1. Introduction

About 60% of the world population in the 1990s lived in rural areas (UNDP, 2000). Rural electrification of these areas cannot but represent a major task for governments and firms. For the developing world, energy is first and foremost, a ‘development’ issue, being it ‘a matter of bread and butter for economic and social development’ (Bagher Asadi, 2002, page 6). No country has been able to raise per capita incomes from low levels without increasing its use of commercial energy. In industrialised countries demand for fossil fuels has expanded more than 50-fold (in energy units) since 1860. (Anderson, 2000). Development comes through growth, which in turn depends on a higher level of economic activity and consequently an inevitable increase in the use of energy (World Bank, 1996). Yet, the lack of adequate energy services in rural areas of developing countries can be astounding and can have adverse social as well as environmental and health effects. Many of the effect dimensions are exacerbated by the almost exclusive reliance of rural populations, in most areas, on traditional fuels coupled with simple technologies characterised by low energy efficiency and harmful emissions (Goldemberg, 2000).

The traditional methods of addressing energy generation and transmission problems in rural places of developing countries may often not be able to provide the solutions in remote areas, which typically are very poor and without easy access to means of communication and transportation. Despite that fossil fuels will continue to constitute an important part of energy supply for most developing countries, they cannot simply be transferred from industrialised countries where the conditions are different and adequate infrastructures have existed for a considerable time. Fortunately, technological alternatives are available today, which, together with new insight into the essential requirements of development, such as environmental protection and social equity, may help to find appropriate energy solutions for remote areas.

Remarkable improvements have been achieved through vast rural electrification programmes in the last decades in developing countries. The grid expansion may not however be the only, most appropriate, or even a possible option for many rural regions. Instead, decentralised technology may offer important benefits to local users. In many cases, it might be the only possible technological strategy at the moment, and for some time to come, for supplying electricity to isolated areas in less developed countries. Although in much modest scale than through centralised electricity expansion, also decentralised technology equipments such as those belonging to micro-hydro, photovoltaic and biogas systems have reached remote populations to enable limited electricity generation. After installation of the equipment, by sustainability of renewable energy technology it is meant that the energy systems must be technically effective and efficient; its maintenance and operation must be affordable as well as done locally; the service it provides must fulfil the needs and priorities of the users; it is also expected to achieve social enhancements in the beneficiaries’ livelihoods and to impact the natural environment in negligible ways; and it is expected that all these features remain constant in the

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1 RESURL stands for Renewable Energies for Sustainable Rural Livelihoods and is a research grant R08018 funded by the UK Department for International Development.
long term. It is argued that little is known however, on how sustainable the decentralised approach has resulted in the remote places where it has been implemented. Information of this type is essential not only to enhance electricity generation to isolated areas, but also to inform future decision making of new electricity development so it may improve the chances to be sustainable for the poorest people.

Despite that there has been undeniable achievements with decentralised renewable systems in developing countries in particular face severe failures to achieve the necessary levels of energy remote areas. There is therefore need to better understand the reasons for failure and success of the implementation of energy solutions in isolated communities. This particular question is currently being addressed by the RESURL –Renewable Energy for Sustainable Livelihoods - research project, which is a joint international collaboration. The aim is to develop a methodology of multicriteria to evaluate the technical and non-technical dimensions of energy systems in isolated rural areas and to appraise degree of opportunity to develop new energy systems. The RESURL project has developed an approach to study questions on barriers and success of the systems and applied it in three Latin American and Caribbean countries. The testing of such models will be discussed at the end of the paper.

2. Rural electrification in the developing world

There are two main approaches to energy generation transmission and distribution in rural areas, centralised and decentralised systems. This section explains few of the main reasons that make centralised electricity generation and distribution a best option for quality of the service and its economic desirability. It mentions some of its limitations and then discusses the main features of decentralised options, that is, the traditional energy fuels such as those that use renewable biomass resources like firewood and human labour; and modern energy fuels such as kerosene and diesel, and also renewable energy technology (RET) which draws on local natural resources.

The centralised approach is when rural electrification programmes have typically concentrated on connecting villages and remote areas to a national grid – often owned and operated by a public utility. The tendency has been to extend the grid incrementally, reaching towns and settlements in order of increasing capital costs. Remote areas with small populations are likely to be the last to receive electricity. Many rural areas face high transmission and distribution costs because the capacity of power lines is inefficiently used due to low population; densities and demand levels are low; villages may have very peaky – undiversified – demand profiles; and line losses tend to be high.

Electricity from the grid is at the top of the energy ladder and is highly efficient and convenient. Nevertheless, for lighting, communication, refrigeration, and motor application, electricity is essential for a satisfactory quality of life. Moreover, electricity is key to improving agricultural productivity through mechanisation and is essential for many rural industrial activities. Considerable progress has been made in rural electrification programmes designed to extend electricity services to isolated villages.

Table 1. Global population and access to electricity, 1970-1990 (millions of people)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>World population</td>
<td>3,600</td>
<td>4,400</td>
<td>5,300</td>
</tr>
<tr>
<td>Rural population</td>
<td>2,600</td>
<td>3,000</td>
<td>3,200</td>
</tr>
<tr>
<td>With access to electricity*</td>
<td>610</td>
<td>1,000</td>
<td>1,400</td>
</tr>
<tr>
<td>Without access to electricity</td>
<td>2,000</td>
<td>2,000</td>
<td>1,800</td>
</tr>
<tr>
<td>% of rural population with access</td>
<td>23</td>
<td>33</td>
<td>44</td>
</tr>
</tbody>
</table>

*Access includes people living in villages connected to power lines. This does not necessarily mean that most households are connected to electricity

Source: Davis, 1995, in UNDP, 2000, p. 374

Between 1970 and 1990, 800 million people in rural areas gained access to electricity. Yet of the 3 billion people living in rural areas of developing countries in 1990, 2 billion were still without access to modern energy forms such as electricity and gas. Average consumptions levels of the 2 billion people who do have access in the developing countries are barely one-fifth of those in the economies of the Organisation for Economic Cooperation and Development (OECD) (Anderson, 2000). Moreover, for many years to come, electricity is unlikely to be practical for general cooking in most rural areas of the developing world.

The dispersed character of rural populations and their low commercial energy consumption results in poor capacity utilisation efficiency for transmission and distribution systems and other energy infrastructure. Extending an electric grid to a few households in a rural setting can result in energy costs of up to $0.70 per kilowatt-hour, seven times the cost of providing electricity in an urban area (World Bank, 1996). Thus conventional approaches to extending energy infrastructure are economically inefficient, which is an additional reason for governments to give the energy problems of rural populations low priority.

Another reason that rural energy development often remains low on government agendas is that there is an increasing demand for electricity in the growing, politically and economically dominant, urban populations. Poverty is perhaps the single most important factor that has constrained access to modern energy services (Habtesion and Tsighe,
2002). As people normally move up the energy ladder when their income increases, shifting from locally available traditional fuels to modern commercial energy carriers, as well as purchasing convenient and energy-efficient conversion devices.

Alternately there is, the decentralised approach. This addresses the problems of applying grid electricity for small, scattered, peaky loads. With decentralised systems, the high costs of transmission and distribution networks can be avoided. Most common decentralised technologies are diesel-engine generator set, small-scale hydropower, photovoltaics, wind, and small-scale bio-power using producer gas. In many cases, the only possibility to develop electricity and energy is through renewable energy technologies due to the great distance of population settlements from the national distribution grids. Renewable energy technologies have an important role in achieving the aims of energy supply, environmental protection and social and economic development; they are indigenous, they generate little or no pollution, and they are becoming a cost-effective alternative to conventional energy technologies (EC, 1998).

Energy supply can particularly have a positive impact on the life of the rural population if developed to suit the conditions of the users. For the poor regions of the Third World, access to electricity and energy can offer services that would enable economic alternatives and introduce social activities that can help to improve conditions of poverty. Modern energy forms are an economic good, capable of improving the living standards of billions of people, particularly in developing countries who lack access to service or whose consumption levels are far below those of people in industrialised countries. It is the pollution arising from energy production and use that is the economic bad, not energy use itself (Anderson, 2000).

Hundreds of thousands of renewable technology equipment has been installed across the developing world. Also, million of devices such as stoves that can improve the energy efficiency of renewable – particularly fire-wood – have been distributed. More than 1 million solar systems have been distributed, for example, 150,000 in Kenia, 100,000 in China, 85,000 in Zimbabwe, 60,000 in Indonesia, 40,000 in Mexico. About 150,000 PV and wind systems had been fixed in health clinics, schools and other shared community buildings. More than 45,000 micro-hidroelectricity plants supply electricity to more than 50 million people in China. There are hundreds of thousand PV and water pumps in Latin America, Africa and Asia (Greenpeace, 2001). Further, as poor people in rural areas lack access to electricity and modern fuels, they rely primarily on human and animal power for mechanical tasks, such as agricultural activities and transport, and on the direct combustion of biomass (wood, crop residues, dung) for activities that require heat or lighting. Human energy is expended in this way. Energy development for rural areas and particularly for isolated regions, in the Third World has potential for development among governments and organisations, international enterprises, and NGOs (non-government organizations). The reason is that the subject of energy for rural areas in the developing world touches three issues of current relevance, to guarantee the future supply of energy, to reduce poverty, infrastructure, a particularly important point in remotely located poor communities. Many regions in the less developed

3. Factors that define the sustainability of the systems

By 2002, renewable energy provided 4% of the world’s commercial energy, half of which is from hydropower. Wind and solar power are the fastest growing sources of renewable energy but they start from a very low base. In theory they could meet humanity’s energy needs many times over, and do so cleanly – but it is unclear how quickly they will be developed. Estimates of their share of the world’s energy supplies in the second half of the this century range from about 20% to over 50% (Lean, 2002).

The advantages that stem from the application of decentralised renewable systems in rural areas are numerous and can be classified as technical and non-technical. Among the former there are technological and economic advantages. For example, due to its ability to work independently of existing grids, renewables like PVs or wind turbines can be particularly important when supplying energy to isolated areas. Three decades of technical development and abundant field experience have reduced the price of these technologies and widened their applicability in developing countries (Anderson, 2000). Wind turbines and PV cells are already profitable in many isolated places. For example, the price of the wind energy has fallen two thirds during the nineties (Cavalo et al., 1993). As solar cells and wind turbines are able to produce extra energy for other types of consumption, especially during the monsoon season, this allows for a much higher level of equipment capacity use and lower unitary costs. Other advantages is that low-density populations in rural areas gain access to and use the renewable energy supply. Innovative low-cost low-cost and successful renewable energy technologies have been developed. Examples include improved bio-fuels stoves, irrigation pumps and pico and micro-hydro turbines (Karekezi, 2002). In 1994, the cost of a typical 48-watt PV system, that is, enough electricity for five bulbs, radio, a television, was $600 (World Resources, 1995).

Renewable energy systems provide an opportunity to increase the amount of energy supplied to rural areas in a short period of time since generally these small, modular and flexible systems have short construction periods and need either limited or inexistential transmission systems. Small renewable energy systems can avoid the bureaucracy and red tape existing in the electricity production and supply industry, while more distributed generation could relieve the grid of the load as well as reduce transmission losses. Renewables are mainly local energies and production of renewable equipments and the installation of renewable energy plants are in many cases independent of the existence of infrastructure, a particularly important point in remotely located poor communities. Many regions in the less developed
RESURL has designed methodology that enables assessment of the barriers energy systems performance in isolated rural communities where connection to the grid is impossible due to high costs and difficult access.

Sustainable livelihoods. The research explores whether the addition of energy systems might improve living conditions for those in developing countries who lack access to services or whose consumption levels are far below those of people in industrialised countries. It is the pollution arising from energy production and use that is economically bad, not energy use itself (Anderson, 2000). Energy generation and supply through modern technology could avoid a great part of this contamination. Poverty continues being a major factor in the lack of access to other forms of energy.

From a social and economic viewpoint, with renewable energy, savings in time and labour can be achieved in the home. When wood fuels are scarce, the time people spend collecting fuel is time they cannot devote to other productive activities. Recent surveys in Nepal show that women spend up to 2.5 hours a day collecting fuel wood and fodder in areas where fuels are scarce. The saving in time and labour, however, extends far beyond the saving arising from the displacement of fuel wood. It includes the economic convenience of modern energy forms and the advances they make possible, including hot and running water, washing machine, refrigeration, etc.

Energy supply can particularly have a positive impact on the life of rural populations if it is developed to suit the conditions of the users. For the poor regions of the Third World, access to electricity and energy can offer services that would enable economic alternatives and introduce social activities that can help to improve conditions of poverty. Modern energy forms are an economic good, capable of improving the living standards of billions of people, especially those in developing countries who lack access to services or whose consumption levels are far below those of people in industrialised countries. It is the pollution arising from energy production and use that is the economic bad, not energy use itself (Anderson, 2000).

From a political perspective, reliance on renewable energy helps to improve the security of energy supply by reducing the country’s dependence on imported energy sources. Local energy autonomy may increase and dependency on national suppliers, like that on the national grid, can be reduced. There are economic benefits to be collected from this energy independence.

Development of renewable energy sources offers developing nations the prospect of increasing energy self-reliance, both nationally and locally, and reaping the economic and security benefits. Due to their ability to function independently of utility grids, renewables such as solar photovoltaic (PV) arrays and wind turbines could be particularly important in providing power to remote areas. The prospect of such decentralised installations is particularly attractive in light of the limited success of current rural electrification programmes in addressing energy needs in the South. Among other problems, these programmes are costly, and transmission lines experience significant energy loss (World Resources, 1994-5).

To RESURL project was designed precisely to address issues of sustainability of energy development in remote rural areas. A main drive for this project was the indication that proved technology was probably failing to deliver the expected results after investment had been completed. Knowledge of the barriers that preclude further development is essential for further application of renewable energy technology.

4. Assessing the performance of decentralised energy systems

RESURL investigates the condition of modern energy technology and applies its links to alleviate poverty for sustainable livelihoods. The research explores whether the addition of energy systems might improve living conditions in isolated rural communities where connection to the grid is impossible due to high costs and difficult access. RESURL has designed methodology that enables assessment of the barriers energy systems performance.

RESURL specific objectives are:
- To identify the technical and non-technical barriers that interfere with effective electricity provision, social and economic improvements, and environmental protection.
- To develop methods and guidelines to evaluate and assess decentralised renewable energy technologies.
- To account for local and national political structures that enable or not renewable energy technologies for livelihood improvement.
- To define the links between poverty and energy

nations have good renewable energy resource potential that can be used to supply the energy resources needed for development. This can be especially valuable in regions with a strong tourist industry, where the increased energy demand needs to be met without spoiling the environmental (EC, 1998).

Renewable energy is largely local energy. Its development can create new businesses, bring employment and encourage economic and social cohesion in regions that otherwise lack industrial development. This local expertise can also be translated into opportunities to exploit the considerable and growing export potential from renewable energy technologies, particularly in the developing world (EC, 1998).

Among the non-technical factors, environmental, social and political factors can be distinguished.

Environmental benefits. An increase in the use of renewables, which are non-fossil sources of energy, helps to reduce CO2 emissions from the energy sector and can contribute towards a more sustainable energy policy. Most renewable sources of energy do not release emissions of SO2 and have lower environmental impacts on soil, water and air pollution in comparison with energy from conventional sources. As renewable energy is a non-fossil source of energy, its use instead of fossil fuel sources can contribute significantly to reducing carbon dioxide emissions. Increasing the share of renewable energy in the energy balance contributes to improved sustainability in energy supplies. The use of traditional sources of energy causes well-known problems related to indoors pollution, as well as problems related to deforestation. Nevertheless, the services these sources offer are essential for rural livelihood. It is the pollution arising from energy production and use that is economically bad, not energy use itself (Anderson, 2000). Energy generation and supply through modern technology could avoid a great part of this contamination.
5. Methodology

Studies were carried out to assess and measure factors that contribute to or hamper efficiency, viability, and appropriate energy development in remote rural areas. The approach entailed empirical field work, is multidisciplinary and participative and experts assessment. A survey was implemented in different geographical areas in selected countries. The survey addressed households, commercial and non-commercial community premises, the local environment, and local leaders. The survey was elaborated by RESURL and it addresses fours aspects of the energy development in isolated rural areas, that is, the technology, the economy and society, the environment, and the institutions and local organisations. The indicators in the four dimensions enable identification of key factors that might contribute to the barriers that preclude effective electricity generation, financial viability and continued maintenance. The research scheme is show in Fig (1). The indicators correspond to technical and non-technical aspects of the decentralised energy technology; the variables are multidisciplinary, the empirical strategies are participative and expert.

Figure 1. Methodological strategies used for assessing the factors that affect decentralised technology performance, RESURL 2002

The method was tested in three countries, Cuba, Peru and Colombia. The study took place in the Escambray mountains in Santa Clara, Cuba. In Peru, in the Andes Province of Cajamarca, and in the jungle Province of Ucayali, Peru and the Chocó on the Columbian Pacific coast, and in the Andean district of Antioquia. In each country, 300 households were surveyed in communities located in remote areas with very difficult access. Information was gathered also from experts who looked after the installations, from leaders and other premises.

Table 2. Main features of the RESURL field work in three countries

<table>
<thead>
<tr>
<th>Features</th>
<th>Cuba</th>
<th>Peru</th>
<th>Colombia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of villages/communities</td>
<td>14</td>
<td>7</td>
<td>14</td>
</tr>
<tr>
<td>Total households</td>
<td>300</td>
<td>300</td>
<td>300</td>
</tr>
<tr>
<td>RETs in other premises</td>
<td>Schools, clinics</td>
<td>Clinics, shops</td>
<td>Clinics, shops</td>
</tr>
<tr>
<td>Remote locations</td>
<td>Mountains</td>
<td>Andes, Jungle</td>
<td>Coast, Jungle</td>
</tr>
<tr>
<td>Decentralised energy systems</td>
<td>Micro hydro</td>
<td>40</td>
<td>Micro hydro</td>
</tr>
<tr>
<td></td>
<td>PVs</td>
<td>18</td>
<td>PVs</td>
</tr>
<tr>
<td></td>
<td>Traditional</td>
<td>132</td>
<td>Traditional</td>
</tr>
<tr>
<td></td>
<td>Hybrid</td>
<td>124</td>
<td>Hybrid</td>
</tr>
</tbody>
</table>
Two main interests of the survey were the actual uses given to the electricity produced through the decentralised systems, and the usual problems encountered with the systems.

The uses of electricity in the isolated areas vary. Focusing on Peru in Cajamarca, in the Andean (Paccha and Chugur – communities with micro-hydro), the major use of the electric energy is for domestic purposes, however families have undertaken some productive activities like: carpentry, grain mills, battery chargers, small business as offices and restaurants, and others. In Paccha and Chugur, they have electric service through a MH, 100% of the population utilizes this energy for lighting the dwellings. In Ahijadero, also in the Andes, where there is no energy development 98% of the population utilizes kerosene for mecheros and/or lamps and the remainder 2% utilizes batteries.

In the Jungle zones, where the communities rely on PV, the main use of generated electricity is for the lighting of dwellings. In San Francisco, Callería and Roca Fuerte many of the families make use of this service by working at night in craft activity, e.g ceramics, embroideries, weavings, jewellery and other objects. In the three communities radio communication has been installed. These business have different electricity tariff in San Francisco and Callería.

In the communities in the Jungle, the use of kerosene is maintained, being the most critical place Vista Alegre, where there is no energy development, where 95% utilizes the kerosene for lighting and only 5% utilizes batteries.

Radios are the main appliances utilized in all the communities, however in those with micro-hydro electricity, especially Paccha and Chugur, the families utilise other appliances including TV, blenders, plates, refrigerators, electric stoves.

In the communities in the jungle, the main appliances are radios and television sets, all function with batteries which are charged by the PV systems. It is important to emphasize that in

As to the current problems, 28% of the families of Paccha consider that the capacity of the MCH should be expanded, 26% that should bring greater social benefits, 14% that should be easy to use and 32% that not be contaminant. In Chugur 18% believes that it the capacity of the MCH should improve, 15% that it should bring social benefits, 8% that the cost of the energy should be less, 20% that should be easy to use, and 39% that it does not contaminate the environment.

In the Jungle in San Francisco 20% suggested that PV’s should contribute to improve the social services, 32% that it must be easy to use, 26% that will not contaminate, and 22% that batteries should be changed.

- In Callería 43% consider that it should bring social benefits, 33% that does not contaminate the environment and 24% that change the batteries.

- In Roca Fuerte 60% considers that it should not contaminate and 40% that should change the batteries.

Despite the encountered problems, there seems to be a considerable level of satisfaction regarding the fact of having some form of electricity. It must be noticed that renewables, particularly PVS always is used along traditional sources. The level of satisfaction tends to be positive, with 58 out of 76 of such cases in Colombia and Cuba. However, in Peru there is a very diverse opinion about renewables, with an almost 33% for each one of the options, Good, Average and Bad. It was found that those who use traditional energy seem to be uncomfortable with their energy system, specially in Colombia and Cuba where 240 out of 260 households rate the current energy system that they used as Unsatisfactory or Very Poor, and 21 out of 30 in Peru regard it as ‘Average’.

Table 3: RET in isolated areas - Peru

<table>
<thead>
<tr>
<th>SYSTEM</th>
<th>USAGE</th>
<th>PROBLEMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jungle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>San Francisco</td>
<td>PV</td>
<td>-Lighting</td>
</tr>
<tr>
<td>Calleria</td>
<td>PV</td>
<td>-Radio</td>
</tr>
<tr>
<td>Roca Fuerte</td>
<td>PV</td>
<td>-Lighting</td>
</tr>
<tr>
<td>Vista Alegre</td>
<td>None</td>
<td>-Radio</td>
</tr>
<tr>
<td>Andes</td>
<td></td>
<td>-Domestic appliances,</td>
</tr>
<tr>
<td>Chugur</td>
<td>MH</td>
<td>-Lighting</td>
</tr>
<tr>
<td>Paccha</td>
<td>MH</td>
<td>-Radio</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Domestic appliances,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Lighting</td>
</tr>
</tbody>
</table>


As to electricity service satisfaction, households connected to micro-hidros, that is, in Paccha, 20% considers that the service is very satisfactory, 63% believes that it is satisfactory and for 17% it is unsatisfactory. The families that indicated that the service is unsatisfactory, consider that this owes to the service not having the capacity to drive equipment and/or industrial machinery. In Chugur, the general opinion is that the service is good. Seventy percent of the population considers it as very satisfactory and the 30% as satisfactory.

In communities with PV, in San Francisco, the majority of the population considers that the service satisfies its basic needs, 80%. According to the opinions obtained, 12% considers it as very satisfactory, 68% as satisfactory, 12% as unsatisfactory and the remainder 8% as very bad.

In the jungle, in Calleria, 43% thinks that the service is very satisfactory and the remainder 57% as satisfactory. In Roca Fuerte also a favorable opinion exists, the 75% believes that it is very satisfactory and 25% as satisfactory. It is important to emphasize that the inhabitants of communities in the jungle, with the exception of Vista Alegre, generally consider the service as satisfactory in spite of having a limited supply of energy, and only sufficient for lighting and the running of small appliances (radios or radiograbadoras).

Other findings indicate that in the case of Calleria in the Peruvian jungle there has been a well-intentioned investment by the community in 40 small solar panels for individual dwellings. Despite having a reasonably well trained local technician, the community after about a year, remained mainly without energy as the batteries soon were not charging. The batteries had been bought as new when apparently they were second-hand. In Chugur in the Andes, for example our study has uncovered that renewable energy faces many difficulties, Direct environmental impacts of the installation included the change in landscape from the extensive canal system, and minor local soil going at release points upstream and downstream of the turbine plant. There was no visible slip or erosion associated with this soil logging.

6. Conclusion

Electricity generation through RET may become very important, and particularly for isolated rural regions, in the Third World. It has the potential to acquire even more importance among governments and organisations, international enterprises, and NGOs. Energy generation for rural areas in the developing world highlights three issues of current
relevance: how electricity to guarantee the future supply of energy, reduction of poverty world-wide, and environmental protection strategies without stopping growth.

To define the energy situation as technologically sustainable, it must be considered that modern forms of energy are not just a social but an economic asset, capable of upgrading the quality of life for millions of people worldwide.

Barnett (2000) emphasises that sustainability must mean development of sustainable energy, it should not assume that the rural population must depend exclusively on the use of energy from renewable sources, particularly in the short term. Renewable energy sources are a mean to human development, not an aim by itself (Barnett, 2000). Technology on its own does not cause rural development and it is not enough unless other development factors are present (Cherni and Hill)

The following points started to emerge from the studies:

- Decisions not only technology/economy determined
- Objectives explain different alternatives
- An integral approach is needed
- A policy-informed vision is also required
- To select the technology is not the end
- Promotion of sustainable livelihoods and poverty reduction

Electricity generation for isolated rural areas in developing countries can have wide implications. An appropriate energy policy goes beyond selection of a centralised or decentralised approach, the careful application of new and renewable technologies. The RESURL project has been working on the development of methodological tools to enable a comprehensive identification of technical and non-technical barriers to and opportunities for decentralised energy systems that have been installed in remote rural areas. The knowledge that the application of new methods can produce indirectly encourages improvement to farmers’ livelihoods, better sustainability of the equipment, assistance in the policy decision-making process, and encourages well-informed investment penetration for renewable energy technology in the markets of the South.

Decentralised systems and particularly renewable energy technology is a highly recommended option for isolated areas. Supporting the promotion of renewable energy resources became a matter of global importance in the 2002 Earth Summit.

Improving efficiency, effective use of conventional fuels must be interconnected with a wider policy to promote renewables goals (as set by the UNDP and EC, 1999). It would be pointless, for instance, to produce PV electricity and waste it on an incandescent lamp and while improving the efficiency of electricity appliances one would be well advised to look also at the overall energy policy for the region. To stimulate this transformation, all stakeholders, but particularly policy makers, must work together to overcome barriers found in the actual places where there has been energy development.

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