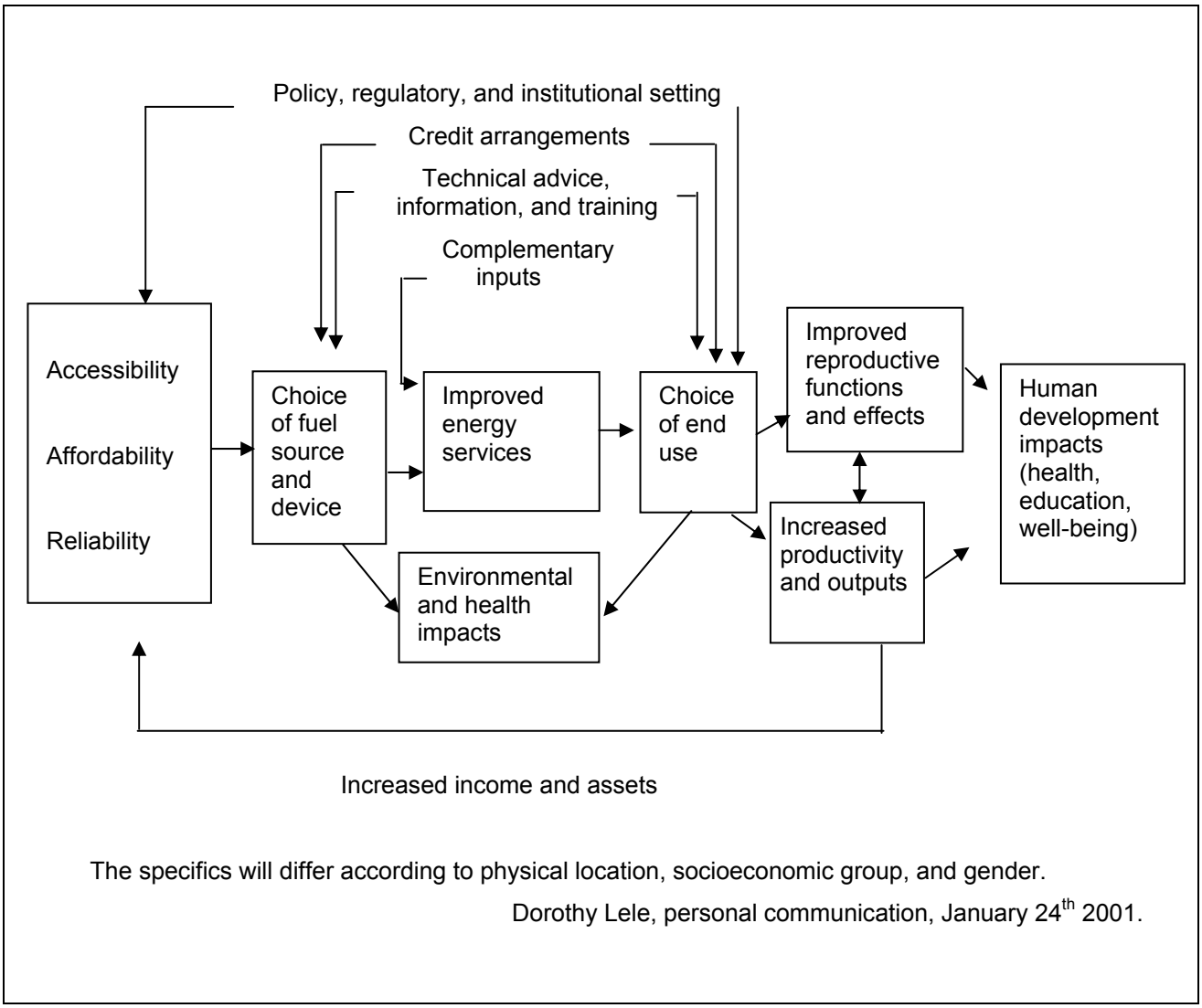
The state clearly plays a crucial role in the provision of subsidies, even where it has been scaled back from direct involvement in providing energy services to poor people. However, subsidies should not be considered in isolation from other aspects of state intervention. Although the climate is growing more favorable to decentralized energy supply options, in most countries the existing regulatory framework is often the major barrier to such development. It can be hostile, contradictory, or uncertain. Taxes and subsidies still often undermine markets rather than encourage them. The supporting infrastructure of training institutions or finance may be nonexistent or inaccessible. Competitors may be able to gain privileged access to subsidies that enable them to sell their products below cost. Without changes to this policy environment, the flow of private sector finance and innovation will be restricted. These are the areas currently at the focus of much analysis, innovation, and reform.

Putting the Pieces Together

There are clearly many ways in which the overall energy supply and use system might be conceptualized. The next chapter will describe the construction of a framework based on the Sustainable Livelihood approach that was used for the fieldwork in China undertaken by this project.

One of the commentators on an earlier draft of this paper contributed the useful diagram in figure 3, which summarizes the key ideas of complementary inputs, the choice of end-use technology and the division between reproductive and productive outputs.

Figure 3: Energy Supply and Use System



The specifics will differ according to physical location, socioeconomic group, and gender.

Dorothy Lele, personal communication, January 24th 2001.

4 Toward an Analytical Framework

In recent times, much of the debate on poverty reduction has focused around two main analytical frameworks. These can be broadly identified with work on Sustainable Livelihoods and Poverty Reduction Strategy Papers. This chapter outlines the main features of these two approaches and considers their relevance to energy issues. An initial synthesis is attempted and a possible framework for future research suggested.

Existing Frameworks for Poverty Analysis

Sustainable Livelihoods

Following the early work of Chambers and Conway (1992), the United Kingdom Department for International Development (DFID) adopted the following definition of sustainable livelihoods:

> A livelihood comprises the capabilities, assets (stores, resources, claims and access) and activities required for a means of living: a livelihood is sustainable which can cope with and recover from stress and shocks, maintain or enhance its capabilities and assets, and provide sustainable livelihood opportunities for the next generation: and which contributes net benefits to other livelihoods at the local and global levels in the long and short term.
>
> DFID 1999

This definition identifies three elements: human capabilities, such as education, skills, and health; access to tangible (financial, capital) and intangible (access to services, information, and so forth, claims on relatives, the state, and so forth) assets; and the existence of economic activities. A livelihood strategy is defined by the interaction between these elements and livelihood security status is measured in terms of both consumption and asset levels. The approach derives from Sen's entitlements model as modified by Swift (1989). In terms of poverty reduction, it focuses attention on ways in which the capabilities of vulnerable people can be enhanced, such that specific households and individuals can secure their livelihoods, whether through production and income-generating activities or by other means.

The analysis of livelihoods focuses on households, but looks both outwards, to examine the relationships between households, community organizations, local government and other actors; and inwards, to examine intrahousehold relationships, such as between men, women, children, and the elderly. In terms of external relationships, a key element of concern is the difference between household assets, whose use is

determined solely by household members, and community assets in which the household may hold some interest and over which it may exercise some limited control.

Poverty Reduction Strategy Papers

Launched by the World Bank in early 1999, the Comprehensive Development Framework (CDF) was seen as a means by which countries could implement integrated strategies for economic development and poverty reduction. It attempted to bring together current trends in development thinking with the aim of facilitating countries to achieve a balance between good macroeconomic management and sound social, structural and human policies. The Poverty Reduction Strategy Paper (PRSP) is based on CDF principles and aims to integrate poverty reducing policies within a coherent, growth oriented macroeconomic framework.

As outlined in the *World Development Report 2000–2001* (WDR), a PRSP has three action pillars: empowerment, security, and opportunity. The empowerment agenda is a reflection of the remarkable rise of participatory approaches within the development community: "once a shout from the radical fringe, the call for participation has resurfaced as a dominant voice in development thinking" (da Cunha and Pena 1997). It emphasizes the need for decentralization, support for poor community groups and organizations, and giving poor people a voice in all stages of decisionmaking. It focuses on the institutional context, where institutions are defined very broadly as humanly devised constraints that structure human interactions. The section on security can be seen as deriving from earlier work on safety nets, risk management and coping strategies, combined with elements of the rights-based approach to human development. The discussion on opportunity links economic growth to elements of the entitlements agenda and emphasize the need to enable poor households to improve their livelihood strategies by asset building. This should include not only include financial and capital assets, but a range of intangible assets, such as employment, education, health, and access to clean water.

Comparisons between the Two Approaches

The UNDP and DFID have developed a sustainable livelihood into a major analytical framework. It has clearly influenced both the approach and language adopted by the World Bank in developing the PRSP. Broadly speaking, in the latter framework, income and capabilities would correspond to opportunities and how they are used. There are also similarities in the extent to which attention is focused on the role of institutions and on the definition of poverty. On the former issue, one key question in sustainable livelihoods can be seen as determining what it takes to translate different types of assets into capabilities. That process is mediated by institutions, and is defined in very broad terms to include rules, laws, norms, and markets. In terms of poverty definition, under the influence of Sen's thinking on the relationship between capabilities and functions, the livelihoods framework encourages an exploration of the multidimensionality of human suffering, rather than concentrating only on the material aspects.

The WDR also stresses the need for a more sophisticated, multidimensional approach to the concept of poverty, which recognizes the importance of dimensions other than income, such as education, health, insecurity and powerlessness. It also moves away from the prevalent use of national average figures for poverty incidence, and examines how economic growth might impact on the poverty status of particular population groups.

Both frameworks run into similar problems when moving from concepts to measurement. For example, although they embrace the multidimensionality of poverty in theory, the monitoring agenda will usually adopt a much narrower perspective when there is a need to derive relatively simple indicators to determine, for example, the impact of specific poverty reduction initiatives. This is particularly evident in much of the econometric work undertaken within the PRSP rubric. The participatory methodology, which is often adopted in studies on sustainable livelihoods, is also problematic, in that it tends to have a community perspective and often fails to focus on poor individuals and households. Much that is written in the name of poverty reduction is about community development: "look at all of us we are all poor, we all suffer from the same deprivations." Poverty mapping, which attempts to combine participatory and money-metric measures, has been suggested as a way of determining the degree to which such measures converge in practice, but the evidence is not yet convincing.

Two major influences on the development of both the Sustainable Livelihoods and PRSP approach have been the good governance and participation agendas. Driven by the neo-liberal agenda of the 1980s and early 1990s, there was much on the failures of the state and the need to pursue market solutions. The tendency within some donor agencies was to identify *good* states with *minimal* states. Governments were often sidelined, with resources being channeled through NGOs. In many countries the majority of development assistance was outside the state budget. Many of those working in the governance area were largely concerned with multipartyism, removal of corruption, downsizing and reform of administrative structures, and rethinking of judicial and legal systems. More recently, both markets and government interventions in markets are recognized as having strengths and limits. There is once again an attempt to define a role for government, particularly in terms of its regulatory function, where markets are either failing to deliver or giving rise to major equity concerns. This has led to an emphasis on good governance, with a particular focus on the need for institutions that can effectively implement good policies (World Bank 1997). Governments are now seen as in need of strengthening with the aim of improving the quality of public decisionmaking and public expenditure in terms of the poverty reduction agenda.

The late 1990s also saw an increasing recognition of the potential role for strong grassroots movements in poverty reduction, a view that had been long promoted by those working on participation. Developments were also taking place in this area, with the realization that to be effective it was essential to involve both local and national governments in order to influence policy and budgetary allocation decisions, which could

either, reinforce or undermine local community initiatives. Thus in recent years, governance experts have tended to move away from promoting democracy and reducing corruption, and have identified poverty reduction as central to their agenda. Advocates of participation have scaled up their activities to bring the voices of the poor and marginalized into the mainstream. Both groups have focused on poor people as citizens and active members of communities, the need for analysis of the institutions that impact on poverty, and the concept of an enabling environment structured around the concepts of regulation and accountability.

The PRSP approach in particular can be seen as primarily concerned with poverty reduction through good governance that involves consultation and participation. But as analysts of democratic local government have pointed out, there are typically no specific benefits for poor people as a result of democratic processes at the local level. Benefit often only accrues if, as a consequence of local government being more responsive to local demands, there is strengthened provision of a universal benefit. In practice, it may be even more difficult to direct resources to poor people through a local government that becomes accountable to local elites. In general, lessons learned from poverty reduction do not indicate a strong link between governance, participation, and the well-being of the poor. In a number of countries, successful programs, such as drinking water, microfinance, family planning, and agricultural planning, have been very much top down; no participation or consultation has taken place and yet there has been massive poverty reduction. There is a risk that an exclusive focus on governance and participation may crucially divert attention away from issues of production, increased productivity, and associated infrastructure investment, which must remain central to any realistic poverty reduction strategy.

Similarity of Basic Concepts

Although there are differences in terms of language and emphasis, there appears to be considerable agreement at least in terms of core concepts between those developing the PRSP and Sustainable Livelihoods approaches. Both clearly accept a broad concept of poverty that goes far beyond the traditional definition based on minimum income levels. Both speak of the dimensions of poverty and focus on the complex interrelationships between these dimensions.

> This Report accepts the now traditional view of poverty as encompassing not only low monetary income and consumption but also low human development such as in education, health and nutrition. It also goes beyond these dimensions to include risk and vulnerability, voicelessness and powerlessness.
>
> World Bank 2000

Cause-and-effect relationships are seen as existing in both directions between the various dimensions of poverty. For example, low income tends to result in lower levels of

human development but is often also a consequence of poor education, sickness, and malnutrition. Increased income tends to reduce vulnerability and powerlessness, whereas greater participation in decisionmaking may lead to the creation of opportunities for improved income earning. Each approach emphasizes the need to take a holistic view of the complexities of the lives of the poor and structure their arguments around three key areas. Sustainable Livelihoods focuses on the following:

- The assets (natural, physical, social, human, and financial) that allow people to make a living. A sustainable livelihood is one that allows a household to at least maintain and hopefully increase its stock of assets.
- Resilience to the multiplicity of shocks, natural, economic, or social, to which the poor are particularly vulnerable. Much early work on Sustainable Livelihoods was focused on Livelihood Security (Drinkwater and McEwan 1992).
- The "institutions" (from informal civil society organizations to the private sector and the State) and processes[40] (ranging from social norms and gender relations to policies and laws) which influence both Livelihood Strategies, adopted by the poor in an attempt to attain sustainability, and Livelihood Outcomes. Interventions will often target these institutions and processes, empowering the poor in order to expand the range of available livelihood strategies and reduce vulnerability.

There are clearly very close parallels to the three pillars of the WDR:

- *Opportunity:* Expanding economic opportunity for the poor by building up their assets and increasing the returns on these assets, through a combination of market-oriented and non-market-oriented actions.
- *Security:* Helping the poor to manage the risks they face in their everyday lives, and managing national downturns to minimize their impact on the poor.
- *Empowerment:* Making state institutions propoor and removing social barriers to poverty reduction.

Integrating the Energy Dimension

Neither of the frameworks offered by the Sustainable Livelihoods nor the PRSP approach deals very effectively with energy in their current configurations. However, both approaches are under development and can be expected to improve, and probably converge. A comparison of categories used by both approaches shows that there is considerable overlap (see table 4). Maxwell reminds us that these similarities in the various approaches are to be expected. "The discourses may differ, but it is hard to

[40] The terms "institutions" and "processes" are interpreted here loosely, reflecting their common usage. See Mahta and others 1999.

escape a vocabulary that deals mainly with raising and spending money, the incentive and regulatory framework, the reform of public services, issues of voice and participation, and the contribution of international aid." (Maxwell 2000)

However each framework has a slightly different focus: the PSRP aims primarily at the macro and meso scales of development activity. This reflects the national focus of the poverty strategies, but is also consistent with the World Bank's recent emphasis on sector reform rather than projects. The PRSP specifically deals with energy through an Energy Tool Box in the form of an energy chapter of the forthcoming *Guidelines for writing Poverty Reduction Strategy Papers*. In the 2000 version the energy chapter covers two main domains of activity: household welfare and growth. It provides a checklist of issues including the interactions between energy policy and improved fiscal stability, and sets out the arguments for different fuel pricing principles and forms of subsidy. It does cover a number of issues at the micro level, particularly in relation to the health effects of biomass fuel use in cooking (page 17) and the benefits of encouraging community participation (page 24).

The Sustainable Livelihoods, on the other hand, emphasizes individual interventions at the micro level of projects and participatory development. But the version advocated by DFID does not (yet) deal adequately with the energy dimension of development.[41] Energy supply and use systems are mentioned as forming part of physical capital, which includes access to basic infrastructure and the ownership of producer goods needed to support livelihoods. "Infrastructure consists of changes to the physical environment that help people to meet their basic needs and to be more productive and producer goods are the tools and equipment that people use to function more productively." (DFID 1999)

[41] An attempt at such an integration is to be found in appendix 3.

Table 4: A Comparison between PRSP and Sustainable Livelihoods Approaches

PRSP energy toolkit		**Dfid sustainable livelihood guidance notes**	
Poverty alleviation outcomes	**Energy linkages and impacts**	**Livelihood assets**	**Sustainable livelihood outcomes**
Income	• Essential input for businesses • Macro stability (increase tax revenues and reduce fiscal burden) • Enhance labor and capital productivity		• More Income • Increase Well-being
Capability	• Essential healthcare and education services • Essential complementary infrastructure • Health improvements (reduced indoor pollution)	• Human capital • Physical capital • Social capital • Financial capital	• More income • Increase well-being
Security	• Energy price stability Illumination and personal security • Environmental sustainability	• Natural capital	• More sustainable natural resources
Empowerment	• Choice of energy services access to information (radio, TV, and communication • Increased accountability of service providers		• Reduced vulnerability

The DFID guidance sheets (DFID 1999) argue that the components of infrastructure usually essential for sustainable livelihoods include the following:

- Affordable transport.
- Secure shelter and buildings.
- Adequate water supply and sanitation.
- Clean, affordable energy.
- Access to information (communications).

According to these documents "Many participatory poverty assessments have found that a lack of particular types of infrastructure is considered to be a core dimension of poverty. Without adequate access to services, such as water and energy, human health deteriorates, and long periods are spent in nonproductive activities, such as the collection of water and fuelwood. The opportunity costs associated with poor infrastructure can preclude education, access to health services and income generation…. The increased cost (in terms of all types of capital) of production and transport means that producers operate at a comparative disadvantage in the market" (section 2.3.4 of the guidance sheets).

In the Sustainable Livelihoods approach, energy is likely to impinge on all aspects of the model (from the vulnerability context, through the livelihood assets, and the transforming structures and processes), and energy will play a major part in determining the nature and range of livelihood strategies that are feasible.

However, the lack of a specific emphasis on small and micro enterprise development seems surprising in an approach to livelihoods. This may result from the approach's genesis in the areas of natural resource and agricultural development, rather than suburban and nonfarm self-employment. By combining "energy supply and use" into the category of "physical capital," the approach also appears to gloss over important distinctions between ownership of the means of production and the ability to gain access to energy inputs, such as fuel, in the process of earning a livelihood.

In common with other existing frameworks it does not deal adequately with the indirect nature of the demand for energy services and the complexities introduced by the fact that that some energy systems are privately and individually owned (such as the self collection of woody biomass for use in cooking) whereas others are best provided either at the level of the community (small hydro systems) or the nation (large electricity systems or the supply of paraffin and LPG).

The central point of the Sustainable Livelihoods approach is the necessity to help stakeholders with different perspectives to engage with the many factors that affect livelihoods—in short: participation. Such a message certainly reflects the trends in the search for decentralized energy supply options for poor people. Cecelski (2000b) points to the apparent success in participatory and gendered approaches in the area of water and sanitation and their applicability to energy and poverty. She refers in particular to the work of Dayal, van Wijk, and Mukherjee (2000). This approach, which was applied in 88 villages on three continents, has obvious similarities to that of Sustainable Livelihoods in terms of its participatory nature and emphasis on and environmental sensitivity.

Certainly people have made businesses of selling water and sanitation services and these may provide useful models for the energy sector.[42] Similarly, there are strong parallels between water supply and energy supply when it is directly related to production

[42] See, for example, the excellent Water and Sanitation Program website http://www.wsp.org/english/activities/small-towns.html.

in terms of irrigation and consumption of drinking water. But as suggested earlier the main factor in determining whose livelihood will be secured by energy interventions will be the choice of end uses.

An Initial Synthesis

Once the basic parameters of the energy links to poverty are laid out they can be superimposed onto the categories used by the Sustainable Livelihoods approach. As indicated above, an attempt to track these poverty linkages to and from the energy systems is made in appendix 3. This shows that it is relatively easy to generate a vast number of possible interconnections. These links specified in the appendix are illustrative, and show that in practice the scale and nature of each link will depend on the local physical, cultural and political circumstances.

But this exercise also has another effect. It serves to emphasize that just as the people conducting livelihood assessments need to be aware of the gender dimension, so too they need to be aware of the ways energy (and other inputs) impinges on poverty reducing strategies. In practice this will mean understanding how their interventions could be improved with the addition of appropriate energy services (or as important, how they would be constrained, in their absence) and being aware of the wide range of options and mechanisms that might best meet the energy needs of particular groups (differentiated by gender, health, class, location, and so on). This is unlikely to be achieved by administrative decree.

The Sustainable Livelihoods approach offers the considerable advantage of forming part of a lively ongoing process of developing participative and other forms of Monitoring and Evaluation.[43] These, combined with the specifically energy focus offered in appendix 3, provide the foundations for systems to monitor and evaluate the impact of energy interventions on poverty and gender.[44]

A Possible Framework for Research

Drawing on aspects of both the PRSP and Sustainable Livelihoods approaches discussed above, it is possible to define the elements of a possible research framework to consider the links between energy, poverty and gender. Livelihood outcomes for poor men and women are taken as the central concern. These outcomes are seen as determined by the

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[43] See Guidance Sheet 3.4 on M and E in http://www.livelihoods.org/info/info_guidancesheets.html. See also Pasteur 2001.

[44] Another recent attempt to develop a system of monitoring evidence of improved energy access (although not energy impact in the strict sense) is provided by Foster 2000 and Foster and Tre 2000.

ways in which the poor use their assets within the existing geographical and institutional environment. The main factors influencing this process are discussed below.[45]

Location, Climate, and Natural Resources

Location is important in that it may strongly influence both the availability and demand for energy services. The distance from existing electricity grids, or markets where fuel supplies or energy using devices may be obtained will affect availability, cost and possible end uses of particular types of fuel. Distance from urban areas will affect the possibilities for maintenance of equipment generating or using energy. Isolated communities that have difficulties in gaining access to markets may also have less incentive to adopt more productive energy-using devices. On the other hand the benefits derived from the social uses of energy may be much greater for member of communities who have to travel long distances to health facilities, schools, or centers where communications or entertainment services are provided.

Access may also be limited by climate factors. Snow or rain may make roads and paths impassable or dangerous at certain times of year. Climate will also have obvious implications in terms of energy demand, such as in terms of heating and supply for solar cookers, or wind generation of electricity. Aspects of natural resources that need to be considered include: availability of biomass materials that can be used as fuel; soil conditions, which will affect the types of crop that can be grown and the demand for irrigation; and water resources, which if plentiful may be used as a source of energy and if limited may consume considerable energy in terms of pumping, transportation, or boiling to render it safe for drinking.

Livelihood Strategies

Poor households and individuals adopt livelihood strategies, which consist of a wide variety of both market-oriented and non-market-oriented activities. The aim of these strategies will be to sustain, and if possible improve, their situation by appropriate use of their stock of assets, both material (physical and financial capital) and nonmaterial (human and social capital). Poverty reduction will imply the accumulation of assets over time. This can lead to both improved living standards and an increase in the range of possible future livelihood strategies. In difficult periods it may be necessary to draw on the stock of assets to maintain minimum living requirements.

Focusing on sustainable livelihoods provides a means whereby the balance between productive and social uses of energy can be understood. Both can be seen as the utilization of energy services to increase asset holdings: one case economic, the other human or social. To understand the potential role of energy services in poverty reduction it is essential to have a clear understanding of the livelihood strategies currently adopted.

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[45] This section of the report was developed during a project workshop held at IDS during the period August 31–September 5, 2000. It was attended by researchers from IDS, ETC, and CRED.

This is necessary to determine if the lack of access to specific energy services may be constraining the range of livelihood strategies available to the poor, reducing both incomes and the possibilities for asset accumulation.

Institutional and Policy Context

Institutions play a central role in the determination and effectiveness of different livelihood strategies. Central and local governments, community organizations, other informal community structures, and private markets determine the economic and social environment within which livelihood strategies must function. The associated policies, laws, customs, and incentives will have a major influence on access to livelihood assets and the possibilities for transformation of assets to generate livelihood outcomes. The institutional context also plays a major part in terms of vulnerability and security. For example, it will determine the extent to which the poor can expect to receive organized assistance when confronted by natural, economic, or social shocks.

Government policies will provide the framework for the development of energy services and determine which organizations are involved in the planning and implementation of such services. Institutional arrangements for the supply of energy and energy-using devices, whether through state organizations, NGOs, major enterprises, or small private traders, will have a major effect in terms of both access and accountability. In addition, as frequently indicated above, energy is essentially an intermediate good whose benefits are realized only in conjunction with other complementary inputs. Energy policy must be considered in parallel both with policy on other sectors (for example employment, education, health, agricultural extension, water, and transport) and with specific policies on poverty alleviation and social security.

Gender relations and cultural norms will have major influences on both the involvement of men and women in energy service decisionmaking and the extent to which energy use in activities—marketed or not marketed—is gendered. They may also largely determine the priorities for the application of new energy services and hence the distribution of benefits from their introduction.

Income and Consumption

As indicated above, poverty is now seen as a complex, multidimensional phenomenon. However, this broad definition does not minimize the importance of increasing incomes and consumption. Apart from the fact that most poor households would probably see income poverty as the key issue, reducing income poverty can be one of the most direct means of, for example, increasing empowerment and reducing vulnerability. Similarly, earned income itself is determined by the levels of livelihood assets and the rates of return on each of those assets. The role of improved energy services in increasing both the options for income-earning activities and productivity in existing activities remains of primary importance.

Time Use and Time Poverty

The poor are typically the most heavily dependent on human energy to undertake production and other essential household activities. Such activities are generally characterized by low productivity and high labor-time inputs. Within poor households, women and girls bear a major share of the lowest productivity, most time-consuming work. Time poverty arises where the rate of return on human assets is so low that household labor time has to be largely allocated to survival needs. Many of the poorest literally have no time to earn additional income during periods when demand for labor is high, take advantage of social assets, which might improve their situation, or play an active role in decisionmaking within households and communities.

The consequent lack of leisure time may also have dire consequences for both health status and other aspects of human capital, and thus further increase vulnerability. The role of energy services, whether by powering equipment or increasing day length, in liberating poor men and women from this cycle (low productivity constraining the ability to increase the stock of economic, social and human assets that could improve productivity), is an essential component of the way energy contributes to poverty reduction.

Physical Asset Ownership and Access

The most obvious route to increased productivity via improved energy technology lies in the increased use of physical capital assets. This may be achieved through ownership or by gaining access to assets owned privately by other individuals or collectively by communities. This increased productivity may provide opportunities for addition income or reduce labor time spent on household activities. Physical assets may also directly act on human capital, for example, by providing light for reading, access to educational communications equipment, or cooking arrangements that reduce household air pollution.

Human Capital

In addition to their effects at household level, inadequate energy services, particularly in rural areas, may substantially impair the provision of community services, such as education, health, potable water supply, and sanitation. The absence of effective lighting, heating, cooling, and pumping equipment may limit the potential benefits of such services and hence the possibilities for maintaining or enhancing human capital assets. Using livelihood terminology, reduced human capital, through sickness or limited education, then leads to diminished capabilities and restricted livelihood strategies.

Empowerment and Participation

There is a tendency for the poor to be excluded both from specific decisionmaking processes and, more generally, from community political, economic, social, and cultural activities. Low levels of social and human capital assets result in reduced social participation. In terms of energy services two aspects are of interest. First, the extent to

which poor households, and poor women within households, are involved in decisions about energy services such as the introduction of new sources of energy or acquisition of end-use equipment. Second, the extent to which lack of access to energy services, in terms of production, communication, education or entertainment activities, in itself tends to reinforce the exclusion of the poorest.

Security

Security aspects of energy services should not be seen only in the limited sense of physical security, such as in terms of the role of lighting in preventing accidents or violent acts. As discussed above, the lack of economic, social, and human assets is the underlying cause of the insecurity of the poor and their vulnerability to natural, economic, and social shocks. Their inability to access energy services may constrain the choice of livelihood strategies that would allow them to reduce this vulnerability.

A Diagrammatic Summary

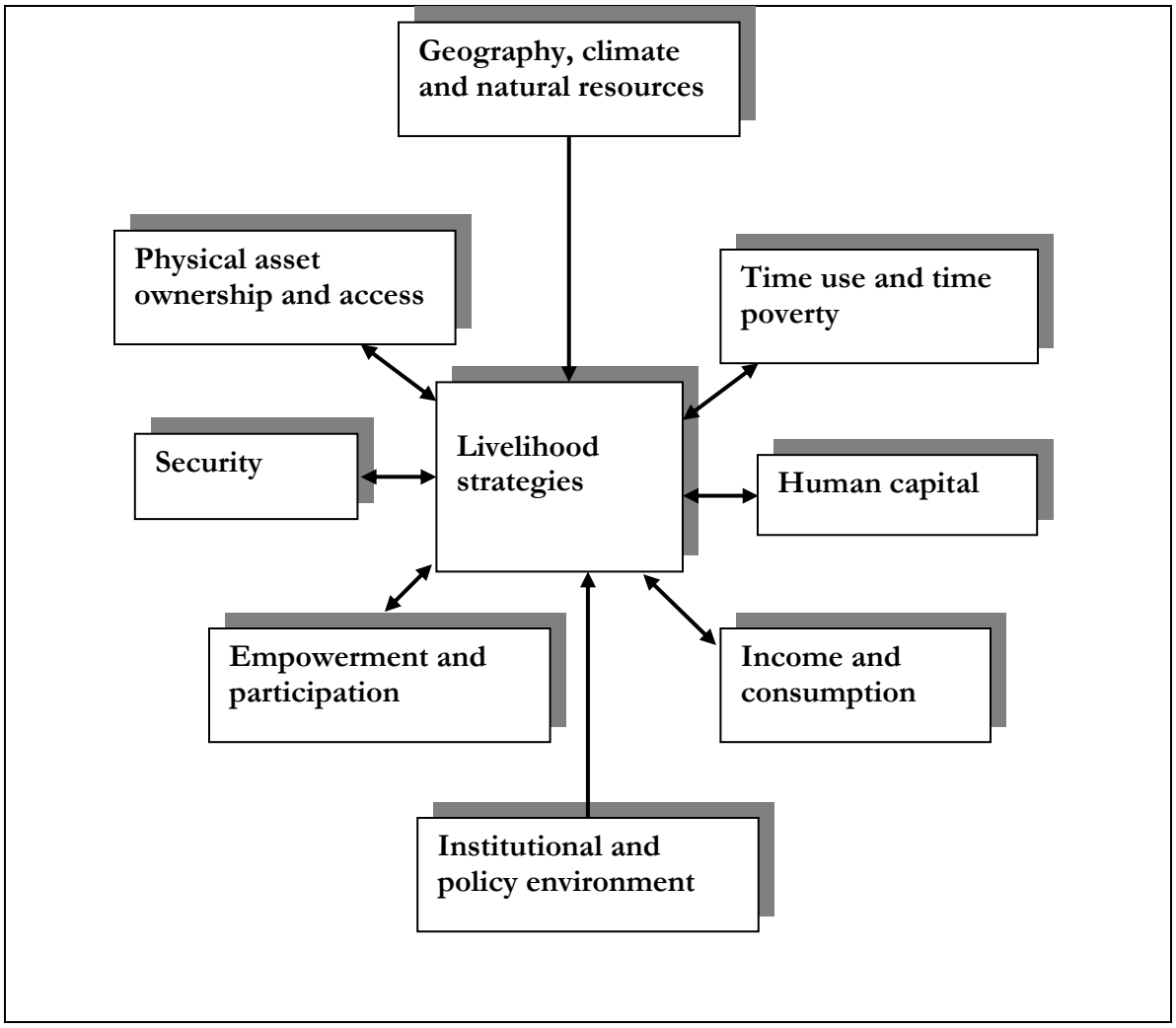
None of the above factors can be viewed in isolation. The closely interlocking relationships between them are of equal importance. Figure 4 below indicates one way of considering these relationships using livelihood strategies as the central focus.

Research Questions

The above framework gives rise to a large range of potential research questions. Some of the key issues are listed below.[46] It should be noted that, given the inter-relationships between the various components described above, the location of a particular question under a particular heading is necessarily somewhat arbitrary.

[46] The questions are an attempt to reflect the main concerns expressed during the IDS workshop (see footnote 45).¥

Figure 4: Livelihood Strategies and Related Factors



Overall

- How important are improved energy services to the reduction of poverty?
- To what extent are alternative poverty reduction interventions dependent on improved energy services?
- What are the implications of improved energy services for gender equity?
- How should the impact of energy projects be assessed if poverty reduction and gender equity are taken as a primary goal?

Geography, Climate, and Natural Resources

- To what extent are the costs and benefits of energy services determined by geographical location, climate, and natural resources?

- Do the effects of geography, climate, and natural resources on energy service access and use vary between rich and poor households? Between men and women?
- Can new approaches to energy services overcome the problems of poor communities in remote areas?

Livelihood Strategies

- What are the principle livelihood strategies within the different study communities?
- In what ways are households poor or vulnerable?
  - What assets do they have and what assets do they lack?
  - What institutions and policies affect them and how?
- What are the livelihood strategies of the poor? How do they differ from those of the not poor?
  - How are the livelihood strategies of women distinct from those of men?
- How do energy services directly and indirectly affect people's livelihoods and the context that shapes them. What is the significance to poor people?
- How do people's livelihood strategies affect their use of and benefit from energy services?
  - Do particular households not use certain energy services? What are the constraints on use?
  - Which energy services are most important to the poor?
- Can improved energy services reduce poverty by enabling livelihood diversification?
- Do new forms of energy service tend to increase the range of services used by households, or displace existing services?
- Who gains and who loses from the introduction of new energy services?
  - Do richer households benefit substantially more than poorer households?
  - Do men benefit substantially more than women?
- How can energy services be adapted to promote positive impacts that are relevant to the livelihoods of poor households and women?

Institutional and Policy Context

- What changes (including institutions, projects, and programs) are occurring at the micro level? How do these affect livelihoods (for example, through conflicting with or complementing livelihood strategies)?
- Do institutional factors have a major influence on differences between rich and poor, men and women, in terms of their input to energy decisionmaking, their utilization of energy services, the costs they incur, and the benefits they derive?

- What are the key enabling and constraining factors and policies?
- What institutional and social arrangements could encourage more equitable distribution of the costs and benefits of energy services:
- Between rich and poor households?
- Between men and women?
- Are there any aspects of the policy and institutional environment that are likely to negate the beneficial effects of new energy services?

Income and Consumption

- Do new energy services improve access to income-earning opportunities?
- How do these opportunities vary between rich and poor households?
- How do they vary between men and women?
- Do households prefer to invest in energy services and devices that tend to increase their capacity for income generation in preference to those that are consumption oriented? Who makes such decisions?

Time Use and Time Poverty

- How are workloads related to energy services?
  - How do these workloads vary between rich and poor households?
  - How do they vary between men and women, adults and children?
- What are the implications of women's time poverty in terms of their livelihood strategies?
- In households reliant wholly or partly on traditional fuels for cooking and heating:
  - Is significantly more time allocated to human energy consuming reproductive tasks?
  - Do women and older girls take on the burden of such tasks to a significantly greater extent than other household members?
- Can improved energy services reduce labor-time inputs to essential household activities?

Physical Asset Ownership and Access

- How are energy services distributed within communities?
  - Who has ownership?
  - Who has access?
- Do improved energy services provide access to more productive technologies?
- Is powered production equipment very unevenly distributed within communities?
- Do poorer households benefit by gaining access to powered production and communications equipment owned by others?

- How do women and men differ in terms of their energy service investment priorities?

Human Capital

- What is the impact of energy services on human capital (health, education) and social capital?
- Which households and individuals have access to communications assets (radio, television, telephone) and what human or social capital benefits flow from such access?
- How does this vary by gender and age?
- In households that are reliant mainly on traditional fuels for cooking and heating, do women and children suffer higher rates of self-reported illness?

Empowerment and Participation

- What is the role of participatory approaches in the development of energy services?
- What are the community- and household-level processes for decisionmaking on energy services?
- How do rich and poor households participate in these processes?
- How do men and women participate in these processes?
- Are people's own livelihood priorities being addressed in the development of energy services?

Security

- To what extent is fuel security, especially for the essential needs of lighting, cooking (including boiling water), and heating, a major concern for poor households and what labor-time do they devote to ensuring it?
- To what extent can improved energy services decrease the risks from natural, economic, or social shocks by increasing the range of options available to poor households in terms of income generation, essential household activities, and service provision?
- Clearly, in specific research exercises a narrow set of issues, adapted to the context and concerns of particular populations will need to be addressed, not only to make it more manageable but also to develop the kind of narrative that underlies the making of most policy.

5 Conclusions: What We Know and What We Do Not

Clearly those concerned with energy in a development context now face a situation that is significantly different from what it was only a few years ago. This includes the following:

- A reclassification of poverty reduction as the primary task of development assistance.
- An increasing focus on poverty reduction strategies and larger, integrated cross-sectoral programs.
- An acceptance that women constitute the majority of poor people, and that their health (and that of their children) is adversely affected by many traditional fuel systems.
- A focus on energy sector reform rather than large energy project loans (mainly for electricity generation).
- Sector reform in which state run utilities are no longer the only clients of Financial Institutions.
- Growing concerns with environmental impact, an emphasis on the need for gender awareness and demands for a more participatory approach to development. Although greater attention to these issues may enhance the quality of projects, it will also considerably increase the time and transaction costs involved in developing new loans.
- Shortage of grant funds to finance the development and preparation of new loans, and the increasing importance of bilaterally funded trust funds within multilateral agencies.[47]
- Additional soft money (mainly through the Global Environment Facility) to subsidize the preparation of projects that have a global environmental impact, but which limit the full menu of options to only those that are renewable (and which are not yet the least cost option without a subsidy).

In addition to the many lessons that have been learned during the past 30 years about poverty reduction, five crucial insights stand out that explicitly relate to the energy sector in general and the rural energy systems in particular:

[47] Within the World Bank the supporters of these trust funds may have agendas that at times will not coincide with those of the Bank or its clients. For example, some trust funds are intended to promote renewable energy rather than necessarily to reduce poverty.

- That the poverty reducing impacts of energy inputs are significantly affected by the existence or absence of complementary inputs (ranging from energy end use equipment, through to the existing of roads to take increased production to market,[48] and so on).
- That the financial sustainability of energy interventions is often determined by the existence of income generating end uses (although most "energy interventions"—such as government initiatives or aid programs—are usually unable or unwilling to support the development of these end uses).
- That the size and distribution of poverty impacts of energy interventions will be significantly determined by the choice of end uses in which the energy is used.
- That the viability of local energy conversion technology (for example, PV, micro hydro, diesel generators) is highly dependent on the load factor: the extent to which the potential energy output is actually used.
- That the energy needs of women are often significantly different from those of men. The poorer people are, the more their inanimate energy requirements are related to "domestic" or "reproductive tasks" of cooking, lighting and space heating where women are the most important actors both in energy supply and use. Therefore women and their energy needs will have to be addressed specifically if energy poverty is to be reduced.

The opportunities for affecting poverty through energy interventions have increased substantially during recent years:

- Both medium- and small-scale energy conversion technologies have increased in efficiency, reduced in cost and increased in convenience, thereby offering a wide range of potential options for profitable, small-scale, decentralized energy supply.
- Energy sector restructuring and regulation has removed some of the monopoly power of government and private sector suppliers.
- Clear evidence that even relatively poor people are willing to make significant cash payments for improved energy services.

This suggests that a broadly market-based approach, combined with carefully targeted support for the poorest, could play a major role in meeting the needs of poor people. Even so it is likely that some forms of subsidy will remain important.[49] However, little of this potential will not be realized in the absence of an effective institutional and regulatory environment.[50]

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[48] Indeed, it seems particularly difficult to provide increased energy services to people who do not have adequate road access.

[49] Discussed in section 1, chapter 3, the subsection *The role of subsidies*.

[50] It appears that it was regulatory rather than technical or economic factors that led to the abandonment of the World Bank (ASTAE-promoted) large wind energy project loan in China last

Similarly, much work remains to be done in developing improved methodologies for monitoring the gendered impact of energy interventions. In the short run it may be difficult to better the pragmatic advice of the Netherlands Development Agency when it says in its recent strategy:

> Most energy projects do not have the potential to completely change the gender balance and the inequalities of centuries, which are often deeply ingrained in cultures. However, they certainly could set the following near-term objectives:
>
> - Ensuring that the heavy work burdens of women are lightened by modernization of the household fuel supply systems, the kitchen and agriculture;
> - Identifying ways in which women can become more independently involved in the cash economy;
> - Ensure that women are represented in local dialogue, extension work and resource management. [51]

Experience of energy poverty programs suggests that they address at least three different objectives, some of which are implicit and some of which are contradictory. However it is clear that each objective requires somewhat different approaches. These include the following:

- *The poverty reduction objective*, which sets out to increase people's access (and use) of improved energy services in the least cost way. This objective is probably most effectively met by focusing on those areas with a high density of unmet energy requirements, and by considering the full menu of technical options: renewable and fossil fuels. This approach will tend to favor options with low marginal costs, such as the extension of the existing power grid, or the extension and improvement of the mechanisms by which fossil fuels (and associated conversion devices) are made available.
- *The location objective*, which sets out to improve the energy services of specific groups of people in specific (usually remote) locations. Again this approach would tend to use the full menu of options (that is, renewable and nonrenewable), but the chosen option will be affected by the specific characteristics of the location and the energy service needs of the people in that location. This objective is probably likely to provide access to energy services at greater cost than the previous option, but, when the location is remote, will tend to favor stand-alone systems, and systems that are associated with lower (fuel) transport costs. Indeed

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year. The program has been restructured to remove 170 MW of wind farms, and the US$87million Bank loan and US$8 million GEF grant have been cancelled.

[51] NEDA 1999.

it may be useful to define alternative energy systems to include decentralized or stand-alone systems, whether or not they are fuelled by renewable sources, on the grounds that they are "alternatives" to the conventional centralized systems.[52]

- *The market penetration objective*, which aims at maximizing the use (or sales) of one or more particular energy conversion technologies, most frequently now renewable energy technologies. This approach is the one usually adopted by the private sector, wishing to sell a particular type of device, such as a diesel engine or solar panel. It is also the approach adopted by people who are particularly committed to a type of technology (for example, the NGO that only works with biogas). This approach seeks those locations and those people whose needs are most likely to be met by their particular device wherever they may live, and probably who have the greatest ability to pay for the device. In the case of PV this may initially be military or telecommunications markets, or other people (such as aid agencies) that are able to meet the relatively high capital cost and see other advantages in the technology (for example, limited need to transport fuel).

The issue is not whether any one of these objectives is superior to another, but to highlight that there are quite legitimate differences. Clearly programs that aim to promote a particular technology will not necessarily provide the solution that best meets the needs of poor people (for instance, most electrical systems do not meet people's needs for cooking) or the least-cost solution. New systems for delivering energy services will almost certainly be more expensive initially than existing systems, which have the benefit of economies of scale, extensive sunk costs in both research and infrastructure, and often substantial subsidies.

However, from the perspective of people who do not currently have access to modern energy services, it is likely that their interests are best served, at least in the short term, if programs:

- Are technology neutral, offering the full menu of options and not just the options that the supplier wants to promote.
- Best meet their explicitly stated (and properly understood) energy needs.[53]

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[52] The definition of "renewable energy" frequently excludes conventional hydroelectricity. Interestingly the Bank's Operations Evaluation Department found that some aspects of energy sector restructuring have resulted in a reduction in investment in large hydropower. They noted the "perverse" shift away from "economically justifiable hydro dams toward...less environmentally friendly, thermal plants" (contribution to the Bank's environmental strategy for the energy sector, World Bank 1998b; pp. 57–58).

[53] This is clearly more difficult than it sounds, and many researchers have remarked on the difficulty of knowing what people want when the range of options includes technologies and services about which the people have no experience.

- Are least-cost in the widest sense, taking into account not only cash but also the opportunity costs of other real resources, such as labor time, health status, and the risks associated with unreliable or unsustainable energy supplies.

In the new situation, the task of all energy specialists has become the difficult one of ensuring that a gendered energy sensitivity is introduced to the mainstream of development thinking (and in the case of the World Bank, into Country Assistance Strategies and more recently into the agenda of the Poverty Reduction Strategy Papers) at an early stage.

On the other hand, it is also essential that specialists from other sectors (water, health, education, small enterprise, and so forth) need to be sensitized to the importance of energy, both to the success of the interventions that they propose and to their particular client group. This is particularly important in the case of poverty and gender specialists. An impression is circulating that other social infrastructure sectors (health, water, education) have more successfully integrated themselves in the mainstream of this poverty agenda than the energy sector.[54]

But there will be no magic bullet. In the same way all poverty interventions need to be sensitive to issues of gender (and indeed many other issues, such as the local, national and international environment), so too will they need to be sensitive to the enabling (and constraining) characteristics of energy services.

What We Do Not Know

Although there is still a strong consensus that the energy sectors of many economies need reform, it is less clear precisely how to do it. Some argue that the reforms have not gone far enough, and it is too early to judge their success. But certainly the inflow of capital (whether private or public) to the electricity sector is less than is required to meet the energy needs of poor people. Now is the time to start thinking about what to do if sufficient capital is not forthcoming. But it is also emerging that very little is known about how to restructure and then regulate national energy systems in ways that are propoor. Some research has begun to reveal the impact of sector reform on poor people and to show how the needs of poor people can be met as these systems are reformed.

At the heart of this report and the research underpinning it are uncertainties over the precise quantitative relationships between energy inputs and poverty reduction outputs. However, as described earlier, there are well known correlations between energy use and both improvements in GNP or indicators of well-being, even though the causal connections are less clear. The main uncertainties arise at the micro level. This is due in part to the intermediate and enabling characteristics of energy, and the necessity of complementary inputs to ensure a particular impact. But it is also because of the huge

[54] It has often been remarked that the *Voices of the Poor* makes little or no mention of energy even though it clearly is the case that energy is a requirement for all human activity.

effort and expense that would be required to establish legitimate quantitative data over a sufficiently large number of cases and during a sufficiently large number of years.[55] Even though it is certain that energy inputs alone will rarely cause poverty reduction, the elements of a clear narrative are emerging about what will work as described above.

Again, there is widespread acceptance that energy markets will continue to produce less-than-optimal solutions, although market prices do not reflect the full real resource cost, particularly of fuels. This is because fuels, such as diesel, are both subsidized and sold at prices that do not reflect the environmental and other related costs of using them. But what is not known is how to move from the current situation to a situation in which energy costs are truly reflected in the price—that is, to "internalize these externalities."[56] The problem is less one of calculating what the full costs are, but more one of finding a political process that can implement it.

As the development assistance agencies move to a more responsive form of poverty reducing assistance based on the so-called Poverty Reduction Strategy Papers, it also seems that not enough is known about how to insert energy into these assistance frameworks, either on the supply side in terms of investment in energy infrastructure, but more importantly on the demand side of the energy services that poverty reduction needs for success.

Finally, although the Sustainable Livelihood approach has been used as the underlying framework for examining energy, gender, and poverty, it clearly has its limitations. Some of the insights that the method provides are described in the previous chapters and in appendix 3. But recent attempts to use these frameworks suggest that they are time consuming and on occasion unfamiliar to both practitioners and poor people. The focus on the household as a unit does not yet easily cope either with the intra household dynamics required of a more gendered analysis nor does it focus attention to some of the older fundamentals necessary for the successful expansion of production, particularly at the level of small and micro enterprises.

These fundamentals are often those more closely associated with business development services. These include selecting and acquiring the most appropriate technology, fully understanding the nature and extent of the demand for the productive output (including the real needs of the people as consumers), the market in which new suppliers will have to operate, and the means of acquiring the necessary goods and services to set up or expand a business.

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[55] See chapter 2.

[56] The World Bank's "Fuel for Thought" (World Bank 1998b) similarly identifies the need for more analytical work to develop pragmatic ways of "internalizing the externalities."

Section 2:
Report on the China Country Case Studies

1 Introduction

As it is hoped that the results of this exercise will be useful across a wide range of countries, it is perhaps important to stress at the outset that China is in many respects a very special case. Perhaps most significantly, it has experienced almost unprecedented success in terms of both economic growth and poverty reduction during the last two decades since the start of the economic reform program. Gross domestic product (GDP) growth averaged around 9 percent during the period from 1978 to 1997 and the number of those officially defined as poor declined from 260 million to 50 million,[57] although there remain very large numbers of people with levels of income and food production only just above subsistence needs (Piazza and Liang 1998).

China has also undergone radical and far-reaching economic and political reforms of a very specific character (Cannon 2000). In particular, the relationships between different levels of government, between government and productive enterprises, and between government and households, have elements that often appear uniquely Chinese. This network of relationships, combined with the ubiquitous role of the Communist Party, has profound implications in terms of the possibilities for policy innovations in all sectors, not least in energy.

A household wealth and income distribution in poor rural communities also distinguishes China from many other countries. When collective production gave way to the household responsibility system under the rural economic reform program, the reallocation of communal land to households [58] was effectively on a per capita basis. Given that the size of households has been limited by the one child policy, this has led to a situation in which there is limited variation in land holding and, because land is the most important productive asset, in wealth and incomes across the majority of households. In particular, the extreme poverty associated with landlessness in many countries is not an issue in China.

This does not imply that in poor villages all households have similar incomes and wealth. Typically a small number of households will be relatively well off, often because they are not totally reliant on their own agricultural production, where output will be limited by land holdings. These may include, for example, those of the party secretary,

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[57] Chen and Ravallion 2000. It should be noted that there is considerable debate as to the reliability of the official estimates.

[58] The "ownership" of agricultural land is a complex issue. Individual households are usually described as having effective long-term leasehold title over their land. However, in line with other aspects of Chinese life, many issues, for example, those relating to the circumstances when leasehold rights may be forfeited, or around the sale or rent of land are often subject to local rather than national regulation.

teachers, village doctors, or those with substantial transfer incomes from family members working elsewhere. Similarly, a small number of households, often with high dependency ratios, or with sick or elderly members, will be considerably poorer than the average.

Poverty in China is seen very much as a regional issue. There now appears to be general agreement that the great majority of the poorest are concentrated in the mountainous areas of the western provinces. Whereas economic growth, combined with a range of policies specifically aimed at improving rural incomes, has dramatically raised the living standards of most of the rural population, these remote and often economically isolated communities pose a major challenge to existing poverty reduction strategies.

In terms of the rural energy focus of this study, China can again be seen in some respects as radically different from the typical developing country case. Mainly in consequence of the astonishing growth of "Township and Village Enterprises" (Sun, Gu, and McIntyre 1999). there has been a dramatic increase in rural energy supply and consumption. In particular, the expansion of rural electrification has led to a situation in which approximately 96 percent of villages and 94 percent of households are now served by large or small grid systems. Thus the great majority of even poor households have access to grid electricity, although possibly (particularly for isolated grid systems) with capacity, reliability or quality constraints on potential applications in terms of production activities.

In these circumstances, lack of access to electricity has become an important indicator of exclusion from the increasing prosperity of the majority. Those villages with no grid connection are typically in the most remote and sparsely populated regions with the most difficult terrain. They also have limited access to roads, markets, and other services. Not surprisingly they are among the poorest in China. This minority who have no access to electricity or rely on batteries or small diesel generators includes some 77 million people in 30,000 villages (Beijing Jikedian Renewable Energy Centre 1999). Particular attention was paid to such areas, and to those in similar locations who have been provided with grid access by means of small-scale generating plants, in considering the impact of the introduction of electricity on individuals, households, and communities.

Chapter 2 looks at some of the general issues relating to poverty, gender, and energy in China. Chapter 3 then describes the methodology used to select the study sites and conduct the fieldwork. It also provides general background on the study provinces and selected counties, townships and villages. The field research was conceived as a series of case studies, using both qualitative and quantitative methods, in selected poor rural counties in two provinces, Gansu and Hubei.

The main findings[59] are presented in chapter 4. Finally, in chapter 5, consideration will be given to the more general conclusions that can be drawn about "the lessons

[59] Separate reports on each case study will be published as part of the overall project.

learned which may improve the impact of projects of the World Bank and ASTAE on poverty alleviation and gender equity in China and possibly in other countries."[60]

[60] Terms of Reference; see appendix 1.

2 Energy, Poverty, and Gender Issues in China

This chapter initially considers some of the general issues relating to poverty and gender in China. It then examines trends in energy supply and demand, with a special focus on rural energy use.

Background on Poverty, Gender, and Energy Issues in China

Rural Poverty in China

> While the "old" poverty is rooted in regions which are ecologically deprived and structurally outside market development, the "new" poverty stems from the insecurities and vulnerabilities which arise in part from market-oriented development and can be found in "rich," "medium" and "poor" regions. An analysis of poverty in contemporary China must move beyond the narrow ecological view and explore more dynamic and elusive forms of poverty.[61]

Based on official figures, the number below the rural poverty line in China has declined from 250 million (30 percent) in 1978 to 42 million (4.2 percent) in 1998. Although the poverty line is set at a very stringent level[62] and, as discussed below, there have been heated debates around poverty measurement methodology, these figures clearly indicate a dramatic reduction. It is generally agreed that this has been achieved mainly as a consequence of rapid economic growth (averaging around 9 percent), combined with low population growth (less than 1.4 percent). Overall, GDP per capita has almost quadrupled (Khan 1999). However, the Chinese government has also adopted a wide range of specific poverty reduction policies during the reform period, partly in response to the very evident increases in regional and income inequalities. One major landmark was the establishment of the powerful Leading Group for Poverty Reduction (LGPR) under the State Council in 1986.

Progress on poverty reduction has varied both over time and between regions. The most rapid decline, from more than 30 percent to around 11 percent, occurred from 1978 (Khan 1999), the start of the economic reforms, to 1984. Increased rural incomes during this period are usually attributed to increased agricultural productivity, following the

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[61] Cook and White 1998, p. 3.

[62] Around US$0.75 per day. Some 106 million (11.2 percent) remained in poverty at the end of 1998 based on the standard US$1 per day PPP poverty measure.

introduction of the household responsibility system, and rising prices. There is general agreement that during the period 1985–89, rural income growth fell back sharply because of stagnating crop prices and rising input prices, as farmers attempted to further increase productivity by increasing applications of fertilizer and pesticides. The absolute numbers living below the poverty line increased, whereas the proportion remained static. Inequality also rose as incomes other than from farming became increasingly important.

There is considerable debate as to developments since 1990 and the official rate of decline during this period (to 4.2 percent in 1998) has been disputed by a number of researchers (Gustafsson and Zhong 2000; Khan and Riskin 2001). China's relatively flat rural income distribution implies that large proportion of the population can be considered near-poor by international standards (Fan, Zhang, and Zhang 2000). Estimates of the decline in poverty incidence are thus very sensitive to variations in the definition of the poverty line over time. One particular cause for concern is that this definition is dependent on the rural consumer price index, and the Chinese State Statistical Bureau does not publish their precise methodology for the determination of this index.

Whatever the precise figures, there is a growing consensus that the potential for poverty reduction through economic growth alone has weakened considerably because a large and increasing percentage of the rural poor are now living in remote localities that are very weakly integrated with the rest of the economy. These populations, often ethnic minority groups, suffer not only severe income poverty but often lack even basic health, education, and other social services. Although they will almost always have land use rights, the cultivated area will typically be small and soil quality poor. Agricultural production will often be further constrained by an unfavorable climate, for example recurrent drought. Infrastructure, including roads, communications, and electricity supplies may be lacking or inadequate and badly maintained. Households will generally be small, a reflection of the population policy, and thus very vulnerable to the loss of any key workers through sickness, accident, and so forth.

Rural poverty reduction policies in China have focused on promoting economic growth in selected geographic areas—specifically the 592 nationally designated "poor counties."[63] These have been targeted for central government assistance, typically in the form of production-oriented loan finance via the Agricultural Bank of China. However, in the light of the retrenchment of collective welfare activities post reform, the implications of defining rural poverty on a purely geographic basis and the assumption that primarily market-oriented development will provide solutions, is currently being debated within China.

It is increasingly recognized that targeting *areas* of chronic poverty may obscure "significant variations between households within communities" (Cook and White 1998, p. 60). This risks reducing the effectiveness of poverty reduction activities by failing to

[63] This list was constructed by the LGPR in 1993.

reach the substantial proportion of the poor who live outside the poverty counties while leaking benefits to their more affluent populations (Cook and White 1998; Gustafsson and Zhong 2000). On official figures, only one in seven of those living in the designated counties would fall below the poverty line. In a study of four provinces, the World Bank found that less than 50 percent of the poor lived in poverty counties. In Shanxi Province, a total of 3.81 million people lived in designated poor counties, whereas 1.46 million poor people lived elsewhere (Cook and White 1998). Gustafsson and Zhong (1990, p. 1004) produced even starker results: they estimate that two-thirds of China's poor are not reached by the targeting of poor areas. New forms of urban poverty caused by the withdrawal of the state from welfare activities, and the restructuring of the economy, have also been well documented (see, for example, Wong 1998).

It is true however, that certain communities are more poverty prone. Although poverty indicators are improving for many, Gustafsson and Zhong found that in the decade between 1985 and 1995 those living in mountainous areas and minorities were experiencing worsening poverty. A recent World Bank report emphasizes the increasing concentration of poverty. Around 70 percent of the poor now live in the western provinces, and a majority in mountainous areas (World Bank 2001) (two thirds of the 592 poverty counties are mountainous). Around 40 percent of the poor are estimated to be from minority ethnic groups, which constitute less than 9 percent of the total population.

Economic reforms, most notably the marketization of health and education, are also changing the face of rural poverty. Evidence suggests that in education, for example, access for the poor has been reduced during the reform period (Cook 2000, p. 4; Gustaffson and Zhong 2000, p. 1004). Households may also be more vulnerable to ill health: in a period of sickness health expenditure is compounded by loss of labor to create a major cause of poverty (Cook 2000). Although most age groups are experiencing improvements in poverty indicators this is no longer the case for children (Gustaffson and Zhong 2000). With a government policy of targeting poverty through increased access to productive assets rather than welfare, sections of the population lacking labor may be increasingly vulnerable, namely the elderly, the disabled, and children (Cook 2000, p. 5).

Income and annual grain consumption have been adopted as the key poverty indicators. This may proscribe the definition of what it means to be poor. A recent study by DFID in Guangxi, Yunnan, and Ningxia Provinces found villagers' own perceptions of poverty to be far more complex and focused on individual households than that of the officials:

> Officials' perceptions of the causes of poverty focused mostly on community level factors: natural resources; climate; infrastructure. The perceived "low quality" of the rural poor was also emphasized. Villagers' perceptions of the causes of poverty focused on the specific situation of poor households; different stages of the domestic life cycle (newly-divided family, school-age children, elderly couple); ill health, mental illness or death in family; lack of investment or credit; lack of

> land or labor; poor family relations; bad household economy; laziness.[64]

The primary agency for the distribution of central government poverty reduction funds is the Poverty Alleviation Office (PAO, or *Fupinban* in Chinese), based in the Ministry of Agriculture, which operates from central down to township government level. The measures employed by the PAO are strongly income oriented and aimed at enhancing productive capacity. They include: subsidized credit and agricultural inputs, training, microcredit and public works programs (Cook 2000, p. 16).

The PAO is ultimately accountable to the LGPR and distinct from other arms of government responsible for welfare and relief. In a situation where Cook and White describe "complex bureaucratic institutions" engaging in "vertical and horizontal competition between levels of government and specific administrative agencies" (Cook and White 1998, p. 36), there is in general very little coordination between those involved in the implementation of poverty reduction policies. Similarly, there appears to be little scope for effective collaboration with civil society organizations and or participation by local communities in the selection, design, or implementation of projects.

The local responsibility system, which provides considerable autonomy to county governments, places considerable strains on the appropriate application of poverty reduction funds at this most important level. The severe lack of fiscal resources in impoverished counties and the absence of effective monitoring and supervision by higher levels, provide strong incentives to divert funding to investment in enterprises that may provide more certain and more rapid returns. Curbs have been placed on the use of these funds for industrial investment in recent years, but these are difficult to enforce and do not inhibit agricultural schemes, even where these have little relevance for poor households.

The tendency to exclude the poorest is reinforced by the fact that the banking system is not wholly compensated for the provision of subsidized loans under poverty reduction policies, nor fully indemnified against the potential higher risks associated with such loans. Banks will therefore tend to adopt a conservative stance, favoring relatively richer communities and households or demanding sureties, which the poor find it almost impossible to provide.

Even if the guidelines are followed, county or township PAO officials may well prefer to target resources at households or communities where projects are most likely to have a successful and visible outcome, avoiding the more intractable problems of those who live away from tarmac roads and have very limited access to markets and support services. It is clear that some members of society will find it almost impossible to gain benefits from poverty reduction funding. These will include the disabled or sick, the elderly, and the many women who are burdened by excessive demands on their time for

[64] Beynon and others 2000. p. 3.

both productive and reproductive labor. Indeed, Gustafsson and Zhong suggest that a majority of those benefiting may well belong to the better-off sections of communities, those who have both surplus time and energy, and can provide the necessary sureties needed to take out loans (Gustaffson and Zhong 2000, p. 1004).

Gender and Poverty—The Institutional Process

> The continued gender inequality in work, education, technical knowledge and health, points to the failure of poverty projects to adequately address the poverty constraints and needs of rural women.[65]

How does gender influence vulnerability to poverty in rural China? Studies that have concentrated on household level data have found no evident gender difference in vulnerability to poverty. However, as White and Cook point out, these have failed to take into account the intrahousehold allocation of resources. Summerfield and Aslanbeigui's explanation of the feminization of poverty in China, using Sen's entitlement theory, says that although "total availabilities of the Chinese household" have increased, the "source of earnings for women, the nature of their jobs, and their employment opportunities" may have been adversely affected (Summerfield and Aslanbeigui 1992). The impact on rural women of the "responsibility system," where the production unit was changed to the household in 1983 has been great:

> First the shift in work environment has placed women in a setting where their command over income is less compared to work outside the home. Where household production is the result of the joint effort of men and women, tradition is expected to rule the assignment of tasks and labor previously decided by the collective…the traditional authoritative relations within the household may be reproduced.[66]

Under the collective system the contributions of individuals were made clear through the allocation of work points (women were typically given 8 work points per day and men 10); now the contribution of women to the household income has become much less visible.

Indicators that female poverty is more prevalent than male include: uneven sex ratios at birth and higher female infant mortality rates; higher female unemployment rates; higher female suicide rates; and lower school enrollments for girl children. The uneven sex ratio at birth peaked in 1991 when 116.1 boys were born for every 100 girls (Gu and Roy 1995, p. 20). This figure speaks of widespread gender discrimination, the effects of which include sex-selective abortion, abandonment of girls, female infanticide and, importantly, the failure to register girl children. The latter is likely to be a particularly strong indicator of the future face of female poverty: if a baby is not registered to the

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[65] Beynon and others 2000, p. 8.

[66] Summerfield and Aslanbeigui, p. 59.

household it has no rights to schooling or any other state benefits. He, or more likely she, is in effect a nonperson. Yi and others (1993) estimate that in 1990, 4 girls per 100 were not being registered.

Infant mortality rates illustrate a significant gender difference: 25.4 for males and 29.4 for females from 1989 to 1990 (UN ESCAP 1997, p. 81). According to Cook and White this is partly attributable to the difference in use in health services: 60 percent of baby boys as opposed to 40 percent of baby girls received medical attention in the 24 hours prior to death. Another health indicator pointing to gender discrimination is suicide rates: China is the only country to report a higher rate of female than male suicide—55 percent according to the World Health Organization (WHO). The highest incidence of suicide is among young, rural women.

Migration and unemployment are significant factors in many rural poor women's lives. Female migration is lower than male, standing at 44 percent in the 1990 census (Davin 1996). Moreover the gendered pattern of migration is quite distinct: women make up most of intraprovincial, rural-to-rural, and urban-to-rural migration because of marriage migration. The proportion of female rural-urban migrants who are married is less than that for their male counterparts. Women therefore, are more likely to be left behind by a migrating spouse, and to have to take on extra labor burdens in their absence. There is an additional burden on older women: the household registration system means that a child's registration follows the mother. Rural to urban female migrants therefore do not have the automatic right to schooling for their children in their new place of residency, leading to many children of migrant parents being sent back to their original village, often to be cared for by grandmothers.

The DFID study referred to above (Beynon and others 2000), identified family labor constraints, both in terms of quantity and quality, as a key determinant of poverty. Partly as a reflection of the success of family planning policies, household sizes tend to be small, placing considerable demands on a limited number of working age adults. Women appear to bear a major share of this burden, often combining long hours on agricultural fieldwork with a multitude of other activities. All domestic and some income earning tasks, for example caring for small livestock animals, are typically regarded as "women's work" and will indeed be largely neglected in male-only households. Women also play a leading, sometime solitary role in caring for aged parents or dependent children and may have to take on additional tasks, such as plowing and marketing, when male household members seek work outside the village. In remote areas the absence of water supplies, roads, and electricity may necessitate many hours spent fetching water, gathering and transporting fuel, traveling to health services or schools, and on manual household tasks, such as milling flour or cutting fodder for animal feed.

In general, the limited studies of energy demand side issues in rural China, focusing on the needs and constraints of energy users, have paid little attention to gender (Taylor and Bogach 1998). It is known that women spend a great deal of their time both

collecting fuel and cooking. Junfeng and Shuang (1999) estimate that in some areas it may be as high as four to eight hours a day. The DFID study (Beynon and others 2000) in Dingshaping village, Guangxi, found that reducing women's labor burden through participation in a biogas project improved their general health. Connection to the electricity grid electricity extended the labor time available to women for domestic and income-generating activities, and to a limited extent permitted the introduction of labor-saving devices.

Energy Supply and Demand

During the last two decades China has achieved the most rapid growth rates in the world. Annual GDP growth was 10.2 percent through the 1980s, 12.9 percent from 1990 to 1994, and 8.7 percent from 1995 to 1999. Industry has grown even faster, with rates of 11.1 percent, 18.8 percent and 8.9 percent (Gan 2000; World Bank 2000). During the period from 1980 to 1996 the consumption of coal, which provided around three quarters of total energy consumption, increased by 138 percent, some 5.6 percent per year, and consumption of oil by 100 percent, around 4.4 percent per year. Energy, and particularly electricity, shortage was identified as a major constraint on continuing high growth rates in the 1980s (Leander 1997), and this led to a rapid expansion in energy investment. In the 1990s, with supply coming more into line with demand, attention has focused increasingly on the quality of supply with diversification into oil, gas and renewable sources. China is faced with the unhappy prospect of becoming one of the world's largest emitters of atmospheric pollutants (Andrews-Speed, Dow, and Gao 2000) as the World Bank predicts a threefold increase in greenhouse gas (GHG) emissions by 2020. As a result, environmental considerations have also recently moved up the government's energy agenda.

The sector has been undergoing major reforms in the wake of the decision in 1998 to redefine the relationship between state industries and government ministries. Andrews-Speed, Dow, and Gao (2000) find three main objectives in these reforms: the reduction of the cost of government through the merging of overlapping functions; the separation of government from the commercial management of the industry; and the improvement of the effectiveness of government in the management of the economy (Andrews-Speed, Dow, and Gao 2000). However, because of the lack of "a strong institutional framework; a clear strategic vision for the sector; and well-defined ownership rights." They hold out little hope for energy sector reform and even predict that unless the performance of state-owned energy companies improves energy costs will increase.

Electricity demand has risen most dramatically, with per capita consumption tripling between 1980 and 1996, most rapidly (around 10 percent per year) in the early 1990s. One aspect of this growth of particular importance for the current exercise is that it reflects an extremely rapid expansion of rural electrification, partly to meet domestic consumption demands, but also to power the growth of the "Township and Village Enterprises," which have been such a prominent feature of the economic reform process.

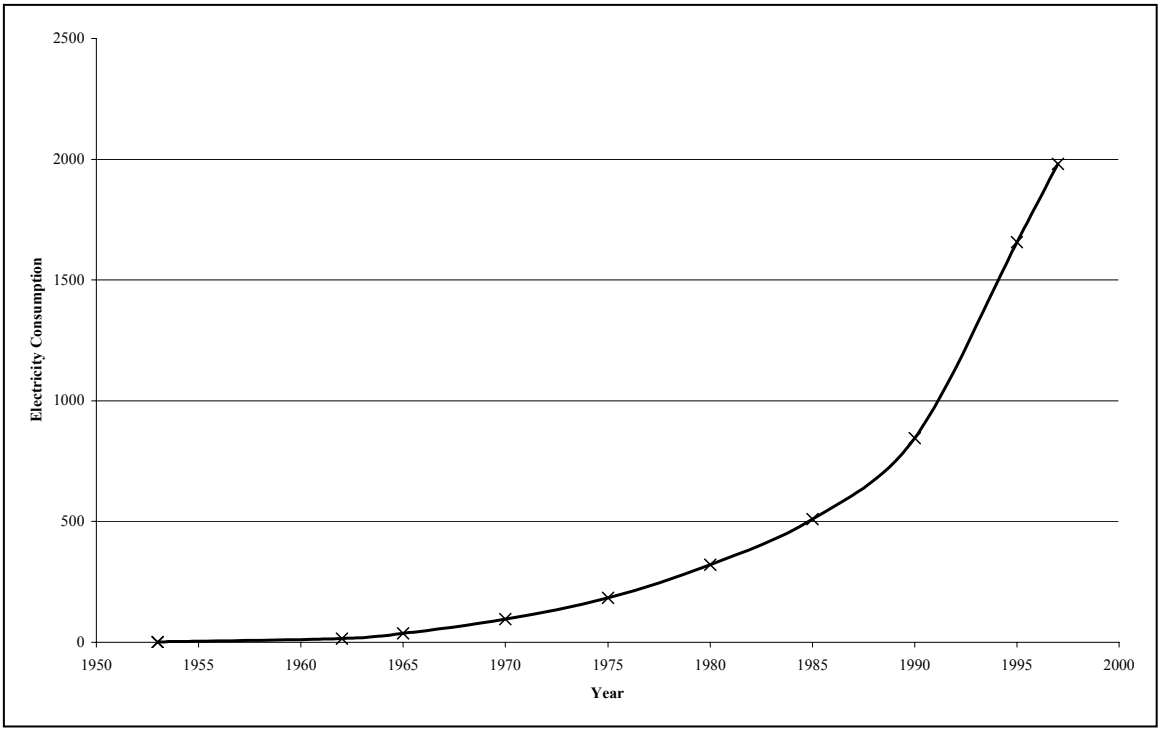
Since 1980, overall rural energy consumption has seen an annual increase of 4.5 percent (Shuhua, Daxiong, and Xiliang 1995).

Rural Energy: Current Trends in Use

Rural households in China use a number of different forms of energy in order to minimize both the costs and the risks arising from unstable supply and technologies. It is not unusual to find households with a solar cooker, biogas ring, and both coal and residue burning stoves.[67] Even though more than 96 percent of villages and 94 percent of the rural population are connected to electricity (as opposed to 40 percent in Indonesia, for example (Junfeng and Shuang 1999)), there is still a heavy reliance on biomass for cooking and heating. Biomass, either from crop residues or in the form of locally collected fuelwood, provides a cash-free option to the rural poor, whereas electricity may cost as much as ten times more than in urban areas. For lighting, kerosene is still much in use. Junfeng and Shuang report that even in households with an electricity supply, kerosene may be a preferred option because of the cost of grid electricity and the instability of supply (Junfeng and Shuang 1999).

[67] Field observations in Gansu Province.

Figure 5: Rural Electricity Consumption 100 Million kWh



Source: Fan, Zhang, and Zhang 2000, p. 9.

Not only do electricity prices tend to be higher than in urban areas, but the quality and reliability of electricity supply are much superior.[68] In the drive to bring electrification to rural areas it seems clear that installation standards and routine maintenance concerns were often neglected. Three of the four villages with electricity in the study complained of breakdowns and the lack of sufficient capacity to drive powered equipment at certain times of day or during periods of the year. Moreover, rural residents have to pay for electricity wastage because of faulty distribution systems. Initial and ongoing capital costs can also be considerable. In order to obtain connection to the grid, village committees will often have to persuade the great majority of households to agree to connect to the system in order to meet installation costs. These households may then face further demands to upgrade or repair the system (see box 2). The ongoing Rural Energy Reform Program was set up to address these issues and has the aim of equalizing both costs and quality of supply between urban and rural areas.

In line with the global environmental concern with greenhouse gas emissions, China has a range of programs aimed at providing energy to remote areas by renewable energy technologies, such as the "Brightness Program." In addition, international assistance

[68] In the study villages, urban unit costs tended to be around 50 percent of those in rural areas.

programs working toward this remit include the World Bank/GEF Renewable Energy Development Project, the Global Environment Facility Energy Conservation and GHG Emission Reduction in Chinese Township and Village Enterprises Program, and the UNDP Capacity Building for the Rapid Commercialization of Renewable Energy.

Renewable energy technologies, notably wind and PV are popular because they seem to address two problems: the provision of an electricity supply to remote areas beyond cost effective reach of a grid, and the limitation of the use of fossil fuels and other environmentally damaging energy sources. The projections of these programs are ambitious: to provide electricity to 23 million people by 2010 according to official government figures. Even with subsidies from bilateral and multilateral aid programs, the cost of grid wind power generation, for example, is ¥ 200–400 per kW higher than the cost of a coal-fired electricity supply. These costs are mainly borne by consumers (Junfeng and Shuang 1999), and the rural poor can ill afford them. Renewable energy sources also require some degree of maintenance: a major problem in a remote area if there are neither local technicians nor local suppliers of replacement parts. Even if officials subsidize the installation of a renewable energy supply, it does not mean that the poor will be able to afford to use and maintain it. Thus the marriage between renewable energy and poverty alleviation may not be as happy as the official line suggests.

3 The China Case Studies

As indicated above, the aim of the fieldwork was to explore the linkages between poverty, gender, and energy, with a particular focus on electrification, in selected poor rural counties. This chapter describes the design and implementation of that fieldwork. Initial reports on the findings in each study county, prepared by the relevant fieldwork team, are attached as appendixes 5–10.

It begins by outlining the overall methodological approach, the personnel involved, the timetable of activities and the research methods used. It then provides background materials on the two study Provinces, which was gathered from published materials and discussions with officials in the initial phase of research. The last section discusses the selection of case study villages and presents the final list of research questions addressed.

Research Approach and Implementation

Methodology

The fieldwork was primarily conceived as a series of case studies, using both qualitative and quantitative methods. The studies were conducted in three poor rural counties in Hubei and two poor and one nonpoor rural counties in Gansu.[69]

The opening phase of research included a review of relevant documents and in-country discussions with national, provincial, and county officials. This phase was undertaken by senior researchers and used for three purposes: to generate initial findings; to identify study counties; and to finalize the principle issues to be addressed in the case studies, based on the research framework discussed in section 1, chapter 4, of this report.

The main fieldwork exercises were a series of in-depth studies during a period of 7–10 days in a selected village community in each county. Two teams of Chinese social scientists undertook this work, each of which included a specialist on rural energy issues. Additional materials were gathered from the corresponding township and county levels, mainly using document reviews and key informant interviews.

Research Teams

Each team consisted of four people: two men and two women. The team working in Hubei was led by a senior researcher from the Department of Agricultural Economics, China Central Agriculture University, supported by two colleagues. The team in Gansu was led by the Director of the Social Survey and Study Center of Gansu Academy of

[69] Poor counties are officially designated by the Chinese Leading Group on Poverty.

Social Science, supported by a colleague from the Center, and a Deputy Director of the Institute of Sociology in Beijing Academy of Social Sciences. Each team was joined by a specialist energy researcher from the Centre for Renewable Energy Development (CRED) in Beijing. In addition, two Chinese-speaking research officers from the Institute of Developmental Studies (IDS) supported the fieldwork in each province and participated in four of the studies. In addition, one of the research officers, working in collaboration with a researcher from the School of Economics and Administration, Lanzhou University, undertook a study of three villages in Gansu that had been provided with photovoltaic equipment under a program supported by the Poverty Alleviation Office.

Timetable and Preparatory Activities

Initial visits to Beijing and Lanzhou were undertaken at the end of July and beginning of August 2000. During these visits, meetings were held with the fieldwork team leaders, the director and senior researchers of CRED, and Professor Liu Hongpeng of the Renewable Energy Division of the State Economic and Trade Commission (SETC). Formal collaborative arrangements were negotiated and discussions undertaken on the nature of the research activities and potential study sites.

A design workshop was held at IDS from August 31 to September 5, 2000, attended by researchers from IDS, ETC, and CRED. This workshop developed a series of draft research questions, based on the framework presented in section 1 of this report, and a range of initial draft survey instruments. These drew on earlier work on poverty and gender in China undertaken by the IDS researchers, and specific studies on energy undertaken by ETC in various countries and by CRED in China.

During the period from late September to mid-October, one IDS and one ETC consultant, accompanied by the IDS research officers, visited Beijing. They discussed research plans and choice of study sites with CRED and then each traveled to one of the study provinces where the team leaders joined them for discussions with local officials. Initial visits were then made to possible study sites and final selections made. Agreements on the timing and arrangements for the fieldwork exercises were reached with county, township, and village officials in the selected areas. The opportunity was also taken to commence initial enquiries relating to energy, poverty, and gender issues and data sources in each location.

Following the county visits, the research questions and related survey instruments were finalized. A one-week training workshop for all members of the field study teams was held then in Beijing. Teams discussed—and where necessary modified—the study instruments and associated documentation, and agreed on detailed procedures for the fieldwork exercises. The fieldwork began one week later and continued until the end of November.

Methods

Each exercise began with reviews of routine statistical data and interviews with officials in relevant departments at county and township levels (including civil affairs, agriculture, poverty reduction, and the electricity sector). The latter focused on development issues, poverty, energy sources and uses, plans for electrification, and perceived impacts of electrification projects.

The village studies began with key informant interviews with members of village committees and party branches, the representatives of the women's federation (where such a position existed), teachers, and rural doctors. These focused on issues relating to poverty, gender, energy, and the impact of electrification where appropriate. A more general discussion was held with village committees on trends during recent years in terms of production, investment, household incomes, migration, and collective institutions, such as schools and health facilities.

In each village the survey teams selected a sample of households for in-depth interviews. The approach varied somewhat, depending on specific circumstances, but the basic principles were as follows:

- A meeting was held with the village committee to classify and group households.
- The three poorest households and up to five big-energy-user households were identified.
- A systematic sample was then made of remaining households to reach the target number of 36.

In most cases, where accommodation was available, the teams lived in their assigned villages for 7–10 days. Otherwise they lived in nearby locations and visited on a daily basis. During this time they used a variety of rapid appraisal and participatory techniques to investigate energy issues and the impact of electrification, where relevant, on households and particularly on household members. These included the following:

- Additional key informant interviews with community leaders, teachers, healthcare workers and male and female members of households.
- Participatory mapping to indicate the layout of households and village institutions, including identification of those with and without access to electricity and related devices.
- Time line diagrams to examine the recent history of the area, particular in relation to electrification, other energy-related issues and changes in production and activity patterns.
- Seasonal calendars to investigate seasonal variations in climate, activities, income, expenditures and demand for and supply of energy.
- Wealth ranking exercises to determine local criteria and ranking of households.
- Community meetings and focus group discussions to explore local perceptions of availability, utilization and cost of different energy sources.

- Personal narratives of male and female household members who had experienced the changes bought about by electrification.
- Matrix ranking exercises by selected groups to compare the perceived relative costs and benefits of different sources of energy for different purposes.

The interviews covered relevant aspects of consumption, production, utilization of services, access to information and communications. Changes in the mix of energy sources were traced and all uses of electricity and substitutes (such as alternative sources of lighting) identified. Consumption quantities were estimated, with prices of major suppliers being used to estimate costs. One important objective of the fieldwork at village level was being to provide a clear elucidation of relevant gender issues. With this in mind, the activities were reinforced by time-use exercises, which allowed estimation of the differential impacts of electrification on the activity patterns of men and women. The membership of the fieldwork teams, list of activities and formal fieldwork materials provided are attached as appendix 4.

Case Study Reports

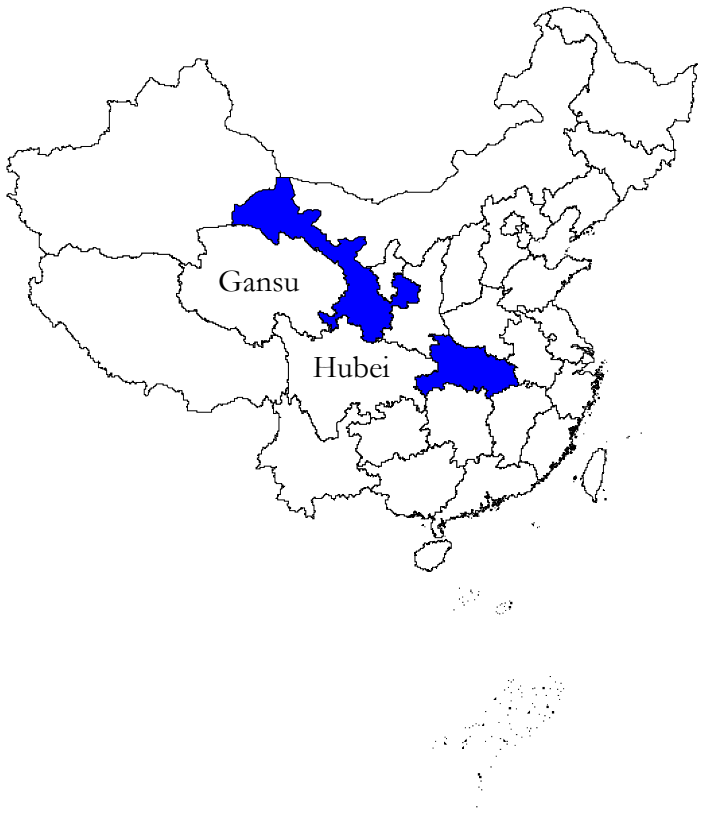
Following the fieldwork exercise, and debriefing workshops, the team leader produced an initial fieldwork report. This was then revised in discussion with the relevant IDS research officer and IDS or ETC consultants.

The Study Provinces

Selection

The Provinces of Gansu and Hubei were selected as being of particular interest for the purpose of the study, although for somewhat different reasons. Gansu suffers from severe water shortages and arid soils, which have had impacts on agricultural productivity and household incomes. It is widely believed that deforestation, primarily a consequence of the clearance of land for agriculture, has been exacerbated by the widespread use of fuelwood as a primary source of energy for cooking and heating. This has encouraged policies targeted at the development of alternative and renewable energy sources. Hubei is one of the most important provinces for hydroelectric power generation, both in terms of major dam developments and small-scale hydropower installations. The mountainous terrain of western Hubei makes communications extremely difficult and there are a large number of remote, very poor villages, some of which have no electricity.

Figure 6: Gansu and Hubei Provinces



It should be noted that 1999 and 2000 were extremely difficult years for farmers in both Gansu and Hubei. In a letter published recently in China, the party secretary in Qipan township, Hubei, stated that a family of five working eight mu of land had to pay US$365 a year—equal in many places to more than the annual per capita income—in poll and land taxes (Pomfret 2000). Gansu experienced severe drought conditions to the extent that many urban dwellers were rationed to a few hours of water per day. The richest village in this study, Xiapai in Yongchang, had crop income levels comparable to those in the poorest, because water supplies were insufficient to feed their irrigation system. Low crop yields in some parts of Hubei and the demands of the rural taxation system, which is based not on outputs but simply on the size of land holding, were reported to have driven large numbers of farmers (in some districts the majority) into urban areas in search of income.

Hubei Province

Background

Hubei Province is situated in central China in the middle reaches of the Yangtze River. Administratively it is divided into 11 prefectural cities, an autonomous region, 35 town districts, 25 small towns, 39 counties, and a forest region. The total population is 59 million, and the total area is 185,000 square kilometers. Much of the land is mountainous and approximately 56 percent is more than 500 meters above sea level. There are more

than 300 major lakes with a storage capacity of 3 billion cubic meters, and more than 1,000 rivers including 42 that are longer than 100 kilometers. The largest of these is the Yangtze, which flows west to east for more than 1,060 kilometers. The province has a subtropical monsoon climate in which most of the yearly precipitation occurs between May and September. The Yangtze River basin can receive in excess of 1,100 millimeters of rainfall per year. This uneven seasonal precipitation, and recurring low-rainfall years, often leads to spring flooding and late autumn droughts.

Basic economic indicators for Hubei are shown in table 5. It is a major producer of both agricultural and industrial outputs. Comprising 4.7 percent of the total Chinese population it produces 4.8 percent of food grains and 4.7 percent of overall GDP. Agricultural production is heavily dependent on the use of chemical fertilizers and pesticides, which has increased remarkably since the early 1980s. Fertilizer application rates are higher than those in the United States (some 253 kilograms per hectare, excluding animal and human wastes), although pesticides application rates of 4.5 kilograms per hectare are common. Between 1990 and 1994, annual sales of pesticide products increased by 13 percent per year, from 14,000 tons to more than 26,000 tons. Fertilizer purchase in particular is a major production expenditure for poor rural farmers and a common reason for borrowing.

Overall, the rural population of Hubei has around the average per capita income and consumption for China as a whole, and is therefore by no means a poor province. However, the mountainous western region has many remote counties where communications are very difficult, the climate is generally unfavorable for agriculture, and there are pockets of extreme poverty. All three case study villages were from this area.

Table 5: Hubei Province: Basic Indicators

Indicator	National	Hubei	%
Population (10,000)	124,810	5,907	4.7
Grain per capita (person)	412	420	101.9
GDP (¥ 100 million)	79,396	3,704	4.7
GDP per capita	6,361	6,271	98.6
Incidence of rural poverty (1996)*	6.3	2.7	42.9
Rural counties	2,141	68	3.2
Designated poor counties	592	25	4.2
of which mountainous	384	23	6.0
Rural per capita:			
Net income	2,162	2,172	100.5
Consumption	1,590	1,699	106.9
Cash expenditure	1,128	990	87.7

Source: China Statistical Yearbook 1999.

Energy Resources and Development: Natural Capital Livelihood Assets

As might be expected, given its geography, Hubei has a huge potential for the development of hydroelectric power generation. Total exploitable capacity has been estimated as high as 40 million kilowatts. Total coal reserves are around 440 million tons, just 0.1 percent of the total for China. The coal industry was developed during the ninth five-year plan, which focused on supporting potentially profitable coalfields or mines in ten counties. Township coalmines became a major source of supply to the provincial coal industry and output increased from less than 10 million tons of raw coal in 1993 to more than 15 million tons in 1996. In 1999, coal production in the province was around 9.1 million tce, whereas consumption was 59.9 million tce. Oil reserves have been estimated at 53 million tons, of which the exploitable oil resource is less than 30 million tons. Production in 1999 was 0.78 million tons and consumption around 7.21 million tons. There is one natural gas well with exploitable resources of some 2.5 billion cubic meters. Overall, conventional energy production within the province is sufficient to meet around 20 percent of requirements.

Hubei was one of the first provinces to build power stations. In 1949 there was one installation with a capacity of 38,000 kilowatts and annual output of less than 85 million kilowatt-hours. During the economic reform period between 1981 and 1990, the province installed additional capacity of 4.1 million kilowatts, based on both coal-fired and hydropower projects. In the early 1980s, with the completion of the Gezhouba hydropower project, Hubei became the most important province in China in terms of hydroelectric generation. By 1999 total installed generating capacity had reached 13.2 million kilowatts and total electricity consumption was 48.7 trillion kilowatt-hours, of

which 25.1 trillion kilowatt-hours derived from hydroelectric power stations. The Three Gorges project is also located in the province and is due to start generating by 2003. This will have a total capacity of 18.2 million kilowatts. In line with the power diversity policy, Hubei is currently preparing nuclear and wind power projects.

Renewable Energy

Renewable energy projects in Hubei mainly focus on small hydroelectric power stations and biogas. The former are intended for areas without access to the electricity grid. As indicated above, total hydropower resources are very rich and 6.7 million kilowatts are considered suitable for medium and small hydropower projects. Development started in the 1950s at Dayou station in Macheng, and to date the total capacity has reached 1.3 million kilowatts, with annual output of 4 trillion kilowatt-hours. 30 counties and 887 villages use electricity from these stations and they supply one third of the total area with access to electricity.

Biomass Energy

Hubei is an important province in terms of livestock production, and total animal waste is estimated at approximately 10.5 million tons per year. The dissemination of household biogas systems is seen as a key task for local officials engaged in rural energy development. The Ecological Home Construction and Poverty Alleviation Program has established approximately 695,000 household biogas systems and the total biogas generation is around 16 million cubic meters. Around three quarters of these are pig-biogas-fruit systems, which use the slurry from biogas production to fertilize fruit and vegetable gardens. In addition to the household systems, there are 60 medium- to large-scale industrial biogas plants producing 0.79 million cubic meters. Annual straw production and other forms of biomass energy resources amount to approximately 30 million tons.

Wind Energy

Thus far, 600 small wind turbines have been installed. Based on the Wind Power Development Program 1999–2030, two large-scale wind farms are planned. One will be in Lichuan City, with a total capacity of 0.36 million kilowatts, and one in Tongshan County, with a capacity of 0.156 million kilowatts. These should be completed by 2010.

Solar Energy

Hubei is not rich in solar energy. The average annual hours of sunshine range from 1,200 to 2,200. The total solar energy radiation is 7628x1014 kilojoules. Solar energy utilization is mainly limited to passive heating. By 1999, the total area of solar housing was 140,000 square meters, and the area used for solar water heating was 450,000 square meters.

Gansu Province

Background

Gansu Province is located in northwestern China, about 1,900 kilometers west of Beijing. It is on the upper part of the Yellow River (Huang He), with a 1,000 kilometer corridor extending north and west between the northernmost part of the Qinghai-Tibet Plateau to the south, and the Gobi desert to the north. The administrative divisions consist of two autonomous prefectures, 13 cities, 60 counties, and seven autonomous counties. The population is around 25 million, 8 million of whom live in urban areas. More than 90 percent of the inhabitants are Han Chinese, with the rest belonging to various ethnic minorities. The total area is 390,000 square kilometers, mostly lying above 1,000 meters. More than 70 percent of the area consists of mountains and plateaus. The climate is subtropical and humid in the southeast changing to a temperate, dry climate in the west. Temperatures shift greatly from day to night as well as from season to season in the central and western parts of the province. Average temperatures vary between –14 degrees Centigrade to 3 degrees Centigrade in January and 11 degrees Centigrade to 27 degrees Centigrade in July. The average annual rainfall can be as high as 860 millimeters in the high mountain areas, with precipitation decreasing sharply to as little as 30 millimeters in the north. 50 to 70 percent of the rain falls during the summer.

The general economic situation in Gansu can be seen in table 6. Droughts and arid soils have constrained economic progress. In 1997, 23 percent of the rural population in Gansu was below the national poverty line (Fan, Zhang, and Zhang, 2000) and 41 counties were identified as national poverty counties. Among the villages within these counties: 16.2 percent had no or limited road access; 16.6 percent had no access to electricity; 40.6 percent had no health facilities; and 10.7 percent had no schools. In recent times the province has experienced some degree of industrial development based on the abundant mineral resources. These include coal, petroleum, nickel, copper, sulfur, and zinc. However, the economy is still primarily agricultural, with main crops including wheat, highland barley, millet, potatoes, corn, sorghum, rice, rape, soybeans, and sun-cured tobacco. The staple foods are wheat, barley, millet, beans, and sweet potatoes. With approximately 2.2 percent of the total Chinese population, Gansu produces around 1.6 percent of total grains and accounts for around 1.1 percent of total GDP.

Table 6: Gansu Province: Basic Indicators

Indicator	National	Gansu	%
Population (10,000)	124,810	2,519	2.0
Grain yield (10,000 tons)	51,230	827	1.6
Grain per capita (kg/person)	412	348	84.4
GDP (¥ 100 million)	79,396	870	1.1
GDP per capita	6,361	3,453	54.3
Incidence of rural poverty (1996)	6.3	22.7	360.3
Rural counties	2,141	76	3.6
Designated poor counties	592	41	6.9
Mountainous poor counties	384	35	9.1
Rural per capita:			
Net income	2,162	1,393	64.4
Consumption	1,590	940	59.1
Cash expenditure	1,128	507	44.9

Source: China Statistical Yearbook 1999.

Energy Resources and Development—Natural Capital Livelihood Assets

Gansu has considerable modern energy resources, including coal, oil and oil shale. There are 164 surface coalmines with proven deposits of approximately 9.6 billion tons and large quantities of associated oil shale. The output of raw coal in 1999 was 18.92 million tons, around 80 percent of consumption requirements. Coal production is mainly from the Huating coalfield, which has an assured geological deposit of 3.4 billion tons. The gasification coal at the field is described as having "three highs"—quantity of heat, chemical activity, and volatilization and "three lows"—dust, sulfur, and phosphorus. It is used for energy generation, chemical production, gasification, and providing raw materials for wood alcohol and chemical fertilizer. The designed production capacity is 10.15 million tons per year. Five additional major mine projects are planned in a project valued at ¥ 5.7 billion.

Exploitable crude oil reserves are estimated as 80.6 million tons and output of crude oil in 1999 was 4.7 million tons. The oil and natural gas resource is concentrated in the Yumen area. A national oil line from Xinjiang to Lanzhou has been completed and a natural gas line from Xinjiang to the east China is under construction. This line will go through Gansu and contribute to available supply.

Gansu Province lies in the upper reach of Yellow River with and has theoretical hydropower resources estimated at 17.2 million kilowatts, of which 10.7 million kilowatts is suitable for power generation. By the end of 1999, overall electricity generating capacity in the province had reached 6.1 million kilowatts and produced 26.2 trillion kilowatt-hours. Of this hydropower provided 11.7 trillion kilowatt-hours, 45

percent of the total. The 330 kilovolt electric power grid provides access to all but a few remote areas.

Renewable Energy

Gansu is one of the most drought-prone provinces in China and suffers severe water shortages, both for consumption and irrigation. During a long period, the reliance on fuelwood for heating and cooking has accelerated large-scale deforestation, reduced water retention and intensified soil erosion, particularly from the Loess Plateau. This has had an impact on agricultural productivity and contributed to the relatively high levels of poverty in the province. The provincial government now regards rural energy policy as central to its attempts to reverse the loss of vegetation and sustain the livelihoods of populations in remote rural areas. The Eighth Five-Year Plan period (1990 to1995) emphasizes the importance of both renewable energy sources and energy conservation.

Biomass

The total output of grain crops in 1996 was 7.99 million tons. This was estimated to produce around 9.6 million tons of crop residuals, 5 million tons of which could be used for rural energy, producing around 2.54 million tce (113 kilograms per capita). The estimated dung resource is 11 million tons, 2.2 million tons of which could be used to provide some 1.1 million tce (54.83 kilograms per capita). Around 54,000 hectares of fuel forest could be used to provide an annually output of around 200,000 tons of firewood, 114,200 tce (5.79 kilograms per capita). The use of biogas systems has expanded, with around 2,236 additional households establishing systems in 1996. However, output is still very limited, at around 6,000 tce. It has been estimated that only 0.3 percent of the total potential has been realized, although some reports argue that this estimate does not make sufficient allowance for the low temperatures in many otherwise suitable areas.

To implement the Western Development Strategy and reduce deforestation and soil erosion, Gansu has decided to convert 30 million mu of cropland into forest and grassland. The southern mountainous areas and the middle and east Loess Plateau will be mainly affected. However, farmers in these locations heavily rely on biomass energy. Around 80 percent of domestic energy requirements consist of crop residues, dung, and fuelwood. It is estimated that the conversion will reduce the energy supply for around 1.4 million rural people and that the total reduction could be up to 1.8 million tce. (Department of Agriculture and Livestock, Gansu Province, 2000).

Solar Energy

Gansu is rich in solar energy resources. The average over three-quarters of the territory is more than 2500 hrs of sunlight, and radiation is 500–620 kilojoules per square centimeter. Around 100,000 solar cookers have been distributed in rural areas and are mainly used for boiling water and cooking in the summer months. More than 50,000 square meters of solar panels for water heaters had been purchased by the end of 1996, mainly in small towns, and some 190,000 square meters of passive solar housing were

constructed. In addition, more than 6,800 hectares of green house space was being used for agricultural production.

Gansu was one of the earliest regions to use solar energy to provide electricity to rural areas. In the 1980s, the UNDP supported the Gansu Natural Energy Research Institute to develop a series of PV demonstration projects. Approximately 20,000 PV systems have been installed over the years to provide lighting and television in remote areas. Four companies now provide PV products and services.

Wind Energy

There are abundant wind resources, especially along the Hexi corridor, which has 4,000 to 6,000 hours per year of potentially efficient wind generation. Approximately 2,800 small wind turbines have been installed, with a total output capacity of about 448 kilowatts.

Small Hydropower

There are 107 small hydropower plants in Gansu, set up to supply electricity to rural areas. The output capacity is about 1,120 kilowatts (the total potential output capacity of small hydro power generation is estimated at 220,000 kilowatts, and annual electricity generation at 6,743 kilowatt-hours).

The Study Communities

The study sites were selected in discussion with local key informants, following initial suggestion by CRED, meetings with provincial officials and a series of visits to potential counties and villages. As noted in the introduction, the sites were selected purposefully to provide a wide range of circumstances but with a strong bias toward poor, remote, relatively isolated, rural communities.

Although, as discussed above, there are risks associated with policies that overemphasize the role of geographical factors on poverty (Cook 2000), they are clearly of considerable importance in rural China. Although living standards have improved for the great majority, there is, as indicated previously, evidence that in the decade between 1985 and 1995 people living in remote mountainous areas were experiencing worsening poverty.

Such communities are the main focus of the current poverty agenda in China. They are also of special interest from the particular perspective of this study because of the obvious association between geography and access to energy services, particularly electricity. In a country where more than 94 percent of rural households have access to an electricity grid, the remainder are almost certain to be living in locations that are simply extremely difficult to reach, whether by electricity grid, telecommunications, or road. It might also be assumed that such communities are the main potential candidates for involvement in alternative energy projects. However, energy interventions alone may be

of little value if there are other, possibly even more important constraints on improved livelihoods.

The villages were also intended to represent diversity in terms of the level of access to electricity. The initial intention was to select three communities in each province that had: no general access to electricity; access to electricity but only through nongrid systems (PV in Gansu and microhydro in Hubei); and relatively recent access to grid electricity.

During the fieldwork, locating a community with widespread use of PV proved extremely difficult for reasons that are still not well understood. CRED had visited two potential natural villages in Gansu, but both were deemed unsuitable because they were understood to be demonstration sites for the Gansu Natural Energy Institute (GNEI). However, meetings with the latter, who are the main body concerned with PV in Gansu, proved unproductive. They also recommended using the sites suggested by CRED and were unable or unwilling to provide alternatives.

GNEI reported that the main users of their PV systems were nomadic and suggested that the study should consider including one such community. However, apart from the difficulties inherent in undertaking such a study the general opinion was that nomadic communities typically had relatively higher incomes and included relatively few poverty households.

As an alternative, it was decided to select a community in Gansu with long established electricity grid access, in the expectation that this might allow assessment of the longer-term benefits. However, in order to retain some perspective on PV, visits were made to the sites suggested by GNEI and to a third site, located by discussion with local officials in another county where a PV project had been initiated by the PAO.

The main study villages surveyed were as follows:

Gansu

Gaozui Village in Huining County: An isolated group of natural villages without road access or electricity.

Zhaoshan Village in Yongjing County: A village in a poverty county with good road access but relatively recent access to grid electricity capable of powering production equipment.

Xiapai Village in Yongchang County: The only county studied that was not impoverished, in one of the most productive agricultural areas of Gansu and with long established grid access.

Hubei

Xiaozhu Village in Lichuan County: A very remote mountainous village without electricity.

Duiwotai Village in Xianfeng County: A village in a relatively remote location with electricity provided by a small, run-of-river hydroelectric generator.

Housanxi Village in Jianshi County: A village in a poverty county with recent road access and grid connection.

Gaozui in Gansu, and all three villages in Hubei, were in mountainous areas and many of their component natural villages[70] were not connected to roads. Where roads did exist, they were typically in very poor condition, often hazardous, and in many places accessible only to three-wheel diesel trucks. Xiaozhu had no primary school, with young children facing a daily walk of up to two hours each way. None of the villages had a health station or health extension worker and villagers reported having to travel more than 10 kilometers to access the nearest formal healthcare facility.

Full details on the villages, townships and counties selected can be found in the individual study reports, which are to be published separately.

Research Questions

The research questions targeted by the field studies draw on the framework are set out in chapter 4 of the first section of this report. In this exploratory exercise it was decided to focus on three broad areas: the primary livelihood strategies adopted by local communities; the nature of existing energy services; and the actual and potential impact of changing energy services.

Livelihoods

- What are the principle livelihood strategies within the different study communities?
- What are the main constraints on livelihood strategies?
- How are the livelihood strategies of women distinct from those of men?
- In what ways are households poor or vulnerable?
- What are the livelihood strategies of the poor?

Energy Services

- How are energy services distributed within the study communities?
- Which energy services are most important to the poor?
- Time allocation to human energy consuming reproductive tasks.
- What are the implications of women's time poverty in terms of their livelihood strategies?
- What is the distribution of powered production equipment?
- Do poorer households benefit from gaining access to powered equipment owned by others?

[70] The word *village* in China is used to refer to an administrative unit typically composed of around 10 subvillages or "natural villages."

- How are workloads related to ownership or access to powered equipment?
- Which households and individuals have access to communications assets (radio, television, telephone) and what human or social capital benefits flow from such access?

Impacts of New Energy Services

- Do new energy services improve access to income-earning opportunities?
- Can improved energy services reduce poverty by enabling livelihood diversification?
- What is the impact of energy services on human capital (health, education) and social capital?
- Who gains and who loses from the introduction of new energy services?
- How do women and men differ in terms of their energy service investment priorities?
- How can energy services be adapted to promote positive impacts that are relevant to the livelihoods of poor households and women?
- What aspects of the policy and institutional environment are likely to negate the beneficial effects of new energy services?
- What are the community level processes for decisionmaking on energy services?
- How do women participate in these processes?

4 Findings

In this chapter the main findings of the study are summarized. Detailed information from each of the study areas are contained in individual reports, which will be published separately. The chapter is structured in line with the research questions described in chapter 3.

Livelihoods

The Principle Livelihood Strategies within the Different Study Communities

The community in Gaozui was largely subsistence farmers, dependent on crop and livestock production. Cultivation was entirely on land that was not irrigated and the main crops included potatoes, buckwheat, oats, beans, and oil seed. Severe droughts in 1999 and 2000 greatly reduced outputs. The very limited cash incomes derived mainly from sales of potatoes and beans, and short-term casual labor, mainly in other villages. Livestock farming focused primarily on pigs and chickens. These were mainly for household consumption, with only a few households earning income from breeding pigs.

The access to a good road system for households in *Zhaoshan* provided considerably greater scope for marketing agricultural outputs. They cultivated nine main crops, focusing on potatoes, wheat, millet, barley, and rice. Potatoes, rice, beans, and broad beans were the primary cash crops in 2000. The other main sources of income arose from livestock farming, especially pig breeding, and working outside the village.

In principle, Xiapai is a highly productive agricultural village, farming mainly irrigated land. The main crops were wheat, barley, potato, corn, flax and rice. Of these wheat and barley were the primary sources of cash income. However, in 1999, when crop production was badly affected by drought and the failure of the irrigation system, these earned only around ¥ 1,000 per household. The other main sources of income arose from livestock farming, pigs, sheep and chickens, and casual work outside the village. A number of households also had members working outside the village on a longer-term basis. These remitted an average of some ¥ 1,500 per household.

Xiaozhu village had many of the characteristics of a “company town.” The main crops were maize, potatoes, sweet potatoes, and tobacco. However, the first three were mainly for own-use and pig feed. Tobacco was almost the only source of farm income and local regulations stipulated that all output must be sold to a single company. Annual income from tobacco averaged around ¥ 2,000 per household.

Most households kept three to five pigs but these were usually for own-use and generated little income. The other main sources of cash were gathering wild herbs and

casual manual labor outside the village. The latter could provide around ¥ 2,000 per household. Given the difficulty of earning income, villagers were often willing to travel long distances and take any form of paid work.

Duiwotai village grew a wide range of crops, including rice, maize, potatoes, sweet potatoes, rape, tea, peppers, soybeans, and peanuts. Apart from the potatoes and sweet potatoes, which were for their own consumption or for livestock, all other crops were marketed. Rice, potatoes, and maize were the major sources of income. Cash was also earned from sales of piglets, pig meat, firewood, lumber, and preserved meat. Pig rearing is an important activity and two thirds of sampled households reported incomes of around ¥ 450–600 per year from this source. Although it was forbidden, three of the 36 sample households reported annual earnings of around ¥ 900 from sales of wood and firewood.

In addition, six households reported long term employment outside the village. Their average income from this source was around ¥ 1,500. Other households whose members worked on a short-term basis in nearby towns earned incomes of ¥ 200–600. Making charcoal for sale was another important income-generating activity in winter. Some households had kilns in the mountains and produced charcoal for others to sell in local markets. Each journey earned approximately ¥ 15–20.

Housanxi mainly produced potatoes, maize, sweet potatoes, rape, and tea. The first three were intended primarily for consumption by households and their livestock. The other two were viewed as commercial crops. Households recently also began to grow tobacco, encouraged by local officials. Apart from crop production, there were a variety of other income-earning activities, the most important being raising and breeding pigs, selling potato flour, and working short-term outside the village. Average income among the sampled households from this last source was around ¥ 1,400. Seven households had members living away from home for an extended period, the average remittance being ¥ 1,900.

Broadly speaking, therefore, Gaozui and Xiaozhu, the two villages without electricity, can be seen as isolated subsistence communities, earning incomes from one or two cash crops. Zhaoshan and Duiwotai, both recently electrified, are also poor agricultural communities, but cultivating a greater range of cash crops with some additional earnings from livestock. Housanxi also has a range of commercial crops and has managed to diversify somewhat into pig breeding and small-scale crop processing. The last village, Xiapai is the only village not impoverished. It is an important crop production area, with fertile, irrigated land where many households have earned reasonable incomes in recent years and invested in small agricultural vehicles.

Migration as a Livelihood Strategy

Overall, households typically earned less than ¥ 5,000 each year from their core farming and other activities. And these incomes could be highly variable. In Xiapai, notionally the wealthiest village, 1999 and 2000 were very bad years and net per capita farm incomes (allowing for costs and taxes) dropped below ¥ 1,000. Given the rising prosperity on

other parts of China, it should perhaps not come as a surprise that when asked how households could improve their situation, both officials and villagers (table 7) almost uniformly placed either migration or working outside the village near the top of their lists of options.

Table 7: Main Ways to Escape Poverty Identified in Focus Group Discussions

Gansu		
Gaozui	**Zhaoshan**	**Xiapai**
Education—acquire skills	Education	Migrate
Work outside village	Increase livestock	Relatives outside village help
Farm cash crops	Set up small enterprise	
Migrate—send remittances	Work outside	
Acquire electricity/equipment		
Hubei		
Xiaozhu	**Duiwotai**	**Housanxi**
Work outside	Set up small enterprise	Earn wages outside
Increase livestock	Increase livestock	Set up small enterprise
	Cash crops	Migrate
		Education
		Acquire a marketable skill

Circumstances in China are unlike those in most other countries in that many poor rural residents can rationally aspire to dramatically improve their standard of living by migration. They are very aware of the opportunities that exist. Members of some of the poorest households in the most remote areas surveyed were able to routinely watch television images of life in Beijing, Shanghai, and other rich east coast cities. They could cite individuals from their own or neighboring villages who had moved to an urban area and found relatively highly paid employment. The attractions of migration, particularly for the better educated, healthier, and more enterprising were very powerful.

More than 25 percent of those identified as household members were living away from home at the time of the survey (table 8). The majority of these were males, 20 to 34 years of age, and generally better educated than others in the village. Villagers said that the young, educated, and healthy went in search of "the bright lights." The elderly, young children, the sick, and those (often women) who cared for them remained behind.

Table 8: Characteristics of Household Members Living Away from Village

(percent)

	Gaozui	Zhaoshan	Xiapai	Xiaozhu	Duiwotai	Housanxi
Men	63	86	61	89	71	79
Women	37	14	39	11	29	21
Aged 20–34	54	59	57	78	64	73
At least lower middle school	39	45	36	0	43	36
Working outside province:	20	23	46	33	79	91
Men	7	23	25	33	57	73
Women	12	0	21	0	21	18
Total number of migrants	41	22	28	9	14	33

The Main Constraints on Livelihood Strategies

Across all study communities the livelihood strategies available to households were seen as most severely constrained by their environment, lack of infrastructure, land holding, and human capital assets. Those in the villages without electricity included energy service constraints.

Soil conditions and climate limited the possibilities for increased agricultural productivity or diversification of outputs. The distance from markets and employment opportunities inhibited the growth of alternative income-generating activities. Limited water and fuelwood resources imposed demands that reduced domestic labor time available for productive activities.

In Duiwotal, for example, women identified poor transportation and their remote location as key factors constraining opportunities for generating additional income. It took more than half a day to walk to the nearest market, which was often almost over by the time they arrived. As a result, produce could not be converted to money. The lack of an adequate water supply because of the high location on the mountain meant that women had to carry drinking water up from the bottom of the mountain. They also needed water to feed their pigs. They only had time for one such journey each day and this was often insufficient.

Land had usually been allocated on a per capita basis with the introduction of the rural reforms during 1978–79. There had been little reallocation since that time and most households still farmed between 0.5 and 2.5 hectares (table 9). In Hubei, the quality of land farmed was typically inversely proportional to the area, given that population densities tended to be less in more remote, particularly mountainous locations where soil fertility was lower. Given the size of landholdings, production of even an adequate crop

in terms of household subsistence needs was said to demand the application of large quantities of expensive fertilizers and pesticides.

Table 9: Distribution by Household Size and Landholding per Capita

(hectares)

Members	Gaozui	Zhaoshan	Xiapai	Xiaozhu	Duiwotai	Housanxi
1	0	0	1	8	1	0
2	3	6	2	9	2	2
3–5	18	20	29	18	27	32
6+	15	10	4	1	6	2
Land per capita	0.26	0.29	0.56	0.23	0.13	0.10
Households	36	36	36	36	36	36

Constrained human capital assets, in terms of both quantity and quality, were seen as another key determinant of poverty. Almost all of the households surveyed were relatively small in size, typically consisting of three to five members. Labor constraints were seen as placing severe limitations on overall agricultural production. Given the time that had to be allocated to basic reproductive activities, as discussed below, villagers reported that it would be extremely difficult to expand crop outputs, for example by renting additional land (which was possible in principle). A similar reason was advanced for the fact that households usually owned less than 5 larger animals (pigs, donkeys, sheep or cattle).

Supporting this observation was the fact that dependency ratios were highest in the four poorer villages, around 0.65 to 0.70, and lowest in the two richest, 0.41 and 0.50 (table 10). Overall, between 23 and 31 percent of household members were younger than 15 years of age and 6 to 15 percent were older than 60. Typically, around one third of households included three generations.

Table 10: Age Structure

(percent)

Members	Gaozui	Zhaoshan	Xiapai	Xiaozhu	Duiwotai	Housanxi
0–14	31	26	25	27	25	23
15–34	33	32	35	38	36	37
35–59	27	26	31	23	25	34
60+	9	15	8	12	15	6
Dependency ratio	0.67	0.71	0.50	0.64	0.66	0.41
Total members	185	155	153	102	151	145

Villagers in Xiaozhu, which had the highest average landholding per capita of the three villagers in Hubei, said that labor, not land, was the main constraining factor on agricultural production. This, the poorest village, is in a mountainous and sparsely populated region and was the only sampled community with a considerable number of single-person households. Villagers explained that it was very difficult to find anyone who would marry into such a community, especially in the absence of electricity. Young men and women said that they would have to leave the village in order to start families.

Levels of education were generally low (table 11), particularly in the villages in Gansu, where around half of those over the age of 15 had not completed primary education. This seemed in conflict with the assurances from both villagers and schools that "almost every" child attended primary school. As indicated in table 7, education is highly valued, with poor education seen as a principle cause of poverty. However, many households reported having difficulty in paying school fees and it may be that villagers were unwilling to admit that high educational aspirations for their children sometimes had to give way to pressing economic circumstances.

Table 11: Educational Attainment of Those 15 and Over

(percent)

Members	Gaozui	Zhaoshan	Xiapai	Xiaozhu	Duiwotai	Housanxi
None	49	61	35	29	21	12
Primary	28	23	40	54	56	67
Lower middle	19	10	19	17	15	16
Higher	4	6	5	0	7	6
Number 15 and over	127	115	114	72	98	109

The Livelihood Strategies of Women

The small size of most households meant that both men and women took an active role in most aspects of agricultural production, with the possible exception of work with or using the large farm animals, cattle, or donkeys. However, all farm-based cash earning activities were generally seen as either primarily the responsibility of men or as joint undertakings. This was even true of small livestock production, even though women often played the lead role in tending pigs or chickens.

As is usually the case with rural household activities, the imposition of a distinction between productive and domestic tasks appeared somewhat arbitrary. It was clear, however, that women usually took the majority of the substantial time input to activities that were regarded as secondary to the main task of working in the fields on crop production. It was noticeable that women tended to identify the labor they had to expend on human-energy-intensive basic tasks as one of the main characteristics of a life spent in

poverty. This was especially the case for water collection and assembling and preparing heating and cooking fuels.

Marriage provided women with one possible migration route out of a poor village. Although marrying out is usually seen as loss of empowerment, often costing the woman access to land, family support, and local connections, many women expressed the hope that they could marry into a better area. One woman in Housanxi whose husband had married into her family complained that this arrangement had been for the sake of her parents who had no sons, and that she had wanted to leave for somewhere better. In *Xiaozhu*, a few men had married out and many men were single and unable to find wives. In *Duiwotai*, most women married out, and in *Housanxi*, the richest village, some men had married in.

Once married, women appeared to be much more tied to their villages than men. Reduction of manual labor through the introduction of electricity was said to have made it easier for men to migrate, leaving women to manage agricultural work. Women worked outside the villages to a much lesser extent than men and the lack of transport seriously affected their ability to get produce to market.

Characteristics of Poor and Vulnerable Households

As discussed above, the distribution of assets across the majority of households displayed less inequality than would be the case in most countries. This was true not only of land but also of the second most important productive asset: livestock. Table 12 below shows the distribution of the main farm animals owned by sample households. Note that no household had more than three large draft animals, and most owned one or two. The distribution of smaller animals, pigs, and sheep, becomes more unequal in the richer villages, Xiapai and Housanxi, but of the 36 sampled households only for in the former and three in the latter village owned more than seven animals.

Similar findings hold for household assets, although given the poverty status of five of the six villages, these are very limited in number. This relatively equal distribution of assets would tend to emphasize the dynamic nature of poverty within a village community. Although it was possible to identify a small number of households who were clearly destitute and an even smaller number who were relatively well off, in general household prosperity could vary considerably from one year to the next depending, for example, on climate conditions, agricultural prices, ill health, and success or failure in finding short-term work outside the village. Thus, although it is possible to assess the general factors that result in the community in Gaozui, for example, being poorer than that in Xiapai, explanations as to why specific households in either village are poor compared to their neighbors are problematic. In the following discussion, therefore, the focus is generally on intervillage, rather than intravillage, comparisons.

Table 12: Distribution of Ownership of Main Livestock Animals

Asset	Number	Gaozui	Zhaoshan	Xiapai	Xiaozhu	Duiwotai	Housanxi
Cattle	0	31	35	12	15	6	19
	1	2		7	16	20	14
	2	2		17	4	9	2
	3	1	1		1	1	1
Donkeys	0	11	5	34	36	35	36
	1	6	11	2		1	
	2	13	17				
	3	6	3				
Pigs	0	3	6	14	7		1
	1–2	30	25	22	19	9	5
	3–4	2	4		8	14	12
	5–6				1	8	7
	7+	1	1		1	5	11
Sheep	0	30	18	8	34	36	36
	1–2	2	3	6	1		
	3–4	1	8	9			
	5–6	1	4	6	1		
	7+	2	3	6			

The Causes of Poverty

In China, the association of poverty and geography remains deeply entrenched, both in the minds of local officials and in existing administrative structures. It is a view that was endorsed by the study communities (table 13). In all the field study sites, focus group discussions with women, men, and village committees emphasized geography, poor land, altitude, remoteness, distance from urban areas, absence of nearby markets, and bad roads as the primary causes of poverty, alongside poor education and ill health.

Table 13: Main Causes of Poverty as Identified in Focus Group Discussion

GANSU		
Gaozui	**Zhaoshan**	**Xiapai**
Drought Insufficient land Sickness or disability in family No access to markets Poor education No electricity	Drought Lack labor Poor land Lack of finance	Cost of inputs and taxes Insufficient irrigation Drought No access to markets
HUBEI		
Xiaozhu	**Duiwotai**	**Housanxi**
Remote mountainous area Poor climate—cold No electricity Little education Lack of market information Sickness	Remote from markets Poor soil Little education or knowledge Poor management	Lack of education Remoteness Poor quality land Poor marketing knowledge

Poverty Indicator: Lack of Basic Needs

A large proportion of sampled households said they had inadequate food, clothing, and housing (table 14). Food inadequacy was most commonly reported in Gansu in the two counties that had suffered most from droughts in 1999 and 2000. In Xiapai, the wealthiest village in the study with by far the greatest accumulation of productive powered assets (26 of 36 sampled households owned small farm vehicles), 64 percent of households reported food shortages during limited periods during the previous year. They attributed these shortages to the failure, partly because of the unhelpful attitudes of local officials, of the irrigation system on which their livelihoods crucially depended.

Table 14: Household Self-Assessment of Standard of Living

(%)

	Gaozui	Zhaoshan	Xiapai	Xiaozhu	Duiwotai	Housanxi
Households reporting less than adequate:						
Food	36	72	64	44	17	28
Housing	22	19	19	47	22	42
Clothing	42	25	36	56	42	36
Periods of food shortage	53	78	64	44	22	31
Difficulties with:						
Healthcare cost	78	69	86	78	67	83
Education costs*	42	36	42	42	47	50
Taxes	61	75	75	81	67	72

* Households with school age children.

Poverty Indicator: Difficulties in Meeting Necessary Cash Expenditures

Education costs were a problem for a substantial minority of households. However, although the legitimacy of fees was questioned they were generally seen as unavoidable to maintain at least a minimum standard of education. Almost all households reported problems in meeting healthcare costs. The direct and opportunity costs of illness had a particularly damaging impact on poor labor shortage households. Labor supply was reduced and reproductive labor demands on household careers increased. Cash expenditure on healthcare services could force a run down of financial and physical assets, reducing labor productivity still further.

All households cited the late spring and summer months, during which the produce from the previous harvest was running out and the new harvest not yet available, as the most difficult period of year. At this time demanding physical labor was needed, people did not have time to leave the village and seek wage employment, food was short, fertilizer and pesticide had to be purchased, and in some cases half-yearly fees were due for those with children in school.

Not unexpectedly, taxes were said to be a major problem for the majority of households in all six villages. Perhaps the surprise is that nearly 25 percent of households did not complain. As discussed in the section of chapter 3 describing Hubei Province, taxes are largely determined by the quantity of land farmed, not by the output produced. Taxes had to be paid in good times and bad and tended to increase year by year. In Xiaozhu, the village committee cited steadily increasing taxes on tobacco as the number one reason for the 20 percent increase in the number of poor during the last 10 years. As in most of the other villages, apart from land taxes there were multiple fees associated with education and livestock farming, although these have been banned by the central

government. The party secretary in Xiaozhu remarked that because of the tax on slaughtering, some families could afford to raise a pig, but not to kill and eat it.

Poverty Indicator: Insufficient Labor Supply and High Dependency Ratios

In most poor households the combined productive and reproduction burdens were high relative to the human capital available. As indicated in table 15, the average number of men and women in the 15 to 59 age band per household ranged between 1.7 and 3.0. In Xiazhu, as discussed above, the existence of a number of single male households reduced the average number of women in this age band to just 0.6. These low numbers in the prime working age band were often linked to high dependency ratios, particularly in terms of aged dependants.

Table 15: Average Number of Men and Women in the 15–59 Age Band per Household

	Gaozui	Zhaoshan	Xiapai	Xiaozhu	Duiwotai	Housanxi
Men 15–59	1.50	1.50	1.36	1.08	1.36	1.56
Women 15–59	1.58	1.03	1.42	0.64	1.17	1.28
All 15–59	3.08	2.53	2.78	1.72	2.53	2.83

In focus groups, when asked about the reasons for poverty, most responded by talking about the climate, geography, and lack of infrastructure. When asked about who was better off, focus groups cited some individuals who had succeeded in taking advantage of improved roads or recent electricity connection. However, more often they talked about people whose lives had improved because of changes in life cycle and family composition. Household poverty was seen as greatly affected by the life cycle and related labor shortages.

For example, as children grew older and more self reliant, they liberated their parents to go out and work as migrant laborers. Parents were seen as becoming better off when children grew up and supported them. Households were seen to become worse off when they had to support children, or elderly parents in deteriorating health. Villagers emphasized the importance of women's strength and capability to determining household well-being, and cited the absence or ill-health of women as a major causal factor of poverty.

In practice, many labor shortage households were caught in a vicious circle, whereby those who could possibly have benefited most from the substitution of machinery for labor were simply too poor to gain access. And labor shortage was often cited as a major reason for their poverty. This situation was frequently related to stages within the household life cycle. As described above, the great majority of households in the study were relatively small, typically composed of three to five resident members. Small households with young children, frail elderly parents or suffering from the sickness of a

key worker, had little time to allocate to expansion of their productive activities or external income earning. They also faced a range of additional expenditure burdens, such as school or healthcare fees. Their financial situation would then preclude them from using those energy services that might have increased their productivity and allowed them to escape from their difficulties.

Poverty Indicator: Lack of Electricity

In villages without electricity, most respondents felt that in itself marked them as among the poorest. Precisely because of the astonishing expansion of the grid in China, those without electricity are acutely aware of being excluded. Almost everyone in the communities without access had routine contact with others in very similar economic circumstances—and perhaps living only 10 kilometers away—who took it for granted. This is clearly a very different situation from that in many other countries where large sections or even a majority of the population live without electricity. In China, access has become not only a means to a better life but a key standard-of-living indicator and a necessary asset for full participation in society. Perhaps this is illustrated most powerfully by the example in box 1 of the difficulties experienced by those living in unconnected villages of finding and keeping a marriage partner.

In villages without electricity there was an evident powerful desire to gain access at least to electric lighting. Such statements as "it would lift our sprits" and "it would make a hard life more bearable" were common. In one household, decorated electric light fittings were hanging from the ceiling "in the hope that one day they will be lit." A children's focus group in Xiaozhu village said they liked studying and wanted to learn characters so that they could go out as migrant laborers. When asked why they wanted to go out, the chorus of replies came "waimian hao" (it's good out there!). When asked why it was good, they shouted out "They have electricity!"

At the start of the project many of the researchers fell into the habit of speaking of approaches to electricity supply for populations in remote areas, such as PV or small wind generators, as "only" providing lighting, television, and similar low-power consuming services. Such approaches were clearly not going to lift people out of poverty in terms of dramatically increased production and income generation. However, the experience of living in the two villages that did not have electric lighting gave a very different perspective. Only one room would usually be lit and this by a tiny kerosene flame. From around 7:00 p.m. each evening any form of productive, educational, or domestic activity, which required being able to see clearly, was almost impossible. In Hubei, almost every girl and woman had scars across her hand from cutting pig fodder manually. They said this usually happened at dusk when they could not see clearly.

One interesting aspect of the importance of electricity for women arose in discussion with officials in Hubei, who pointed out that among the Miao minority, embroidery was not simply a pastime but an essential social skill. Households were judged by the quality of their clothing, and a woman seeking a husband, who would almost always be from

another village, would have to demonstrate their ability in order to satisfy his family. Being able to undertake this activity in the evening by electric light was extremely important in terms of the standing of a woman within the community. In some cases it also allowed them one of the few opportunities to earn nonagricultural income. As the majority of Miao villages had been electrified, those without access were now greatly disadvantaged.

Box 1: An Extreme Example: Xiao Jikai and His Household

Xiao Jikai's was the poorest family visited in the village without electricity in Hubei. He owned the fewest physical assets, not even matches or a lighter. His 16-year-old son kept house and kept the cinders alight from which to coax a fire every morning. The household had no stove, just a three-legged grill, of which half was missing.

Different people gave different reasons as to why Xiao Jikai was so poor. His wife had divorced him ten years previously, apparently unwilling to cope with the hard life she had married into. She had since died. People said that the absence of a woman to manage the household and contribute labor was the main factor in pushing the household into poverty. Output on their land was also low because they had no money to buy fertilizer. The previous year, Xiao Jikai had gone to the city to do migrant labor but had earned nothing. Some said he had gambled it away. Although migrant labor was one of the most important ways out of poverty, there were many accounts of people migrating to urban areas and failing to earn back even the cost of their travel.

While Xiao Jikai was away, his 16-year-old son ran the household and the farm with his 13-year-old sister and 9-year-old brother. Since their father's return, the two younger children had been released from farm labor long enough to go to school. Xiao Jikai managed to borrow their annual tuition fees, which amounted to several hundred yuan. After school, they would spend several hours on domestic and farm chores before doing their homework by the light of the family's one lamp, which consisted of a wick in a small jar of kerosene. They said that the light was smoky, hurt their eyes, and was inadequate, even though they took turns in using it.

Xiao Jikai's was one of just four households out of the 71 in the village that received relief assistance from the Bureau of Civil Affairs. In the previous year the township government gave Xiao Jikai 560 jin of grain, along with some bedding and clothing.

The Livelihood Strategies of the Poor

As discussed above, the households in poorer communities had fewer livelihood strategy options. Given the limited agricultural possibilities, they would try any alternative source of income. In the poorest village, Xiaozhu, women would spend considerable time gathering wild medicinal herbs for sale and a few villagers reported trading in wood, an arduous (and now, technically, illegal) occupation. Some men routinely traveled to Lichuan city and worked collecting rubbish for recycling. In Duiwotal both men and

women would travel long distances carrying charcoal to sell in Sichuan Province where prices were higher.

Poorer households were unlikely to consider spending scarce cash resources on hiring labor, and often placed onerous burdens on women or child members. They were particularly vulnerable to a variety of economic or social shocks. Any event that further decreased labor supply, increased productive or reproductive labor demands, or necessitated cash expenditures could precipitate a downward spiral into extreme poverty unless family or friends were able to help.

For all households, borrowing was by far the most important coping strategy in difficult times (table 16).

Table 16: Common Coping Strategies Adopted in Times of Need

(%)

	Gaozui	Zhaoshan	Xiapai	Xiaozhu	Duiwotai	Housanxi
Borrow from relatives	40.3	38.1	34.8	40.2	42.3	52.2
Formal loan	9.0	17.5	15.2	0.0	0.0	0.0
Credit	6.0	1.6	9.1	11.8	15.4	8.0
Selling animals and assets	11.9	14.3	1.5	7.1	9.4	8.5
Selling grain-crops	16.4	15.9	21.2	9.4	18.1	7.5
Casual labor	3.0	1.6	3.0	29.1	12.1	2.0
Migrant labor	13.4	11.1	15.2	2.4	2.7	21.9

Almost all households reported borrowing money during the previous year. However, sources varied (table 17). In Gansu, although the majority of households in all villages relied most heavily on relatives and friends, formal loans were available at village level. In the two less poor villages, around one third came from this source, with a few households, particularly in the richer Xiapai, approaching township banks. In Hubei, loans were obtained from friends and relatives or other households, with almost no interaction with formal credit institutions.

Table 17: Number of Households Borrowing by Primary Source and Median Amount

Source	Gaozui	Zhaoshan	Xiapai	Xiaozhu	Duiwotai	Housanxi
Relatives or friends	24	16	22	21	24	27
Formal loan	2	13	11	4	1	1
Other source	1	1	0	7	7	7
All sources	27	30	33	32	32	35
Median amount	1,325	1,500	3,000	870	875	1,000

Borrowing in the poorest village, Xiaozhu, took on a special character. As indicated above, it was operated essentially as a company town. Tobacco growers were required to buy a specified fertilizer from the local tobacco company. They would be offered a credit agreement if they could not raise the money for this fertilizer elsewhere. Villagers complained that with recent higher tobacco taxes and falling tobacco prices, selling tobacco back to the company made just enough to pay back the fertilizer debt.

Energy Services

This section will focus on the nature and distribution of existing energy services, their uses for both domestic and production activities, and the implications for the poor and women, with particular reference to livelihood strategies.

How Are Energy Services Distributed within the Study Communities?

In Gaozui most households used kerosene for lighting, with candles, edible oil, or butter as alternatives when kerosene ran out. Crop residues, grasses, and twigs were the main fuels for cooking. Residues and dried dung were used to heat the Kang (fire bed) and coal or coal briquettes to heat the room. A few households possessed powered three-wheel vehicles or motorcycles. Three households in the community owned televisions powered by car batteries. Grain milling and grinding equipment were located near the main road into the village and owned by a few richer households in an electrified subvillage. People in the communities without electricity had to carry their grain up to 7 kilometers to get it processed. There were no communication facilities in Gaozui or nearby villages.

All the sampled households in Zhaoshan used electric lighting, with kerosene, candle and battery-flashlights as alternatives when there were supply problems. The main fuels used for cooking were straw and stalks, firewood, and dried dung. Richer households used coal in winter. Since gaining access to electricity, a few households used electric pot heaters to boil small quantities of water for tea. Most households had a solar cooker, used to heat water and boil potatoes in summer. The township government had encouraged the planting of red willow for firewood, and provided seeds. Local people said they were

pleased to use these trees because they were easy to plant, grew quickly, and could be used directly without the need for long drying periods.

Households usually heated the Kang (fire bed) from late October to April. Women spent some 20 minutes every day preparing the fire using crop residues and dried dung. During the coldest days, an iron coal or coal briquette stove was used to heat the bedroom. A number of households had three-wheeled diesel powered trucks for transporting crops, although some had stopped using these because of cost.

Electricity was also used for lighting in Xiapai. Because the supply was reasonably reliable, kerosene was not widely used, with households using a battery-flashlight or candles if required. The main fuels for cooking were straw and stalks, firewood, dry dung, and coal briquettes. Most households used iron stoves in winter. The fire bed was used here as in Zhaoshan. Most households had three-wheel diesel powered vehicles (San Ma Zi) for transporting crops. The majority of these were purchased in 1998 following a good harvest. Some families in the village used these to transport cargo or passengers and earn additional income. A number of households also had gasoline-fueled motorcycles. There were two irrigation wells in the village, powered by electricity.

Lighting in Xiaozhu was mainly by kerosene lamp, with battery-flashlights, candles and “xiao youzhu” (small oil bamboo) as alternatives. Firewood and straw were the main energy sources for heating. A few richer households used coal and charcoal. Firewood was rated as by far the most important energy source for cooking, with just one household selecting coal—and this related to its use for curing tobacco. Almost all households insisted that manual labor and cattle were the main energy sources for production.

Almost all households in Duiwotal regarded electricity as their primary energy source for lighting, with just one selecting kerosene. Because supply was uncertain, however, 34 households said that they would keep kerosene lamps on hand. The same number selected firewood as their first energy source for heating, with 10 choosing crop residues and twigs, 7 charcoal and 4 coal as second choice. The same 34 households used firewood as their primary energy source for cooking, with 14 selecting crop residues and twigs as a second source. Only one household used coal and one charcoal.

All households selected human labor as by far the most important for production and the great majority placed animal labor second, with just one choosing diesel. Electricity was seen as important, but only at those times of year when they needed access to crop processing equipment. Very few households responded to questions on the use of energy for transport or water. They reported having very little contact with powered vehicles and had to rely on there own efforts to carry water.

Housanxi again relied heavily on electricity, and also stressed the need for standby kerosene lamps. Wood or crop residues were used for heating. Coal was typically only burnt when there were relatives or friends visiting. Wood and crop residues were also the primary fuels for cooking. Only one household used mainly coal. Many households had

bought electric grinders to mill grain and chop pig food. This equipment was reported to be available to other households at the cost of the electricity used, normally about ¥ 4 per 50 kg. Transport was almost always on foot, with diesel buses or trucks only considered for very long journeys.

In each village, households were asked to rank alternative energy sources in term of their importance for specific purposes. The results are shown in table 18 (only the first and second ranked sources are displayed).

Although table 18 may appear complex, it does illustrate a number of important general points. First, it is clear that villagers maintain a wide variety of energy sources for different purposes. Thus, electricity is adopted almost uniformly for lighting when it is available but kerosene lamps, candles, and various flammable vegetable oils are retained. In general as villages become richer they expand their options in terms of energy sources (this is even more evident in the detailed village reports where third- and fourth-choice energy sources are presented). Second, electric lighting is selected by all but one household in electrified villages, including the poorest households in the sample. These households clearly find electric lighting sufficiently attractive that they are willing to pay the associated costs.

Third, almost all households, even in richer villages, insisted that humans and animals were the key energy sources for production. Very few selected modern energy sources even as a second (or in the detailed studies, third or fourth) choice. When prompted they will agree that, for example, electric- or diesel-powered grinding or milling machines were very useful. However, such equipment was typically seen as saving a relatively small proportion of total human labor time during limited periods of the agricultural year, and making production a little easier. If it were not available (and in Duiwotai in particular supply problems meant that this was often the case), production would continue using manual substitutes.

The only exception to this perception was the high importance attached to diesel for transport. This was clearly in part a simple reflection of the use of trucks to move produce to market and buses that allowed people to make longer journeys. However, it also reflects the investment in small agricultural vehicles by some households who would now find it very difficult to manage without them.

Table 18: Most Important Energy Sources by Use

	Gaozui		Zhaoshan		Xiapai		Xiaozhu		Duiwotai		Housanxi	
Rank	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**
Lighting												
Electricity			36		36				35	1	36	
Kerosene	34			15		2	33	1	1	34		30
Candles	1	4		14		11		3				1
Batteries		17		2		9	1	14				1
Butter/Oil		1					2	15		1		3
Cooking												
Dry wood	18	5	26	4	8	6	35		34	1	35	1
Crop residues	14	9	8	7	5	13		16		14		18
Coal		2	1	7	18	6	1	1		1	1	4
Charcoal								1		1		1
Livestock dung	5	12	1	8	5	11						
Solar cooker				2								
Heating												
Dry wood	2	7	3	4	11	1	35		34	1	29	5
Crop residues	1	12	8	14	6	13		10		10		11
Coal	4	7	10	7	17	7		4	2	4	6	7
Charcoal								2		7	1	6
Livestock dung	28	3	10	10	2	14						
Production												
Human	28	7	27	7	22	6	36		36		36	31
Animal	7	26	7	28	3	18		29		34		
Coal								1				
Diesel		1			9	9				1		
Electricity	1		1			10						2
Transport												
Human	26	4	12	3	29	4	35	1	35	1	35	1
Animal	1	1				1				1		
Petrol			9	5	2	6				2		1
Diesel	8	22	12	6	5	19		2		6		13

Note: The numbers in each section do not always add to 36, as some households said they could not assign a rank. The most common reason was that the importance of fuels varied by season.

Energy Service Expenditures

Cash expenditures on energy services in the two poorest, villages without electricity, were very limited. In both Gaozui and Xiaozhu the main recurrent expenditures were on kerosene for lighting. Typically, households would purchase 1–2 kg each month at a cost of around ¥ 4–5, a total annual expenditure of some ¥ 50–100 per year. Candles, sold in the villages for around ¥ 0.5–1.0, were kept for special occasions only, as they were consumed too rapidly for daily use. Almost all households had a small flashlight, but it was used only in emergencies, and batteries, which cost around ¥ 1.6 per pair, were said to last for 4–6 months.

Richer households who could afford coal or coal dust would purchase it just before winter arrived. They would usually buy around 500 kg at a cost of ¥ 100–200. *Xiaozhu* was relatively near to an open cast coal mine, and raw coal, said to be of inferior quality with high sulfur content, could be purchased for ¥ 200 per ton. Firewood was purchased two to three times per years, in lots of 25–50 kg at price of around ¥ 1 per kg. Candles were purchased at most three times per year in lots of 10 to 20, costing between ¥ 0.2 and ¥ 0.5 per candle. Light bulbs needed replacing roughly twice each year at a cost of ¥ 1. Households also bought boxes of matches and lighters every two to three months at a cost of ¥ 1.

In Gaozui, the owner of the only truck reported using around 1,000 liters of diesel in the previous year, at a cost of ¥ 3,400. In *Xiapai*, where most sampled households owned a small farm vehicles, average annual expenditure on diesel per household was around ¥ 175.

Price information required careful interpretation (table 19). Purchase quantities varied considerably and almost all prices were open to negotiation. As might be expected, transport costs tended to increase prices between county, township, and village levels. However, prices in village shops of items, such as small batteries or light bulbs, tended to be only marginally higher than in the township. Quoted prices of bulk items, such as coal, could be 50 to100 percent higher, particularly for smaller quantities. However, it seemed unlikely that those living in the village often paid these prices. Because most households would have to make regular visits to the township, they would take this opportunity to purchase goods and if necessary arrange transport back to the village. In some cases, family members might physically carry even large quantities of bulk items, such as coal, over considerable distances to save transport costs.

Table 19: Prices of Common Energy-Related Purchases

Item	Unit	Gaozui	Zhaoshan	Xiapai	Xiaozhu	Duiwotai	Housanxi
Candles	unit	0.5	0.25–0.8	0.5–0.6	0.2	0.2–0.3	0.2
Firewood	bundle	0.2		0.2	0.1	0.1	
Charcoal	kg				1–1.6	1.2	1–1.5
Coal or briquettes	ton	240–300	290–350	280	200	160	250
Kerosene	kg	4.2	4		5	4.4–5	4.8
Diesel	liter	4	4.2	3.8		3.8	3.6
Dry cell batteries	pair	1.6	2	1–1.5	1.4	1.5	1.4
Car batteries	unit	300–600				180–250	
Light bulbs	15–60 W	1–1.5	1–1.5	1.5	1–1.3	1–1.5	1
Flashlight bulbs	unit	0.2	0.2	0.5	0.2	0.2	0.2
Equipment:							
TV	BW-C	380–2,500	900–1,200	1,200	300–700	300–400	300–700
Radio		30–120	50–90	110	50–200	30	50–500
Cassette		80–340	160	60		70	
Water heater		80–140	50	50	100		100–200
Miller-grinder		460		500	400	500–1,000	500–1,000
Electric motor	1.5–7 kW	600–1,500		1,500–2,500	1,000–4,000	4,000	3,000
Fan	30W	52	33				

Electricity prices varied considerably. Households in Xiapai said that they had seen prices reduced and quality of services improved following their inclusion in the Rural Energy Reform Program referred to above. They reported charges of ¥ 0.45 per kilowatt-hour as compared to ¥ 0.7 prior to the reform. Households typically spent around ¥ 10 per month, mainly on lighting four to five bulbs per household and running a television. Costs in Zhaoshan were a little higher at ¥ 0.5–0.6 and expenditures were similar. In both Housanxi (¥ 0.6–0.8 per kilowatt hour) and *Duiwotai* (¥ 1.2–2.0 per kilowatt hour) costs were higher and varied depending on the length of transmission line to the household. Both communities also complained that they had to maintain at least a one-month supply of kerosene, costing ¥ 5–10, to allow for electricity failures.

Which Energy Services Are Most Important to the Poor for Reproductive Tasks?

Heating was a major concern in all of the villages, and one of the most time-consuming activities for both poor women and men. As indicated in chapter 3 of section 2 (section on Timetable and Preparatory Activities), the fieldwork was carried out in the late

autumn, when the weather was worsening and the temperature falling, particularly in field sites at higher elevations. Residence in the villages allowed the researchers to appreciate the extreme difficulties experienced in terms of heating and cooking at this time of year. With or without access to electricity and coal, there was still a heavy reliance on biomass, whether in the form of animal dung, crop residues, or locally collected firewood. These typically provided a cash-free option but one involving considerable labor time inputs, often borne by women. Coal, and even the cheaper coal dust, which was made into briquettes, was considered expensive to buy and usually had to be conveyed a considerable distance back to the village. Households buying coal would often carry it for 5 to 10 kilometers to avoid paying for transport.

Women undertook primary responsibility for cooking in all the villages and devoted far more time than men to the actual process and to the associated activities of fuel preparation, use, and water collection. Modern energy services appeared to play a very limited role. Only a few richer households burned coal; the great majority used crop residues and firewood.

Sources of firewood, which was the most favored of the three traditional fuels in terms of ease-of-use and heat output, have diminished rapidly, given that most forest land has been cleared for agriculture. In most of the villages, collection of firewood entailed traveling distances of up to 10 kilometers and could occupy a full day at least once per month. In Housanxi, people reported having to travel much longer distances to collect fuelwood because of prohibitions on cutting wood introduced three years previously. Traveling long distances to gather wood was usually undertaken by men and in some cases could entail a full day away from normal activities. The aim would be to gather sufficient wood to last for an extended period. Of course, women might well have to take on additional tasks while the men were absent.

In many of the areas surveyed, deforestation is a matter of great concern to the Chinese Government. They are included within the scope of a recently introduced program that offers farmers food grains in return for planting trees on previously cropped land. In Gansu in particular, soil erosion linked to the loss of forestlands has reached catastrophic proportions. Given the cost, it was said to be impossible for most households to substitute coal for wood, even though villagers recognize that there may be environmental consequences if trees are cut down or damaged in the collection of firewood. In Duiwotai, poorer households would produce or buy charcoal and then and sell it at a nearby market. They could not afford to use it themselves.

A great majority of women were very unhappy with their dependence on these energy services. Fire lighting was difficult, often involving the use of damp or green wood. Sufficiently high temperatures were hard to maintain and the fire required constant attention. Household smoke pollution was a major concern and recognized as a cause of eye problems, sore throats, and coughs. There were also many complaints about the

impossibility of maintaining a reasonable standard of cleanliness in the household while burning these fuels.

Time Allocation to Human-Energy-Consuming Reproductive Tasks

Table 20 shows the time allocated to various "non-income-earning activities" (the form of words that seemed to capture this concept in discussions with villagers) in the study communities in winter. The table excludes the small number of single-person households in order to avoid problems of interpretation.

Women estimated that they spent an average of 33 to 49 hours each week on these "non-income-earning activities" and men between 10 and 31 hours. Note that this does not include childcare, because villagers found it impossible to estimate the time spent devoted solely to this activity. Typically, it would be combined with other household tasks and undertaken primarily by women.

In some cases, the poorer, more remote households, located far away from roads had better access to fuelwood, being located in areas where conservation regulations were unlikely to be strictly implemented.

The Implications of Women's Time Poverty in Terms of Livelihood Strategies

Clearly, the labor required simply to sustain the household from day to day is considerable. Adding the time spent on the "main activity" of crop production provides some indication as to why most households said that they had to work all the time and had "no time to take on new activities." An example from table 20 was the preparing pig fodder, which required both cutting and then cooking into a swill, and was a major time-consuming activity for women. This was a key constraint in deciding how many pigs the household could raise, even though they had identified pig breeding as one of the few options for improving their situation.

Table 20: Time Spent on "Non–Income-Earning Activities" Each Week in Winter

(hours)

Hubei	Xiaozhu		Duiwotai		Housanxi	
	Men	**Women**	**Men**	**Women**	**Men**	**Women**
Cooking	2.7	18.6	1.1	20.2	0.6	23.9
Fuel gathering	8.0	5.6	5.4	9.2	6.4	5.2
Fetching water	5.7	2.0	3.7	2.4	4.8	1.6
Washing	1.1	3.9	0.4	2.2	0.4	3.5
Grinding/Milling	4.9	3.7	0.7	1.6	1.2	0.3
Prepare pig food	2.3	8.6	0.6	7.3	2.5	9.7
Prepare cattle food	0.3	0.5	1.3	1.8	0.3	0.1
Grazing cattle	5.0	0.5	1.9	4.8	6.8	0.4
Collect compost straw	0.0	0.0	0.0	0.0	0.9	3.0
Other	1.0	0.9	0.0	0.0	0.0	0.0
Total	**30.9**	**44.2**	**15.2**	**49.5**	**23.7**	**47.7**

Gansu	Gaozui		Zhaoshan		Xiapai	
	Men	**Women**	**Men**	**Women**	**Men**	**Women**
Cooking	1.1	11.9	2.5	12.6	2.7	18.8
Gathering fuel	1.4	9.6	2.8	4.6	1.2	2.7
Fetching water	2.4	2.2	1.1	0.6	1.0	1.7
Washing clothes	0.6	2.1	0.4	1.8	0.4	3.6
Feed livestock	3.5	2.8	6.7	2.2	4.2	2.3
Grazing sheep	0.5	1.6	5.3	2.4	3.3	1.2
Feeding pigs/chickens	0.0	2.1	0.3	3.7	0.1	3.1
Clean house/yard	0.0	2.5	0.4	3.6	0.4	4.3
Gathering dung	0.0	0.8	0.4	1.6	0.1	0.1
Total	**9.5**	**35.6**	**19.9**	**33.1**	**13.4**	**37.8**

Distribution of Powered Production Equipment within Communities

There was a clear correlation between powered production or transport equipment and living standards (table 21). In the poorer, more isolated villages without electricity, one or two richer families owned the little equipment available. In the recently electrified villages, equipment was more plentiful and varied but again concentrated in relatively few private households. Overall asset ownership was more widely distributed in Xiapai,

in the richer county, but in terms of powered equipment households appeared to have invested mainly in agricultural vehicles. Only in Housanxi were electrically powered machines, in this case grinders and fodder cutters, owned by a majority of the sampled households.

The households that owned powered assets in the poorer villages were also relatively rich in terms of financial, human resource and social assets. A number had income from salaries, such as local officials or teachers. The schoolteacher in Zhaoshan owned a variety of electrical equipment including a saw, a milling machine, and a noodle maker. The party secretary owned the diesel grinder in Duiwotai, to which many people brought their corn. Some had incomes other than farming, such as from shops or healthcare clinics, and others had remittance income from family members employed in urban areas. Indeed the ownership of equipment and the resulting agricultural productivity increases, which reduced the demand for labor, was seen as allowing household members to seek wage employment or at least casual labor elsewhere.

Table 21: Powered Production or Transport Equipment: Ownership

Item	Gaozui	Zhaoshan	Xiapai	Xiaozhu	Duiwotai	Housanxi
Milling machine		2	1		1	21
Grinding machine	1	2	1		4	27
Pulverizer (diesel)			5			
Noodle maker		1				5
Fodder cutter		1			1	17
Oil press		2				
Electric saw		2				
Small tractor	5	6	27			
Motor cycle	2	1	4			
Truck	1		1		1	1

Note: In practice there may be limited distinction between milling and grinding machines. The villagers' description has been adopted for this table.

Access by Poorer Households to Powered Production Equipment

In general, households with equipment were very willing to hire it out, at what appeared to be relatively low prices, and this provided them with yet another income stream. This implied that most households in electrified villages had access to powered equipment, and even in Gaozui and Xiaozhu almost 50 percent of households were able to use equipment owned by others (table 22). Interestingly, in Duiwotai, access to machinery could often be obtained in exchange for labor, enabling the poorest to have at least some access to production equipment. However, the exchange rate, which would obviously determine who benefited most from this arrangement, was very difficult to determine.

Equipment was obviously in demand at harvest time for cutting, gathering, and threshing. At other times, the hire of powered equipment appeared to be at least as much for domestic and subsistence production purposes as for market-oriented processing. Common activities included: wheat-, maize-, and potato flour-milling; rice-husking; fodder-cutting; production of cooking oil; noodle-making; and sawing of timbers for construction. There were a few processed agricultural commodities that were produced primarily for sale, such as potato starch and refined vegetable oils, but the income from these was almost always marginal compared to the main household income from the sale of crops or livestock.

Table 22: Powered Production or Transport Equipment: Access

Item	Gaozui	Zhaoshan	Xiapai	Xiaozhu	Duiwotai	Housanxi
Milling machine	12	10	12			
Grinding machine	22	25	15	15	31	24
Noodle maker					1	8
Oil press	14	24	24			
Electric saw	3	5	2			
Welder			5			
Small tractor			8		3	11
Truck	20	6	2			

Access to powered equipment was particularly important when a household member sought to earn income by casual labor or by short- or long-term employment outside the village. It was not unusual in these circumstances for women to take on the full burden of running the household farm in addition to maintaining the household and possibly caring for children or elderly parents. The ability to access labor-saving equipment in these circumstances might determine the feasibility of this option.

How Are Workloads Related to Ownership or Access to Powered Equipment?

Many households saw the primary value of powered equipment as being to save domestic labor inputs and allow more time to be allocated to their primary production or other income-oriented activities. As indicated above, Housanxi village was of particular interest because a considerable proportion of households owned electrically powered equipment. Table 23 shows reported time allocations in households with and without the most commonly owned piece of equipment: a fodder cutter.

Table 23: Time Allocation by Ownership of Fodder-Cutter: Housanxi Village

Task	With fodder-cutter		No fodder-cutter	
	Head	Spouse	Head	Spouse
Cooking	6.4	17.8	0.0	31.6
Fuel gathering	6.3	5.9	7.5	4.3
Fetching water	5.5	7.5	3.5	1.9
Washing	2.9	2.9	0.5	4.2
Grinding/milling	0.8	0.1	0.6	0.5
Gather food for pigs	4.2	8.4	0.4	12.1
Gather food for cattle	1.0	0.0	0.1	0.1
Grazing cattle	9.5	8.9	3.0	0.0
Collect straw for compost	3.8	2.1	4.4	2.8
Total	40.3	53.4	20.0	57.6

Although table 23 does demonstrate the interesting shift in time allocation between men and women in terms of preparing food for pigs—men only perform this activity if the household has a fodder cutter—it also underlines the difficulties inherent in making such comparisons. Households that own equipment are, not surprisingly, generally richer than those without, and thus more likely to have a different pattern of time allocation. In the table, for example, households with a fodder cutter are much more likely to own cattle and therefore to allocate more time to looking after them. Again, as discussed earlier, poorer households tend to be those with limited labor supply, possibly explaining why the principle woman in households without a fodder cutter tend to spend much more time on reproductive activities.

Access to Communications Assets (Radio, Television, and Telephone)

It is clear that television has become a very important part of rural Chinese social life. The ownership of television was remarkably high, even among the poorer households in these poor communities (table 24).

Table 24: Powered Communication Equipment: Ownership and Access

	Gaozui	Zhaoshan	Xiapai	Xiaozhu	Duiwotai	Housanxi
Ownership						
TV	2	25	27		9	22
Radio		8	4			
Telephone			1			
Access						
TV	17	8	6	3	24	36
Radio		7				
Telephone			14	1	18	15

Even the poorest in electrified villages said they could have free access to television, although they were often reluctant to take advantage. People, or at least men, from the Gaozui, which has no electricity, would often walk a considerable distance to the next village, often along poor roads and in darkness, to watch a favorite program. Interestingly, there seemed to be some reluctance to report watching television simply for entertainment or relaxation. Adults would tend to stress the use for children's education, or the importance of television as a source of information, including on production and markets. Often only one or two channels could be received, mainly local county or provincial channels, which included programs on practical topics, such as pig breeding.

Radios appeared to be much less highly valued. This may have historical roots. Many people reported that their villages had been equipped with radio broadcasting systems before the reform period but these had gradually ceased to function. Telephone use appeared to be confined to the richer communities, although some households in poor villages reported that they had received messages via telephone. Only one household in the study owned a telephone.

Impacts of New Energy Services

This section will consider the potential impact of the introduction of new energy services for both domestic and productive uses, with particular emphasis on the implications for the poor and women.

Do New Energy Services Improve Access to Income-Earning Opportunities?

One of the most important issues raised by the research was the extent to which bringing improved energy services (whether through biogas installations, solar cookers, electric lighting, television, or electric-powered production equipment) to such remote poor areas should be seen as more than a short term palliative remedy. Can such initiatives assist in

promoting the economic transformation required simply to prevent the steady decline of villages in these areas through out-migration?

In some cases, local officials have clearly decided that the answer is no. In Yongjing County, for example, the county government has decided that it will often be more cost-effective to simply move populations from inaccessible locations rather than struggle to provide them with the services they lack.

However, much of the county, township, and village data identify a wide range of actual or potential initiatives to increase access to income-earning opportunities. Sometimes households or communities themselves develop these initiatives; sometimes they are the outcome of interventions by government or party officials. Most of these have energy implications and would be enhanced or diminished depending on the availability and quality of energy services. It would be extremely difficult to identify and measure specific causal linkages between changes in energy services and poverty reduction impacts in what is inevitably a multifactor system, with energy being only one of a linked set of variables.

It can be said that the absence of appropriate energy services can sometimes preclude areas from participation in poverty reduction initiatives. One among a number of cited examples was the exclusion of Housanxi, which has one of the largest tea plantations in Hubei, from a tea factory development project because it did not have a grid connection when the project was devised.

Complementary infrastructure is needed to tap the poverty-reducing potential of improved energy services. One clear example is the importance of roads to allow access to an expanded market, without which there is little incentive to increase productivity. In addition, it was clear that in order to utilize improved energy services there is a need for dedicated credit arrangements and support to develop small-scale industry. As a minimum, the interrelationships between energy services, credit, transport-infrastructure and agribusiness development must be considered. One other key area of complementarities that should be explored in the study provinces is that between energy and water services. Almost all of the villages emphasized the central role of a regular water supply in improving livelihoods. As discussed above, even the relatively asset rich Xiapai, suffered dramatic falls in income in 1999 and 2000, which were attributed to drought and the mal-administration of the local irrigation system. Interestingly, none of the officials, village leaders or communities in the two provinces linked the two issues of water shortages and energy services.

Grid Electricity

In the specific instance of grid electricity, those without access had extremely high expectations of the potential benefits. They viewed the connection to the grid as an essential step on the way to greater productivity, higher incomes and a better way of life. They had no difficulty in explaining the investments in equipment they would make and the new activities that would be open to them (table 25). 29 of the 36 households in

Xiaozhu and 25 of those in Gaozui said that having electricity would increase their incomes. Among the suggestions made were: buying a milling machine and charging for its use; breeding more pigs and using a pig fodder cutting machine; breeding sheep; working later into the evening to allow time to breed chickens; doing more housework in the evening to allow time to grow more crops or dig for herbal medicines; and increasing productivity to allow household members to go out and do paid work.

Table 25: Opportunities That Electricity Would Provide to Increase Income

Opportunity	**Number**
Gaozui	
Buy an electric mill to process grain and sell flour	14
Buy a planer and electric saw to offer carpentry services to other households	6
Buy a grinder for fodder and raise more pigs	2
Raising chickens and sheep by working in the evenings	2
Buy an oil press and offer service to other households	1
Make noodles for sale	1
Buy a fridge and sell cold drinks	1
Open shop in the evenings	1
Watch TV and listen to radio to learn how to increase crop yields	1
With light and TV children can study well and earn more money in the future	1
Lichuan	
Buy fodder grinder and rent to other households	6
Buy brick making machine	2
Buy electric saw and offer carpentry services	1
Make wine in the evenings	1
Use fodder cutter and breed more pigs	6
Doing more work in the evenings would allow sheep rearing	3
Raise chickens for sale using heater to incubate eggs	2
Doing housework in evening would allow time to search for wild herbs to sell	4
Longer working hours would allow increased crop production	6
Ability to do household chores in evening would allow time to look for wild herbs to sell	4
With electric light it would be possible to do carpentry work in the evenings	2
Access to TV and radio would provide information on casual work and crop prices	1

In villages with electricity, on the other hand, the major benefits that came most readily to mind were concerned with the quality of life, not production. Lighting, television, and reduced labor on domestic tasks usually ranked highest. Only on reflection

was it argued that by increasing the length of the working day and reducing labor requirements for household chores, more time was available for production or other income-generating activities.

In Zhaoshan, village leaders said that they had previously been very enthusiastic as to the scope for developing small processing factories once the capacity and quality of the electricity supply had been improved. However this potential not been realized because other elements, particularly access to credit had not materialized.

In Housanxi, the richest village of those in Hubei, villagers had developed some minor new processing and income-generating activities, such as potato flour processing, after the connection of electricity a few years previously. However, villagers regarded the possibilities for increasing incomes as very limited, and shared the general view that the most important livelihood development in recent years was the increased opportunity for outside employment.

In Xiapai, the community with the earliest, highest capacity and most reliable connection, and with by far the greatest accumulation of electrically powered assets, the strong impression given was that electricity was now largely taken for granted. Diesel was the primary fuel associated with production activities. Electricity was used for smaller domestic equipment and viewed mainly as a consumption item. Its importance lay in its less tangible benefits: allowing women to work in the evening; allowing children to do their homework and read; and access to television.

Can Improved Energy Services Reduce Poverty by Enabling Livelihood Diversification?

A general view was that the major impact of electricity on livelihoods arose from its capacity to reduce general workloads and lengthen the working day, thereby increasing the possibilities for diversification of activities.

In focus group discussions, women in Housanxi, a recently electrified village, were still very enthusiastic about electrification, and said that it had improved their lives in a number of ways. Households could raise more pigs if they had access to powered fodder cutting machines; electric milling machines allowed the production of potato flour for sale and freed time to work on the land or seek other sources of income; physical work was less arduous; but most importantly, men could migrate and leave women to farm with the help of machines. This last option was commonly expressed by both men and women and was clearly acted upon in many households.

Communities saw improved physical infrastructure, principally roads, water, and electrification, as essential if households were to find alternative ways to improve their situations other than through migration. They were convinced that if only their village could be provided with these basic assets, households would themselves take strategic decisions to invest in physical and human capital and could thereby increase their incomes and living standards. One key aspect of such investments was said to be their impact on human capital constraints. Roads would reduce time spent on essential travel,

particularly to towns and markets. Drinking water and irrigation systems would reduce the time required to fetch and distribute water. Electricity could allow the substitution of physical labor with powered equipment and, by means of electric lighting, even extend the time available for domestic and production activities.

Both rich and poor households placed a high value on infrastructure projects, including electrification. The capital cost of extending the grid into remote areas is obviously considerable. This is the main reason why microhydro has been promoted in Hubei, and PV systems in Gansu. However, once their village—or rather natural village—had been provided with access to the grid, almost all households in the study elected to be connected and pay the required fees, even if their use was limited to a 40-watt light bulb turned on for a few hours each evening. Location, rather than individual household income, was the main factor in determining connection in all the villages surveyed. Only in Duiwotai, where a total of 25 of 168 households remain unconnected, and in Housanxi, where the party secretary reported that 20 percent of the 262 households were too poor to pay for connection, were the numbers of unconnected households in a village with electricity substantial. In Duiwotai, local officials said those without access were not only low-income but "remote, stubborn, and not wanting to change."

The Impact of Energy Services on Human and Social Capital

Very little use was made of electricity in either schools or health stations in poorer villages—even for basic lighting—on the grounds that it was simply too expensive. No electrical equipment was reported in any village-level health facility. In Gaozui, although the school used by village children had electricity, teachers complained that they had to prepare lessons and mark homework each evening using small and very dim kerosene lamps. In Houshanxi, even though each classroom had a 60-watt bulb, one teacher claimed that these had never been used. Teachers were reluctant to turn them on even during the dark winter afternoons because they were concerned about the cost of electricity. In Duiwotai, the school had no lighting except for two oil lamps used by teachers, even though all the surrounding houses had electricity. Children from Xiaozhu, the poorest community in the study, had to walk to a school in the administrative district, up to two hours away. Even in this school, only two of the nine classrooms had electric light. Teachers reported that if it became too dark to do normal lessons, as sometime happened in winter, children would do physical exercises instead. Interestingly, the headmaster's office had a 29-inch TV, DVD, hi-fi, and recently connected telephone. Only the school used by pupils from the richest village, Xiapai, made formal use of television, radio, and video for teaching.

Even though winter temperatures could fall to zero and below in at least four of the villages surveyed, there were seldom any provisions for heating. In Zhaoshan, primary school children were asked to bring fuel to school each day. In Duiwotai, they each took a small brazier and some coal. In Housanxi, where teachers said that burning fuel in the

classrooms would be unhealthy, they would shut the doors and windows tightly on cold days and the children would jump up and down.

Who Gains and Who Loses From the Introduction of New Energy Services?

A specific exercise was undertaken in Housanxi to examine how time allocation had been affected by the recent arrival of electricity. A focus group of women was asked to list their daily activities. The facilitator then grouped these in discussion with the participants, and drew a grid on the floor in chalk, with each activity being represented by a drawing. Each woman would take a handful of corn kernels and place these against each task to describe how she spent her time on a proportional basis. The task was then repeated for a second round, with participants adjusting their corn allocation to describe how they spent their time before electricity had been connected (table 26).

Table 26: Time Allocation by Women before and after Electrification: Housanxi Village

Task	Ratio of time spent after and before electrification (percent)
Housework (cook, sweep, fetch water, child care)	99
Pig food preparation	45
Working on the fields	157
Resting	132
Sleeping	101
Total	100

With electrification the main time saving occurs in grinding and milling activities, where men play the major role, rather than in the preparation of fodder for pigs, which is women's responsibility. Indeed, the total burden on women was *greater* in the villages with electricity. The arrival of electricity does not, of course, impact on the time spent on most major domestic chores. In the grid-connected village of Housanxi, cooking still occupied more than 24 hours each week and fetching water and gathering fuel still required some 18 hours.

Clearly, the biggest change after electrification was a reduction in time spent preparing pig food, with the mechanization of pig fodder cutting and corn grinding. Women's resting time also increased substantially. However this was partly offset by an increase in the time spent working in the fields. This was said to be partly because time saved on pig feeding was transferred to an overall increase in household agricultural work, partly because some men migrated, leaving their agricultural work to women. The women indicated that seeking work outside the village became a much more realistic

income-earning option with the arrival of electricity, as this enabled women to continue farming in the absence of male household members.

The responses of one couple interviewed in Duiwotai village may suggest radically different gendered attitudes to the benefits of electricity. The wife was very enthusiastic because "I can work late into the night." The man was equally pleased because "I can sit around and talk to my friends in the evening." Similar comments might suggest that women worked longer hours than men, and that electricity might exacerbate this. However, questions to women about who was worse off, worked harder, ate better, and was poorer, usually elicited the response "We are all poor, all tired." They did not declare their husbands or men in general had a better life.

In general, electricity does not seem to have made serious inroads into the time spent by women on onerous and health-harming reproductive tasks. There was little evidence that reliable energy sources have improved women's productive potential other than by extending their work hours later into the night. The essential need would appear to be for a package of inputs, such as credit plans specifically directed at women that would enable them to gain access to end-use technologies that can take advantage of available energy sources.

How Do Women and Men Differ in Terms of Energy Service Investment Priorities?

The general impression across the villages was that women would benefit most, productively and reproductively, from expanded use of biogas, fuel forests, energy-saving stoves, and machines that reduced the labor inherent in the preparation of livestock fodder and pig swill. The observed demand for energy service investments typically reflected the division of labor. For example, in villages with electricity women seemed to be the main motivators for purchase of pig fodder cutting machines, whereas men were more interested in milling machines because they were usually responsible for grinding grain by hand or carrying it to the nearest available powered equipment.

Although they clearly had a different viewpoint from men on these issues, there was little evidence in any of the villages that women had an effective input to decisions on equipment purchases. Women reported that expenditure on capital goods that reduced reproductive toil would always come second to productive, income-generating expenditure. However, it should be noted that the line between domestic and productive activities was difficult to define. In Duiwotai, for example, almost every household used powered equipment to mill flour, a process that would previously have diverted considerable labor time from other activities. Interestingly, in this village the preparation of pig swill, traditionally undertaken by women when done manually, was taken over by men in those households that had purchased a machine for this task.

Around 20 percent of households in Duiwotai and Housanxi villages had energy-saving stoves, which were said to use 25 percent less firewood. Although in general men were said to make the decisions on stove design and building, most women with these

stoves had heard about them from relatives in their mothers' villages and persuaded their husbands to get one of the same design.

Can Energy Services be Adapted to Promote Positive Impacts Relevant to the Livelihoods of Poor Households and Women?

Biogas was much promoted at the prefecture level, and a government biogas project had been established near Housanxi. However, because of what were described as prohibitive start-up costs and lack of information, no biogas was being used in the study villages. In Duiwotai, the village committee asked for government support in this area. They saw the potential of biogas as a clean and effective energy source for lighting and cooking, particularly appropriate where electricity connection was too costly. The climate and altitude in the three study villages in Hubei were likely to be suitable according to rough calculations undertaken by the energy specialists within the fieldwork team.

Two notable innovations were observed in Gansu. As noted above, solar cookers were much in evidence and heavily used for much of the year. Interestingly, they were not rated highly in terms of fuels used for cooking, probably because their use was largely limited to boiling water. In China, unlike most countries, the use of boiled water is extensive (which may have considerable health benefits). Solar cookers are well suited for this purpose as (within reason) timing is irrelevant. A container of water can be hung onto the cooker in the morning and is available when needed.

Many women were using small, hand-turned fans as bellows to increase the efficiency of the cooking fire. The stoves were clearly constructed to facilitate this process and it was very effective in producing much higher temperatures and more complete combustion, greatly reducing the volume of smoke produced. The main problem was simply that they could not operate the fan and attend to the cooking simultaneously. Whenever they stood up to stir the food, the temperature would fall and they would be engulfed in smoke. The obvious solution, which a number of women suggested, was an electrically powered version of the fan (possibly using a small PV panel in villages without grid connection). However, no household possessed such a fan and they did not appear to be available for sale at the township level. Even the fans that were on sale in the county towns (costing around ¥ 40) would have been difficult to adapt for the stoves most commonly used in rural areas.

Aspects of the Policy and Institutional Environment Likely to Negate the Beneficial Effects of New Energy Services

The agency with primary responsibility for implementing government policies on poverty is usually translated as the Poverty Alleviation Office (PAO). This agency was of particular interest to the study, not only because of their central role in poverty interventions in general, but because of their role in the allocation of funding for energy-related projects in poverty counties. Their title, seemingly implying a desire to assist those in distress, is somewhat misleading. Poverty alleviation is largely restricted to the

operation of an absolutely minimal program by the Ministry of Civil Affairs, which meets the survival needs of those households who are experiencing extreme difficulties. In the Hubei villages, for example, only the four poorest households, as identified by the village committee, were usually provided with assistance, such as grain, clothing, or bedding from the local government. To some extent this can be seen as a continuation of the communal welfare system, which was available only to those who really could not work. Those that worked automatically gained access to income and communal services.

A common approach adopted by the PAO is the establishment of pilot interventions, which were described by one official as "shining lights." In most cases officials explained that these were intended to demonstrate the potential of new technologies or approaches to other households. One apparently successful example was evident in Gansu. Here the introduction of solar cookers in a number of selected villages, subsidized by the PAO, had resulted in their widespread acceptance by farmers to the extent that they were prepared to purchase them at full cost.

The more problematic aspect of this approach, as openly stated by one county official, was that pilot sites were adopted because they could be shown to visiting provincial or national officials in an effort to win their approval. For this purpose, it appeared that the site or beneficiaries would be specifically chosen to ensure a successful presentation. Ideally they should be in an area of economic growth with good road access. Those taking part should be competent farmers who were capable of explaining the benefits of the initiative. One observed site included what appeared to be a very expensive, energy-efficient house, which had been constructed for a village leader. It was difficult to understand the relevance of this project for the majority of poor households. In Lichuan, government poverty alleviation policy was described as "Seize the large, leave the small." Larger-scale, more centralized projects were said to be preferred over those that dispersed resources to individual households, because they were easier to manage and the effects were more visible.

Apart from this, Chinese government policy is heavily focused on poverty reduction through increased access to productive assets. For example, households taking loans through official channels to purchase agricultural inputs or productive assets were able to borrow, with the support of the PAO, at an interest rate of 2.5 percent. By comparison, rates of 6 percent would have been charged to those borrowing to pay healthcare costs, if they had been able to provide the required surety.

Although officials, and sometimes village leaders, tended to refer to the POA as "providing funds," in practice they essentially facilitate subsidized loans. Indeed, it was reported that such loans were often still difficult to obtain by poor communities or households because the banks providing them required substantial collateral. In Duiwotai, the elaborate procedures required to ensure collective household involvement in such a loan appears to have caused major delays to the installation of their electricity system. The general impression formed during the research was that many PAO initiatives,

because they were usually predicated on the provision of loan finance aimed at increased productivity, had a high entry cost that biased them toward the *less* poor.

All provincial and county officials are clearly very conscious of the rapid economic growth in some regions of China (study visits to Beijing and Shanghai were cited as one of the main activities of one County Women's Federation) and their primary objective is to emulate that growth. Those poverty-reduction activities, which can contribute to that objective by, for example, increasing productivity or encouraging diversification into higher income generating activities, claim most of the attention. Pure welfare projects, designed to alleviate hardship, are of less interest to aspiring officials. In terms of energy services it may be that village photovoltaic (PV) electricity systems, for example, fall into this category. The PAO has been instrumental in installing such systems in a number of isolated villages in Gansu, but this activity appears to be seen as providing limited assistance for communities that are always going to be poor. After the initial provision of equipment, often funded by external donors, there appeared to be minimal interest in either sustainability or impact. It was therefore not surprising that within a few years various components had failed and the majority of the beneficiary households were once again without electricity.

Service Quality

As discussed above, three remote villages with limited prospects of grid access that had been provided with PV systems were visited during the study, two at the suggestion of the Gansu Natural Energy Institute and one proposed by Huining County Government. There was initially some concern that in all cases the installation of PV had been subsidized by the PAO in collaboration with foreign donors and that the sites might provide an overly optimistic impression of the costs and benefits of such systems. In practice, two of the three interventions seemed to have collapsed very soon after implementation and the third, implemented only a few months prior to this study, had already experienced the failure of some systems.

The household PV system used in the villages could in principle power two 20-watt light bulbs and one black and white television. The lifespan of the battery was said by villagers to be about three years. The cost of installation had been around ¥ 2,000, although most households were heavily subsidized. Initially, farmers were happy with the system. It provided brighter lighting than kerosene and was cleaner and easier to use. It could provide television, which farmers believed was an important way to educate their children. Within a relatively short period of time, however, most systems were no longer functioning. After installation the farmers rarely saw the engineers again. The light bulbs tended to last around two to three months and could only be purchased in the county town, which was up to eight hours away along very difficult roads. When batteries or chargers failed—some after only a year—the farmers simply gave up on the system, knowing that replacements would have to be purchased out of their own pockets. They

reported that they would prefer to save the money in case the opportunity for grid connection, which they now saw as much more beneficial, should arise.

In two villages in Hubei, Duiwotai and Housanxi, related issues were raised concerning the effects of the unreliability and costs of grid electricity in poor rural areas. In Duiwotai, ambiguity over ownership of the microhydro station and the electricity generated led to problems over maintenance of equipment. Fuses were often blown when villagers used powered equipment and local men had learned how to replace these on the village transformer. However, problems that required outside help were not so easily resolved. At the time of the fieldwork the transformer in the village had been out of action for two months, cutting off all electricity supply. It was only when the field team notified local officials they were about to arrive that it was repaired.

The frequent power cuts, low capacity, fluctuating voltages, and uncertainty over when or if repairs and maintenance would be undertaken, appeared to discourage increased utilization and investment in powered equipment. Dependence on this modern fuel would clearly have been a risky strategy for farmers and hence they were forced, for example, to maintain at least one month's supply of kerosene for lighting. The poor quality of the supply was also reported to have direct cost implications in that, even at times when the voltage fell below that required to power equipment or provide reasonably bright lighting, the meters would still be running.

Clearly the quality of services (box 2) is an issue the Chinese Government is treating very seriously, as witnessed by the Rural Energy Reform Program (Nong Wang Gai Zao) that was active in both provinces. This national program aims to equalize prices between urban and rural areas and improve rural electricity infrastructure and supply. In Zhaoshan in Gansu, where the program has been fully implemented, it appeared to have been very successful in terms of repair and replacement of equipment, although there remained major differences of opinion between suppliers and consumers as to the cost of electricity. The program is being implemented gradually, starting with pilot villages that are able to contribute to the costs of new equipment, such as electricity meters. Neither of the two electrified villages in Hubei, Duiwotai, and Housanxi, were yet implementing the program, and the village committees reported that they were not likely to start soon. Villagers were still recovering from the cost of their initial electricity connection and the meters, which they had purchased two to three years previously. Many were still in debt from this outlay.

Box 2: Comment from Housanxi Village on the Quality of Their Electricity Supply

In the last few years they collected a sum of money [from villagers] to do high-voltage improvement. I heard that now they want to do rural grid improvement, and they'll be collecting another ¥ 100 or ¥ 200. Lots of people are unhappy about this and don't want to or can't afford to pay the money. We've just been connected a few years, and they've already collected money several times. People are not happy about this. When they first did electrification, we were very keen. We saw that people lower down [the mountain] had been using electricity for ages, so of course we wanted to have it too, and collected together the money for it. Then they connected it up here, and it wasn't light enough. In the evening if you turned the light on, it wasn't even as light as a kerosene lamp. They said it was the wire, or the transformer that wasn't O.K., so they did the high-voltage improvement. So that had to be done. If it wasn't done, then you might as well not have electricity, the lights were so dim. So we paid another lot of money to get proper lighting, and so there was enough electricity supply for electric corn mills. It did get much better. Still sometimes the voltage was too weak, if you were using your electric corn mill. I wouldn't be able to use mine. Now they are saying they want to do the rural grid improvement, of course if they do it things will get better, but we don't have the money. These few years we've already paid several lots of money for electricity.

Quality Measurement Issues

One interesting question arising from the evidence of the study is how the concept of "access to electricity" is defined and measured. Clearly the indicators most often quoted on the percentage with grid connection do not tell the whole story. In principle, measures of access could be categorized, not only in terms of the source (grid, microhydro, wind, and so forth) and theoretical capacity, but also quality of services. In the provision of health services it is now generally accepted that access to facilities should be defined in terms of the type of services available and whether basic quality requirements are fulfilled in terms of personnel, drugs, and so forth. Assessment of the latter may involve judgments on a range of factors, but in theory can be effectively and routinely undertaken by trained staff. It seems reasonable to suggest that similar quality assessments—to determine at least service continuity (forced outages), consistency (percent of time voltage within acceptable limits), and adequacy—could provide useful guidance on progress in improving services and targeting investment.

Impact of Reforms on Education and Health Services

As noted above, physical access to electricity has often not translated into effective use of electricity in schools and health facilities. To some extent this can be seen as an unplanned impact of the economic reform program. Previously, the collectives, with very limited fee payments, largely funded village health stations and primary schools. In the case of health stations, drug fees now account for almost all their income. Village doctors, previously paid in work points along with other workers, are now essentially

private care providers. At most they may receive some technical support from township health centers and be contracted to provide preventive services, such as immunization.

Village primary schools are in a somewhat better position, with some teachers' salaries directly paid by government, but they also have to depend on local support for all other costs. Where townships or villages had profitable enterprises, these would usually contribute sufficient income. Otherwise, fees are the only alternative. In poorer areas, such as those included in this study, the support from all sources is minimal and both health facility and school managers seek to cut costs wherever possible. It was not surprising, therefore, to find that energy expenditures were kept to the absolute minimum.

Environmental Policies

Existing conservation programs include regulations restricting wood collection in both provinces. Nevertheless, as described above, a few villagers in Xiaozhu reported gathering wood for sale and in Duiwotai, 3 households out of the 36 surveyed reported selling wood. Here, charcoal production was also an important activity, both for the two households with kilns, and for many others who made money carrying heavy loads long distances to sell in the neighboring province of Sichuan. The kiln owners recognized that this activity could only last another few years, until they had exhausted the wood on the hillsides they had leased specifically for this purpose.

Duiwotal is located in Xianfeng, which is one of 140 counties piloting a national government environmental plan to restore grassland and forest. Households that join the plan will receive free saplings and be provided with 150 kg of food grains and a ¥ 20 forest management fund each year. This will continue for five years where forests can be used for commercial sale and ten years where this is not a viable activity.

What Are the Community-Level Processes for Decisionmaking on Energy Services?

In all the study villages, the local Village Committee and Communist Party Branch, which were often effectively indistinguishable, were the only active community-level institutions. Even then they often seemed to see their roles mainly as intermediaries between government and households, passing on new policy decisions rather than behaving proactively to further the interests of their communities. In Xiapai, for example, it was said that major issues were in practice decided by the township government, who would pass on their instructions. Recent interventions from the township had included requiring increased output of maize, setting new production targets, deciding irrigation policy, and establishing planting percentages. The Committee members would similarly inform male household members of new policies and decisions, usually via the head of each natural village. It would be very rare to call a general village meeting except at election time, and it was openly said that those who took part in village decisionmaking were mainly those who were richer and more educated. Poorer people had few opportunities to participate.

The effectiveness of village committees often seemed to depend on personalities rather than formal structures or procedures. In Hubei, it was said that in principle each village committee should consist of at least a Party secretary elected by the membership, and a chairman, accountant, and women's representative, all chosen by popular election. However in Xiaozhu the chairman had resigned over a conflict with the party secretary, the women's representative had migrated, and the accountant had never been elected. This meant that the only village committee member left was the secretary, an old man who had held this post for decades. Weak village leadership was blamed by many in the community for the failure of an electrification scheme to which villagers had contributed ¥ 10,000 and which depended on negotiation with higher levels of government for matching funds.

In Housanxi, the party secretary appeared to run the village without reference to the other Committee members, but many villagers remarked that he was very capable and attributed their road access to his effective way of relating to officials from township and county. In Duiwotai, the community was very divided, and the village committee weak as a consequence, but electrification had been carried out and the road connected with the help of poverty alleviation funds. This was attributed to the influence of one official at county level who originated from the village.

How Do Women Participate in These Processes?

The studies all strongly emphasize the lack of women's voices at village level. Although in principle each village committee should have included a women's representative, this post was not subject to the payments or allowances that were provided for the other three office holders: the chairman, secretary, and party representative. One village head, in explaining that women were not notified of village committee meetings as "they are held in the evening and it is not safe for women to walk in the dark" perhaps best expressed the general attitude.

In Hubei all three village committees and corresponding district management committees were entirely male. In Xiaozhu, the women's representative was said to have migrated. In Duiwotai, the secretary's wife was said to be the women's representative, but she vigorously denied this. In Housanxi, the supposed women's representative said that she had been elected against her will and had no intention of filling this role, as she was far too busy running her farm.

5 Conclusions

In this final chapter consideration will be given to the more general conclusions that can be drawn about "the lessons learned which may improve the impact of projects of the World Bank and ASTAE on poverty alleviation and gender equity in China and possibly in other countries."[71] The chapter will consider conclusions under three headings: those relating to methodology; those arising from the fieldwork of specific interest in the rural Chinese context; and more general lessons for rural energy projects.

Methodology

The experience of the fieldwork suggests that the rapid-appraisal case study approach adopted, based on aspects of SL and the PRSP approach, *was* successful in gathering valuable in-depth information on many of the issues relating to the linkages between energy and poverty. On reflection it was less successful in dealing with issues concerning gender and energy, for reasons that will be explored below.

The standard techniques based around community mapping, key informant interviews, focus group discussions and time lines worked well, although questions arise as to the validity of the various methods used to assess labor-time allocation. As discussed below this is an important area that needs further work. The use of structured research instruments to gather basic quantitative and qualitative information, in the course of semistructured interviews with households undertaken by experienced social scientists, appeared to work well in terms of gathering directly comparative data on a wide range of issues while also allowing for simultaneous interpretation and elaboration. However, given the wide range of issues addressed, it did suffer from the potential disadvantage of generating a large volume of qualitative information that was difficult to fully analyze in the limited time available.

As pointed out by a number of reviewers, it is clear that neither the SL nor PRSP approach as yet adequately addresses gender issues. One reviewer[72] pointed out that the current PRSP Sourcebook includes distinct and separate chapters on gender alongside heath, education, and so forth. This may be indicative of the difficulties of integrating

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[71] Terms of Reference; see appendix 1. It is not the task of this report to investigate the current status of the ASTAE program nor to determine changes in its orientation over time. The original motivation for ASTAE would appear to be primarily to meet objectives of maximizing the market penetration of "alternative energy." For instance, the original objective was "to mainstream alternative energy (renewable energy and energy efficiency) in the World Bank's power sector lending operations in Asia" whereas the new objective is "to make a measurable impact in reducing greenhouse gas emissions and providing remote rural access to modern energy, more and larger alternative energy projects are required." (http://www.worldbank.org/astae/)

[72] Dorothy Lele.

gender into all aspects of the framework. Work is also needed to incorporate gender analysis more fully into the SL approach. This is principally because of its tendency to focus attention on productive activities and away from reproductive activities or reproduction-production linkages and thus not adequately reflect the social and gender divisions of labor in households.[73]

A great deal of work remains to be done in developing a general framework for the future study of these issues. No great claims would be made for the framework, which was agreed between the poverty, gender, and energy specialists who contributed to the research approach, other than the hope that it will make a contribution to what must be an ongoing process. The SL approach has obviously been under development for many years. There has recently been discussion of its weakness in dealing with issues of power relations and rights. Its limitations in terms of linking micro and macro issues have long been debated. The question is whether it can or should be modified or abandoned. To some extent the decision of the research team was that it was probably the least-worst framework available. Attempting to develop yet another entirely new approach did not seem appropriate, given the scale of time involved. It does offers the considerable advantage of forming part of an ongoing process of developing participative and other forms of Monitoring and Evaluation.[74] These, combined with the specific energy focus offered in appendix 4, could provide the foundations for systems to monitor and evaluate the impact of energy interventions on poverty and gender.[75]

Productive and Reproductive Activities

One key addition to the SL framework adopted for the research was the use of a specific focus on "time use and time poverty." This was partly related to a general concern with the importance of considering time use in relation to gender issues and partly a reflection of the perceived importance of labor shortages as a cause of poverty in rural China. An attempt was then made to link this to different categories of activity based around the distinction between productive and reproductive activities. Reproductive activities were defined from an anthropological standpoint as "The human resources and labor time required to enable households to reproduce themselves both intergenerationally and on a daily basis."

In practice, the value of this distinction was far from clear. It was not one that was self-evident to households themselves. Their main distinction was between activities that were at least potentially income-generating and others that were not. However, the

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[73] Dorothy Lele also suggests that the framework should be extended to include "reproductive strategies" alongside "livelihood strategies," arguing that this would lead to a focus on broader "human development outcomes," instead of production-oriented "livelihood outcomes."

[74] See Guidance Sheet 3.4 on M and E in http://www.livelihoods.org/info/info_guidancesheets.html. See also Pasteur 2001.

[75] Another recent attempt to develop a system of monitoring evidence of improved energy access (although not energy impact in the strict sense) is provided by Foster 2000 and Vivien Foster and Tre 2000.

relationships between these two types of activity were very close and they were often complementary. Women who had access to machines that reduced the labor time for domestic activities could then allocate more time to crop production or animal rearing.

The role of machines—for threshing, grinding, husking rice, producing oil, cutting grass, making noodles, and so forth—driven by nonhuman and nonanimal sources of energy is critical here. Since most of these are traditionally women's tasks, there is a clear potential for the introduction of such equipment to have a major impact on women's workload, household division of labor, and household relations.

To fully analyze the implications on time use, and to assess the differential impact on men and women is clearly an important task, but one would require a much more complex methodology than that adopted in this study. In particular, a cost-effective, not excessively intrusive procedure would have to be developed for accurately and reliably measuring labor-time inputs to the full range of "necessary" household tasks. This would have to deal with the additional issue that women, in particular, frequently undertake two or more tasks, for example cooking, child minding, and tending animals, simultaneously. The relative crude methods adopted in this research —essentially assisting people to report estimates of time use—would not be adequate for this purpose.

One additional methodological issue arising from the research was the importance of measuring access to and utilization of energy assets and services. Ownership of assets alone did not necessarily even imply use, as in the example of the schools described below, and lack of ownership did not imply lack of use. It was common practice in the study villages for those with energy assets to hire them (in one case in return for labor) to those without.

Findings from the China Fieldwork

The rapid growth of China's economy during the reform period combined with policies that have specifically targeted the rural poor has achieved an unprecedented decline in the number of people living in poverty. Whether one accepts the 5 percent indicated by the very stringent measure adopted in official statistics or the 10 percent probably implied if international standards are applied, there is no doubting the magnitude of this achievement.

However, it should not be assumed that the stated ambition of the Chinese government to eliminate poverty could be achieved by simply continuing existing policies. The remaining rural poor are not an arbitrary group that have missed out on the benefits of growth and propoor policies by chance. The evidence would suggest that they are poor because of specific factors that have led to their effective detachment from the mainstream economy and curtailed their access to current poverty reduction programs. Geographical location, and the associated environmental and climatic conditions would appear to be the most important of these.

The majority of the absolute poor live in remote, often mountainous areas, in the western provinces. They typically often have to contend with poor soils and hostile

climates. In Gansu, for example, drought is a consistent concern from year to year. They face long, often-difficult, sometimes costly journeys to access markets, health facilities, and even schools. They have very limited opportunities to approach government officials, including the PAO, or financial institutions, all of which that are typically located at township level.

Of particular concern for this project, infrastructure of all types is usually very limited. This situation is well illustrated in terms of electricity. The astonishing spread of grid electricity in China during the reform period is a remarkable achievement that has undoubtedly had a major impact on rural development. However, the relatively small proportion of villages without access to the grid are now clearly identified both in the minds of the communities themselves and outsiders (including government agencies) as isolated and backward.

Lack of grid access is (usually correctly) taken to imply an absence of adequate roads, water, and communication systems. This implies a further assumption that such villages will not be able to attract or retain good teachers, village doctors, or other even moderately educated workers. Given this range of unpromising factors, poverty alleviation officials may well be wary of attempting to support projects in such villages, mindful of the high resource costs, the possibly limited benefits (given that the populations are typically small) and the substantial risk of failure.

One key further constraint lies in the area of human resources. Partly as a result of the efforts put into the family planning program in China, household sizes are generally small, often with just two to three members of working age. Given the nature of their surroundings, the reproductive labor burdens are considerable. Such tasks as gathering fuelwood, fetching water, cooking, looking after children, and tending animals, may consume many hours each day. Added to time and labor required for crop production (even though farm sizes are also relatively small), the overall labor demand may severely test the available supply.

The position may be made more difficult if, as is commonly the case, the household also has to care for elderly relatives. The success of the Chinese primary healthcare system at the time of the “barefoot doctors” considerably increased overall life expectancies, even in poor rural areas, and a large population of the elderly is characteristic of many poor villages. Households also live under the threat of serious illness, particularly if this affects a key worker. In such circumstances the household faces a triple burden: the cost of treatment, loss of the workers labor time, and increased care burdens on remaining workers.

The poor living in such areas thus face multiple deprivations and generally have very limited assets—whether natural, capital, financial, human or social—with which to overcome them. Their general problems are clearly unlikely to be amenable to simple solutions based on sector projects of whatever kind. This would suggest three broad alternative strategies:

- Accept that the primary objective of some projects is poverty alleviation: making life less arduous, less hazardous, or simply more enjoyable for the poor. Such projects might have additional benefits in terms of reducing reproductive burdens or increasing human capital and thus allowing an extension of productive activities. However, the latter would be seen as possible additional benefit and not assumed in the project appraisal.
- Develop a broadly integrated program targeted at sustainability and growth of identified poor communities. Such a strategy would need to consider all potentially binding constraints, including those relating to (or potentially ameliorated by) energy services, and ensure that they were addressed.
- Relocation of poor households to richer areas.

Poverty Alleviation

Poverty alleviation should perhaps not be viewed unfavorably in terms of energy projects in China. The widespread use of solar cookers to boil water in Gansu has clearly made a substantial improvement to the quality of life of many poor households. This may be a country-specific reflection of the importance of hot water for drinking and cooking. The very extensive improved stove program has almost certainly reduced both health hazards and ongoing annoyance for many poor women. As discussed in the previous chapter, the use of a PV-driven fan in place of the existing hand-turned equivalent could probably also provide worthwhile benefits.

Perhaps most interestingly, as indicated above, the success of the electricity grid expansion program has led to a situation in which lack of access to electricity for lighting and television has become central to poor people's own sense of "exclusion." Living and working in the semidarkness of kerosene lamps has become unacceptable to many. As reported from the fieldwork, poor men will walk many kilometers over rough tracks in the dark to watch television in a neighboring village. Access to electricity for these purposes, which have sometime been regarded as subordinate to access for production, now appears to be closely associated with a minimal quality of life in China. Its absence is seen as sufficient cause for children to desire to leave their home village as soon as possible and for women not to marry in. Even if electricity can "only" replace kerosene as the principle source of fuel for lighting, the welfare benefits appear very highly rated by those living in these communities

However, as the discussion of the "PV villages" indicates, ad hoc attempts to address energy poverty through one-off decentralized energy options are unlikely to be sustained unless provision is made to cover the recurrent costs and to establish a robust system to

supply operational and maintenance services. In remote areas, robustness and sustainability under adverse conditions and in the probable absence of regular (or any) maintenance must be prime considerations.

Integrated Programs

The importance of an integrated approach to the "new" poverty agenda is reflected in the importance attached by the Chinese government to the Western China Development Strategy. The detailed components of this strategy remain to be specified, however it would seem that the role of appropriate energy services might not have been sufficiently considered.

In principle, energy services can considerably enhance the most important asset that the great majority of households possess: human resources. As discussed above, there is a close association between poverty and constrained labor supply in many poor households. Even where households themselves perceive possibilities for improving their incomes—by crop diversification, keeping more livestock, sideline activities or seeking work outside the village—the evidence from the fieldwork is that they often feel unable to take on the additional workload.

In cases where labor shortage has been identified as a major constraint on the potential success of an antipoverty strategy, energy services would appear to be one of the obvious potential solutions. Although construction of roads, drinking water supplies, or irrigation systems may reduce the time spent traveling, fetching water, or irrigating crops, energy services may offer the possibility of reducing labor time over a wide range of productive and reproductive activities through mechanization, and increasing the length of the working day via the provision of adequate lighting. They are also clearly relevant to the provision of communication services that again, through the provision of education, training, and information, may enhance existing human capital and further increase labor efficiency.

It is important to stress that all labor-consuming tasks are relevant in this context, irrespective of whether these are characterized as productive or reproductive, subsistence or income-generating. However, it would be essential to consider the impact of improved energy services in shifting the time spent on each activity in terms of the probable implied changes in the workloads on men and women. It is clear from the case studies that men tend to dominate decisions on energy conversion technology.

To suggest that energy services may be relevant in overcoming one constraint does not, of course imply, that this will result in a successful program. Unless complementary infrastructure and services are in place there may well be little or no impact from improvements in energy services alone. Increased production of pigs through the use of powered fodder cutters, as described in the discussion of Hubei villages, is of limited value if there is no reasonably priced means of transport or accessible market.

Institutional constraints may also frustrate potentially successful innovations. The village studies show the crucial distinction between having access to energy services and

using those services to best effect. Although most schools had access to electricity, which could have allowed full time education in the winter months, in practice the lights were almost never turned on and pupils were sent home early. This was based on a decision by school principals that other expenditures had priority over payment for electricity when allocating their meager recurrent budgets.

When, as in most parts of poor rural China, local facilities, such as schools and health centers, are under extreme financial pressures, such possibilities have to be factored in to ensure that possibly high levels of capital expenditure are not wasted because of the lack of relatively tiny amounts to meet running costs. One possible lesson from this example is that more work is needed to provide a toolkit that enables local government agencies' personnel to design and implement appropriate and sustainable energy interventions.

Energy services designed to increase labor efficiency would need to be targeted in terms of greatest need and greatest feasible benefit, irrespective of the technology involved. For example, space heating is a major energy need in all the study villages, and the time needed to collect and prepare fuels for heating was generally seen as "one of the most time consuming activities for both women and men." If it were possible to reduce this time, for example by developing more efficient methods of burning the existing fuels of crop residues and dried dung, this might well be the preferable option. On the other hand, if such methods could not be identified, powered equipment for crop cutting or milling, even though the potential benefits were much more limited, might be the rational choice.

Again, whether the source of power should be, for example, diesel or electric should be determined simply on the merits of each in a specific context. Most importantly the tendency to interpret "energy" with electricity must be avoided. The villagers themselves did not consider energy as a single category and this may partly explain why it rarely ranked highly in their list of concerns. The field studies revealed many energy needs and a wide range of fuels and conversion appliances relevant to local conditions. For example, although pig producers in Housanxi had widely adopted electric fodder cutters, the farmers in Xiapai found that increases in production and cash income came mainly from the transport capacity provided by their diesel engine vehicles.

Relocation

The third option is being actively pursued both by central and local governments in China on the basis that it is easier and cheaper to move households within the orbit of existing services, including grid electricity, than to extend services to every remote village. Voluntary relocation from some very remote villages may be a more plausible option than attempting to provide the level of energy and other services necessary to provide a reasonable standard of living. However, given the land constraints that apply in China, relocation policies clearly have to be approached with great caution. It is well known that migration has been underway on a large scale for many years. In the simplest situation one member of a poor household, often using social contacts in an urban area, finds

employment and remits money back to his or her family. In some poor counties this process has greatly increased income levels and has been encouraged and assisted by county governments. However, as with most other propoor programs, those on the poorest, most remote villages are the least likely to benefit. They lack information, are rarely targeted by officials and usually cannot obtain loans to meet the cost of travel.

Long term out-migration of particular individuals or households (typically, as illustrated by the fieldwork, those who are younger, better educated and more enterprising) may worsen the situation for those left behind. This can occur at the household level, for example young men or women may leave their aging parents to farm unassisted, or at the community level, when a teacher or health worker leaves. In the case of ethnic minority populations, those migrating may also face difficulties in integrating into Han communities. Gansu Province has recently instituted a policy of relocating entire ethnic minority villages in response to the reluctance of individual households to take part in resettlement schemes.

Lessons for Future Rural Energy Projects

Overall, the field work confirmed the list of five principles for energy projects set out in section 1 of this report, in brief:

- That the poverty reducing impacts of energy inputs are significantly affected by the existence or absence of "complementary inputs."
- That the financial sustainability of energy interventions is often determined by the existence of income generating end uses.
- That the size and distribution of poverty impacts of energy interventions will be significantly determined by the choice of end uses in which the energy is used.
- That the viability of local energy conversion technology is highly dependent on the "load factor," or the extent to which the potential energy output is actually used.
- That the energy needs of women are often significantly different from those of men.

A number of specific lessons can be drawn from the case studies for the management of future projects and these are detailed below. However, great care should be taken not to rely too heavily on examples that:

- Are focused on a small sample (in this case of counties, townships and villages), and such studies can be seen as "indicative" rather than "representative."
- Purposefully did not include any projects associated with the World Bank.
- Purposefully did not seek out villages that were known to represent successful implementation of "new" renewable energy schemes.
- Are located in China, which is dissimilar in many ways from other poor countries.

Given these caveats, the chief lessons would appear to be as follows:

- **Be clear about objectives.** It is essential to be clear about objectives. If the primary objective is income poverty reduction then energy schemes must promote end uses that, directly or indirectly, promote income generation, and carefully evaluate both their realistic potential and the economic, social, or environmental constraints on the realization of that potential. However, the welfare aspects of improved energy services—directly improving poor people's quality of life and access to social services, as opposed to necessarily increasing their incomes—are too often seriously underestimated.
- **Improved energy services will rarely be sufficient reduce income poverty in the absence of complementary inputs.** The fieldwork communities struggle under multiple and reinforcing disadvantages. In such circumstances, substantial reductions in income poverty will require an integrated mix of energy, agriculture, livestock, forestry, rural infrastructure, marketing, and credit interventions. Each link in the chain of production and income-generation must be assessed. In particular, the choice of end-use technology will determine the size, form, and gender-distribution of the impact of improved energy services. This means that finance and technical assistance relating to energy end use technology are likely to be crucial complementary inputs, as will be mechanisms to ensure women have a say in the choice of investment options.
- **Consult early and widely.** Rural energy systems (as rural systems in general) are complex and location specific. There is therefore no substitute for an extensive period of consultation to: understand users' needs; determine what resources exist; identify constraints; and predict the impact on both men and women of changes in energy services and energy end uses. Contrary to initial expectations, in the fieldwork villages labor shortages appear to have been the main constraint to escaping from poverty and therefore energy interventions would have to address this issue. The need to understand local circumstances suggests long gestation periods and the need to find the resources to do this preparation effectively.
- **Women's energy needs are different from those of men.** Energy needs are clearly highly variable across the study villages but in all cases strongly influenced by different gender perspectives. This is not simply related to a traditional split between domestic and "productive" uses, a distinction that the findings suggest can be highly misleading.
- **Energy-related decisionmaking is mainly a male prerogative.** Women in these villages do not seem to be involved in most decisionmaking processes related to energy systems or end uses. Access to electricity appears in some circumstances to increase the work burden on women, although they may regard this as acceptable if it is associated with opportunities for other family members to find

employment elsewhere. This underlines the importance of collecting gender disaggregated data on energy use and decisionmaking and adopting a gender inclusive approach to consultations.

- **Adopt an integrated approach.** If poverty reduction is the main objective of intervention, then this requires an approach that integrates a number of complementary inputs into a single package, and work to improve the enabling environment. The study suggests a need to strengthen the processes whereby communities use their social capital to gain better access to energy services and put pressure on relevant authorities to ensure that their energy services are of high quality. Furthermore it suggests that local government officials may need assistance (for example, by the development of a toolkit) to design and implement a sustainable energy component as part of an integrated package of interventions.
- **Consider the "full menu" of energy options.** This study confirms work elsewhere that poor people have many energy needs, use many energy sources and adopt many energy conversion technologies. It is essential for project managers to consider energy needs from a perspective that includes all uses and sources, rather than focusing on one end use or one energy option or source. In particular, it will be necessary to bring a number of decentralized options and especially biomass uses in poverty households into mainstream analysis and action.[76] It will be important that these innovations are not unfairly inhibited by the allocation of subsidies to existing suppliers (to grid electricity and fossil fuels). It is also likely that these alternatives will remain relatively costly until the full (social and environmental) costs of fossil fuel-based systems are reflected in retail prices. In these villages energy for transport (giving increased access to markets and to fuels), energy for irrigation (to increase livelihood security in drought prone areas), and energy for fodder processing appeared particularly significant. Solar devices for boiling water and mechanical stove blowers appeared particularly attractive to villagers in the specific cultural, ecological and economic situations that they faced.
- **Providing access is not enough.** There is a need to go beyond simply increasing access to modern energy services, as there are clear cases where the availability of electricity did not result in its effective use. In particular, the study showed that where local facilities, such as schools and health centers, are under extreme financial pressures the benefits of improved energy services can be wasted because of the lack of relatively tiny amounts to meet running costs.
- **New and renewable energy conversion technologies need regular and long term support.** Although there are advantages in decentralized renewable energy options in those areas that cannot be reached by the grid (particularly the

[76] Comment by one of the reviewers, Dorothy Lele, with which the authors fully concur.

elimination of the regular transport of fuel), these studies suggest that these technologies do not bypass the need for robust and continuing systems to assure the supply of spares and maintenance. These systems can be very expensive. In most cases this probably means reliable road access and schemes that can generate a sufficient cash flow to cover these costs (even if the initial capital costs are subsidized). In the small number of cases examined here, PV plans failed because of inadequate supporting systems. "New renewables" are likely to be more costly in terms of scarce capital and skills than more conventional systems. At least initially, they will also involve higher transaction costs. Improving the efficiency and extending the reach of services that deliver grid-based electricity and fossil fuels are likely to remain a significant element in any attempt to reduce poverty. However, new institutional mechanisms are likely to be required to make these improvements financially sustainable (for instance privately financed user cooperatives to retail electricity bought in bulk from the grid suppliers).

- **Load factor is likely to be crucial.** There do seem to be financially sustainable decentralized options available to supply improved energy services, but their viability is crucially determined by the extent to which they are used. In these villages load factors were often maintained by hiring out devices (such as milling machines) at marginal costs.
- **Subsidies are likely to be required.** People will pay for electric lighting, but the start-up costs of all systems are likely to prevent all but the richest families gaining access (this is particularly so for renewable energy that is characterized by high capital costs and low running costs relative to fossil fuel options). Such subsidies should be "smart" and apply to the options that best meet the needs of poor people rather than be restricted to particular conversion technologies. This may well require technical and financial support both to the energy supply business and to energy users. This in turn suggests changing the way that financial institutions provide credit, and ensuring that funds are available both for the energy service provider and the end user, with particular attention to women, whose access to credit must be strengthened.

Special Issues for Projects Targeting Remote Communities

- **Cost effectiveness.** The shortcomings of PAO activities in relation to poor households in remote areas have been previously discussed. However, poor county governments do face a genuine dilemma in deciding whether to invest very scarce resources in such areas, or focus on projects in less remote, better-off townships with much greater prospects for generating additional revenue and possibly for benefiting considerably large numbers of poor people. Energy projects in remote areas that make demands on counterpart funding or other inputs must deal explicitly with this issue.

- **Decentralized energy options will not be effective unless it is possible to support them with spares and maintenance.** Possibly one of the most surprising aspects of the fieldwork was the evident failure of PV systems in villages located relatively close to Lanzhou, the provincial capital of Gansu and headquarters of the Gansu Natural Energy Institute. The underlying issues appeared to be overoptimistic assumptions as to the reliability and robustness of the systems and lack of incentive to undertake maintenance activities for a relatively small group of poor households with very limited opportunities for effective complaint. Remote populations, the natural target beneficiaries for decentralized energy systems, are clearly in an even more difficult position.
- **Will improvement in energy services be combined with other essential inputs?** As indicated above, the remarkable efforts that China has made to link villages to grid electricity mean that those remaining off-grid are seen as very much marginalized communities. Such communities typically also have limited access to other essential services, such as transport, markets, and formal credit institutions. They find it extremely difficult to recruit or retain those with marketable skills, or both, including teachers and health workers. To the extent that their effectiveness is to any degree conditional on complementary inputs, energy service projects in such communities would be advised to adopt cautious assumptions as to their availability and sustainability.
- **How does the project relate to opportunities for migrant labor?** Access to paid employment in better-off rural areas and off-farm jobs in both local and more distant urban area, is widely seen within remote communities as one of their few options to overcome poverty. Energy projects, which might be seen as *only* addressing domestic energy demand, may nevertheless provide a mechanism for freeing labor time, allowing poor households to benefit from migrant labor income (although often at the cost of increased burdens on women). The potential costs and benefits of this approach need to be compared with alternatives targeted at, for example, output diversification or increased productivity.
- **Consider explicitly if relocation is an option.** There are powerful arguments against relocation in general and serious risks that such policies may assist the marginally better-off in remote communities at the expense of the poorest, including the old and sick, who remain behind. However, in the most remote communities in this study, the desire to leave, particularly among the younger members of the population, was so strong that it was difficult to see that any realistic project would persuade them that potential benefits would outweigh those to be found elsewhere. If a realistic assessment suggests that amelioration of extreme poverty is the best that can be expected, the merits of resettlement in a more viable location should be explicitly considered.

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