Poverty-environment-energy linkages in Rwanda

POLICY BRIEF

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INTRODUCTION to IEP and IRP

This policy brief should be read in conjunction with the Concept Note on Poverty-Energy-Environment. The Concept Note establishes the linkages between energy, poverty and the environment specifically in the Rwandan case. However establishing linkages between sectors and national priorities does not provide a strategy for implementing solutions. What is needed is an energy planning methodology which considers all energy resources and includes environmental and poverty considerations and priorities. This paper suggests a methodology for combining integrated energy planning (IEP) with integrated resource planning (IRP) to order to make optimal use of energy resources in a sustainable way.

IEP may be defined as *a planning process which aims for a least-cost development path for the energy sector to guide policy-making and implementation* where 'least cost' very clearly refers to broad economic cost rather than direct financial cost. IEP is therefore targeting optimal efficiency in the energy sector, and encompasses broader concerns of the entire economy in addition to 'least financial cost' considerations.

Key components of IEP are:

- Explicit link to national priorities
- Demand-focus (since this is the reason for existence of the supply-sector) – considering the most appropriate energy source for the required service (as opposed to just 'electricity' for example)
- Demand Side Management (DSM) is considered on a par with supply-side measures

Integrated Resource Planning

IRP focuses on improving the process of decision-making. Overall economic efficiency is a goal of IRP, it is also clearly intended to improve consideration of energy efficiency and environmental issues in utility planning. Although IRP was originally formulated as a mechanism to guide the electricity sub-sector, it can be used for decision-making in any energy sub-sector where substantial investments are concerned. IRP seeks to achieve: *The combined development of energy sub-sectors supply options and demand-side management (DSM) options to provide energy services at minimum cost, including environmental and social costs.* Because IRP support the key objectives of IEP directly, it can be considered a mechanism for integrating IEP principles into decision-making at the project level.

The challenge for many developing countries remains the development of a framework to undertake planning in a way which not only considers demand-side options on a par with supply-side options, but that includes quantifiable and non-quantifiable impacts such that the overall benefits to the country are optimised. This is true least-cost planning. In addition, this least-cost decision-making framework needs to match the capacity and other constraints of the government and energy sector in general. This paper offers a methodology and an example of how these frameworks may be constructed and how all the costs may be considered.

1. Background

According Vision 2020[1], in the next fourteen years Rwanda will have to produce enough energy to meet all economic and social development activities without further damage to the environment. In promoting national development, Rwanda has focused on economic development, poverty alleviation, and sustainability – including environmental sustainability. The impact of the energy sector in each of these areas is recognized and hence the broad ranging plans to expand generation capacity, extend electricity provision in urban and rural areas, and exploit local energy sources such as hydro power, methane and peat, amongst others. However a large proportion of the population remains poor and is dependent on a depleted biomass resource for basic energy needs. Even if modern fuels were available to it, the rural poor would be unable to afford them.

A challenge facing energy planners in Rwanda is that of providing for the needs of different sectors in a way which maximises the benefits of resources allocated, and manages the negative social and environmental impacts of such interventions. While various policies and strategies are in place to guide decision-making, such as the Poverty Reduction Strategy, Vision 2020, the National Energy Policy and the Energy Sector Strategy, at a practical level there is little guidance on how various considerations such as financial costs and environmental externalities may be integrated into decision-making such that national objectives are best supported. Specifically, energy interventions need to consider environmental implications if they are to be sustainable. This policy brief aims at providing the requisite guidance.

2. The issues

Rwanda's economy depends heavily on its fragile ecosystems. That fragility was exacerbated by the effects of the genocide and subsequent actions taken to provide settlement and land for returnees at the end of the genocide. The increasing social and developmental pressures on the fragile ecosystem has implications for the pursuit of economic growth that is primary to successful alleviation of poverty in the country and for the integrity of the ecosystems that underpins the prospects for sustainable development. It is in this context that environmental issues should be put at the top of the agenda in energy planning and decision-making.

A number of challenges facing the energy sector in Rwanda at present revolve around the dependence of the majority of the population (approximately 90%) on biomass for cooking staple foods, and the related steady degradation of the biomass resources - although energy use is only one of various pressures on these resources. Making modern energy services available to the population as called for by the Millennium Development Goals (MDGs) – to ease environmental pressures and alleviate health problems associated with traditional fuel use – is difficult in the face of very low household incomes.

[1] 2002. Rwanda Development Vision 2020, cited in Energy Policy for Rwanda (pg 8, 24)

One of Rwanda's areas of focus to alleviate poverty is economic growth, in which the agricultural sector is expected to be a strong player. It is hoped that by raising the incomes of the poor they will increasingly be able to afford modern fuels, thereby enabling them to reduce their dependence on the diminishing woodlands in the longer-term. Energy interventions should therefore be designed to support of both rural productive activity and industrialisation. In this regard, Rwanda has plans to expand electricity generation capacity, and in the longer term develop local resources such as methane from Lake Kivu and peat deposits[2], as well as numerous potential hydro-generation sites around the country.

To enable the majority rural population benefit from energy services, there are plans to develop rural centres that provide health, education, ICT and government facilities as well as agro-processing activities with adequate access to energy services. It is hoped that this approach to providing energy services to the rural population will contribute to poverty alleviation.

Given the range of interconnected challenges facing the country, and the scarce financial and other resources at its disposal, it is prudent that energy planners optimize the use of these resources while preserving 'some of the most precious natural environments on earth'[3].

3. A framework for including poverty and environment into energy planning

Integrated energy planning is consistent with Rwanda's Vision 2020 and PRSP. However, its effective application would require adequate knowledge of the externalities to reckon with in the provision of energy services. Some of these externalities are environmental. The key ones relate to the continued degrading of woodland resources, and the health impacts associated with biomass dependence and vehicle emissions[4]. Potential externalities or externalities related to electricity generation or methane production would also have to be considered. The poor are the most affected by those externalities and would be the least able to adapt to them. It is in this regard, therefore, that energy planning has to be adequately linked to use and management of the natural resources in order to avoid undermining Rwanda's sustainable development goal enshrined in Vision 2020.

In order to include environmental impacts in a structured assessment of energy interventions to ensure least economic cost for the country, it is necessary to have a sense of their national importance. Both quantitative and qualitative assessments can be used to discern the impacts. Available evidence indicates that where environmental concerns are incorporated into project economic analyses, they often substantially change the outcomes. The World Bank, for instance, found that the effect of including environmental benefits in their projects ranged from an NPV increase of between 10% and 153%[5]. This points to the fact that neglect or inadequate consideration of such externalities can lead to misallocation of resources – a situation which, in

[2] 2004. Sector Strategies Document of the Ministry of Infrastructures (2005-2010) (pg 124)
[3] 2004 *Energy Policy (Final Draft).* Ministry of Infrastructure (pg11).
[4] 2004. Sector Strategies Document of the Ministry of Infrastructures (2005-2010) (pg 22).
[5] Silva P and Pagiola S, 2003. *Review of the Valuation of Environmental Costs and Benefits in World Bank Projects.* World Bank. And 1998. *How much is an ecosystem worth?* World Bank.

developing countries, is all the more critical to avoid. The following are examples of externalities that are relevant to the Rwanda situation.

Local air pollution and health impacts

The impacts of indoor and outdoor air quality on welfare are of widespread concern, and according to a study undertaken by the universities of Harvard and Berkeley, smoke from wood fires for cooking will result in 10 million premature deaths in Africa by 2030[6]. What is more, the poor are predominantly affected, as they are more reliant on biomass energy sources. A study in South Africa on poor household fuel impacts indicated that externalities mainly from fires, burns and air pollution increased the economic cost of paraffin (kerosene) by over 78% and wood by a significant amount[7]. Addressing this situation is key to the MDGs.

According to the Harvard and Berkeley study, *The best situation in Africa would be to transition from biomass fuels to petroleum-based fossil fuels such as kerosene and LPG, which could prevent 1.3 million to 3.7 million premature deaths, depending on the speed of the transition* (although the economic cost of such a transition is recognised as unachievable – and charcoal use is considered the most likely shift from current biomass use patterns). In Rwanda hopes are pinned on the production of methane to meet household and industrial demand, despite the very real constraints faced in this endeavour[8], and the weak purchasing power of the population.

Although placing a value on human life is contentious, it is useful to note that, where used in economic analyses, values may be around US$80 000[9] or even US$ 3 million[10]. This gives a sense of the economic impact from the high incidence of air quality-related deaths.

Transport emissions are another potential cause of significant externalities. Research is showing that the bulk of energy used by a large African city is for transport[11], which in turn contributes substantially to local emissions (particulates, VOCs and sulphur and nitrogen oxides) and therefore health externalities. In Rwanda, transport accounts for 69% of the approximately 100 000 tons of petroleum product[12]. However the urbanised population is still in the minority (approximately 16%), and therefore the localised concentrations of transport emissions may not yet contribute significantly to health externalities compared with indoor air pollution from biomass burning.

Assessments of electricity generation from fossil fuels also show a noticeable, although much less significant, health impact. A study in Europe indicated that coal generated electricity

[6] 2004. *Energy and Health in Africa*, Universities of Berkeley and Harvard.
[7] Thorne S, 1997. *Economic costs of energy services in South African Cities.* Energy Research Centre, University of Cape Town, and Borchers M, 1997. *Strategies to promote economically sound energy use in low-income households*. Energy & Development Group. Cape Town.
[8] 2004. Sector Strategies Document of the Ministry of Infrastructures (2005-2010) (pg 124).
[9] This is the figure used in South Africa for road fatalities.
[10] This is a common figure for the value of a human life in the USA.
[11] For example the 2004 *Cape Town State of Energy Report* (City of Cape Town and Sustainable Energy Africa), 2005 *Ekurhuleni State of Energy Report* (African, Tshwane), and the 2005 *Tshwane State of Energy Report* (Nyathi Energy, Johannesburg).
[12] 2004 *Energy Policy for Rwanda (Final Draft)*. Ministry of Infrastructure.

resulted in health damage of around USc 0.88 per kWh (approximately 10 to 20% of the electricity tariff)[13]. The health externality from gas generation was lower at US$ 0.4 per kWh, with hydro at US$ 0.051 per kWh. Since Rwanda's generation is from hydro-generation, externalities from electricity generation may not be a significant factor for the country.

The value of forests and other ecosystems

The World Bank has undertaken several studies to quantify the value to countries of forests and other ecosystems[14]. Although results vary widely, partly because of large differences in local conditions as well as equally large differences in assessment methodologies, in general such studies confirm that ecosystems hold substantial value – typically quantified at between US$ 50 and US$ 10/ha per capita annually (the lowest estimate – in Papua New Guinea – assumed an economic value of US$ 2/ha per annum). One study concludes that, on average, forest benefits in the region amount to about 1 percent of GDP. While these analyses acknowledge that they cannot include all benefits and costs of these ecosystems, they nevertheless illustrate their role in a nation's wealth, which is so easily overlooked by decision-makers because of the invisibility of this area to the market economy.

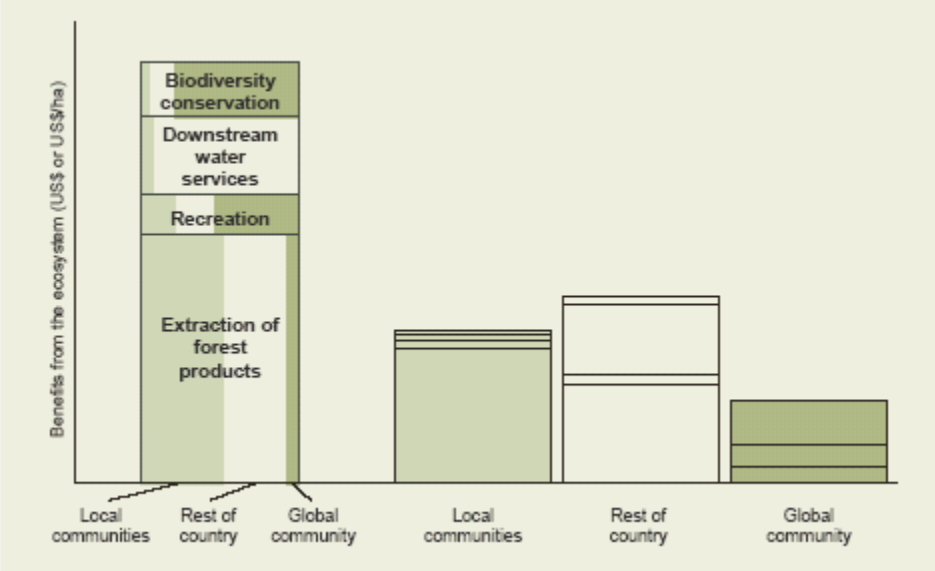

Figure 1: Example of a quantitative analysis of a conservation project[15].

Rwandan forest area has reduced from 26% to 18% in the last 12 years – equating to approximately 17 500 ha per annum loss, which, considering the above World Bank figures, amounts to an ongoing massive loss to the national economy.

[13] ExternE: 2003. *External Costs*. European Commission, Brussels
[14] Silva P and Pagiola S, 2003. *Review of the Valuation of Environmental Costs and Benefits in World Bank Projects*. World Bank. And 1998. *How much is an ecosystem worth?* World Bank.
[15] 1998. *How much is an ecosystem worth?* World Bank.

However, it needs to be remembered that energy is only one of the sectors that draw on forests. According to one study, causes of soil degradation in Africa can be apportioned roughly as follows[16]:

- Wood fuel overexploitation 13%
- Land conversion and logging 14%
- Overgrazing 49%
- Agricultural activity 24%
- Industrialisation 0%

It also needs to be noted that such assessments particularly do not account for food security and time implications of depleted fuel wood resources. These two factors have huge implications for poverty alleviation, and would add substantially to the 'externality' value of wood resources substantially. Again, the limitations of purely quantitative least-cost economic analyses are apparent. A World Bank study to clarify the externality valuation of ecosystems also cautions against relying too much on economic valuations for long-term and large-scale problems:

> *While valuation can shed useful light on many issues, there are several questions that economic valuation techniques handle poorly…..Economic valuation tends to handle very large scale and long-term problems rather poorly. Existing economic valuation techniques can provide reliable answers to questions involving relatively small-scale changes in resource use or availability, but become less robust as the scale of the analysis and the magnitude of environmental change increases. Similarly, economic valuation tends to deal poorly with very long time horizons. Uncertainty about future benefit flows becomes increasingly important, and the role of discounting increasingly determinant. Alternative non-economic approaches … may be more suitable in such cases*[17].

Other external costs and benefits

Other costs have seldom been quantified in a useful way. They need to be considered qualitatively. However this does not indicate that they are necessarily of secondary importance. Examples of these are discussed briefly below.

Improved health care: this is clearly essential to Rwanda, with the incidence of malaria and HIV, as well as dealing with respiratory and other illnesses to which women and children are most susceptible. Electricity supply to rural clinics is a critical intervention in this regard, as the level of service a clinic is able to provide is linked to electrification. A link can also be made between the availability of modern fuels to households, such as electricity and LPG (or methane), and reduced respiratory problems, as availability enables some people to shift from biomass-based cooking. This impact depends largely on the affordability of these fuels to poor households. Affordability levels at current prices are low.

[16] Lazarus M and von Hippel D, 1995. *A Guide to Environmental Analysis for Energy Planners*. Stockholm Environment Institute, Boston.
[17] 1998. *How much is an ecosystem worth?* World Bank

Improved education: education and general human resource development is a strong policy focus as current human resources are recognised as severely lacking. It is a core aspect of the MDGs, and is recognised as a key component of sustainable development. It impacts on environmental and poverty issues in the medium and long-term. Energy services have a role to play in providing food for children, as well as adequate electric lighting for schools and homes to enable night-time studying. Education and energy services are therefore linked to some extent.

Improved water provision: access to safe water supply is low in Rwanda. The World Bank has quantified externalities of improved water supply schemes, considering health benefits, time externalities and increased availability of water[18]. The benefits were found to be significant. Willingness to pay for improved supplies was generally between 1 to 3% of income for poorer households. Where electricity is available, it can facilitate the pumping of water as well as water treatment plant operation.

Economic growth stimulus: Economic growth is primary to successful poverty alleviation in Rwanda. With the current dependence of 90% of the population on agriculture, the PRSP emphasises the poverty alleviation focus on agro-processing and small business development. While it is important that energy supports these objectives, the impact of energy on such business development, although considered an important input to many operations, is difficult to clarify. This is partly because economic growth is usually more dependent on non-energy interventions than on energy inputs, particularly in poor areas, where business skills and access to finance, markets and transport infrastructure are often very limited.

Energy and general household welfare: It is particularly difficult to quantify the impact of energy use on poor households, and the likely benefits of different supply strategies. The Table below lists a few research findings which illustrate the burden and potential benefits linked to energy.

[18] Silva P and Pagiola S, 2003. *Review of the Valuation of Environmental Costs and Benefits in World Bank Projects*. World Bank

Table 1: Examples of energy and welfare links for poor households

Source	Finding
Cecelski E 1984. *The rural energy crisis, women's work and basic needs: perspectives and approaches to action*. World Employment Programme, International Labour Office, Geneva.	Metabolic energy use of women engaged in wood and water collection and agriculture in rural areas is high, but they often feed themselves last, potentially weakening their systems, especially if they are pregnant. It is estimated that women work at least 1/3 more hours every day than men.
Tinker I 1980. *The real energy crisis: women's time*. Equity Policy Center, Washington DC. Thamae, S. 2001 Energy and health – revisiting the World Commission on Environment and Health. Paper prepared for the Gender and Energy Network and focal point in Lesotho.	In a studies of energy and nutrition it has been found that a scarcity of energy leads to a) cooking less staples, b) cooking more refined –potentially less nutritious –foods, c) cooking food less thoroughly and risking Gastro Intestinal Diseases (GID)
ESMAP. Energy, Poverty Gender initiative, 2002	Indirect benefits: A series of studies done in south east Asia showed that where conditions make it possible, women use time that has been freed up by not having to collect wood, for productive and income generating purposes
Sengendo M 2001. Photovoltaic project for rural electrification – Uganda. In *Energia News* vol4 Issue 3 pp14-15 Indirect benefits	Rural development in Uganda has been seen to be facilitated through improved access to energy (in this case solar lighting) where educational and health facilities are provided, and where agricultural production (e.g. fruit packing) may be done at night or in the early morning. Solar drying facilities have enabled commercialisation of produce.
Annecke et al 2005. An assessment of PNES customer satisfaction and the contribution of electricity to the quality of life households in Khayelitsha, South Africa	Indirect benefits: In the majority of cases the electrification of households leads to slow but steady transition to electricity for all uses, and investment in the household – appliance purchase, upgrading, and an increase in the value of property .
Crawford Cousins C. 1999 A question of power: The electrification of rural households. Energy and Development Research Centre, University of Cape Town, South Africa	Low level chronic fatigue is well-documented among poor people especially women – multiple consequences include reduced ability to care for household and self, increased spending on indigenous and western medicines, reduced productivity.

Carbon dioxide emissions: This policy brief takes the position that the global environmental concerns around carbon emissions, while important, should be a secondary consideration for Rwanda at this stage of its development since its overall carbon contribution is negligible. However, it is important to seize opportunities provided by the CDM to promote investments that enhance the attainment of Rwanda's sustainable development goal.

4. An overview of integrated energy planning

The oil crises of the 1970s led to an unprecedented focus on energy efficiency in developed countries, which contributed to the shift from supply-side planning and strengthened the case for demand-side considerations to be incorporated in order to optimise economic efficiency.

In an effort to promote effective energy sector planning in the light of these global developments, one of the planning frameworks that emerged in the late 1980s and early 1990s was Integrated

Energy Planning (IEP). The main thrust behind the development of IEP was around changing the predominantly supply-side planning (often in the form of 'Energy Masterplans') which had dominated the energy sector, to considerations of the demand side. This supply-side planning was typically driven by the big utilities and state technical planners. Problems associated with such planning was that the interests of non-supply-side groups (such as the energy users!) were not well represented, national priorities (e.g. around poverty alleviation) were not properly considered, and externalities were seldom factored in to decisions, which were based almost exclusively on financial cost-benefit analyses.

IEP may be defined as *a planning process which aims for a least-cost development path for the energy sector to guide policy-making and implementation* where 'least cost' very clearly refers to broad economic cost rather than direct financial cost. IEP is therefore targeting optimal efficiency in the energy sector, and encompasses broader concerns of the entire economy in addition to 'least financial cost' considerations.

Key components of IEP are as follows:

- Explicit link to national priorities
- Demand-focus (since this is the reason for existence of the supply-sector) – considering the most appropriate energy source for the required service (as opposed to just 'electricity' for example)
- Demand Side Management (DSM) is considered on a par with supply-side measures
- Externalities are clearly considered.

Demand-side management

DSM has come to the fore as a critically important focus within the energy sector because of the generally clear financial benefits and environmental advantages it offers. In all sectors of economy efficiency improvement potential is expected to be substantial, and energy savings of 10% to 20% are common with little or no financial investment, and without any change in the service provided by the energy. Environmental impacts generally come from generation or sourcing of energy (power stations emissions or biomass harvesting-related deforestation), or use thereof (outdoor and indoor air pollution). Efficiency in the production or use of energy therefore has direct environmental benefits, and usually also direct financial benefits, yet does not affect production or other services provided in any way. However, the historical legacy of supply-side planning to this day tends to de-prioritise DSM, partly because of lack of technical expertise in this area, and partly because the logistics of DSM implementation – where interventions by numerous end-users need to be encouraged to realise a saving – are considered more cumbersome than simply dealing with one supply utility to increase supply. It has often been said that, where energy supply utilities are involved in DSM promotion, it can be ineffective – their core business is selling more energy, and they are therefore not naturally good at saving energy. In spite of these potential problems, the benefits of DSM are such that its promotion is almost universally required nowadays for sustainable development[19].

[19] In one example in Brazil the combination of policies which required universal access with conditions that restricted energy supply (the severe drought in 2000) saw energy efficiency increase up to 30% as users were educated about how to make the most of the rationed supply.

Integrated Resource Planning

While IEP deals with national energy planning, Integrated Resource Planning (IRP) focuses on improving the process of decision-making. Although IRP was originally formulated as a mechanism to guide the electricity sub-sector, it can be used for decision-making in any energy sub-sector where substantial investments are concerned. IRP seeks to achieve: *The combined development of energy sub-sectors supply options and demand-side management (DSM) options to provide energy services at minimum cost, including environmental and social costs.* Because IRP supports the key objectives of IEP directly, it can be considered a mechanism for integrating IEP principles into decision-making at the project level and offers a mechanism for linking energy-poverty-environment goals.

Practical application of IEP

Although the concepts behind IEP are sound, the planning process has seldom been carried out in anything like the manner initially intended. Typically involving substantial data gathering (often requiring primary research) and modeling, the demands of undertaking a thorough exercise are usually too much for all but the best resourced countries. In addition, the modeling component is often inaccessible to energy stakeholders, and therefore decision-maker's confidence in findings can be limited. So that while IEP stressed the need for considering externalities in the planning process, it did not overcome the practical difficulties of quantifying them and thus including them in any structured way. In a recent IEP modeling undertaken to assess the least-cost method for meeting the energy needs of a rural village[20], the difficulties in quantifying externalities also were apparent. Although both the health impacts from energy emissions and cost of fuel collection were considered substantial externalities, only the former could be quantified and included in the assessment, while the latter, the costs associated with fuel collection time, arguably the most immediate and significant for women, were 'not considered directly'. This paper offers a methodology for assessing externalities without computer modeling and which takes opportunity costs such as women's time, into account.

Key components of IEP

It is clear that least-cost assessments need to include the various essential components which IEP thinking has mainstreamed in energy planning, although they may not be implemented in the rigorous way as specified by the initial IEP framework. These essential components are as follows:

[20] Howels M, Alfstad T, Cross N, Jeftha L, 2002. *Rural Energy Modeling*. Energy Research Centre, University of Cape Town.

Table 2 Components of Integrated Planning - examples on energy provision in rural and urban sectors

	Component	Component description	Situation in Rwanda	Assessment	
				Rural Centres	**Urban Households**
1	National priorities	Clarity on national priorities, and extraction/ specification of implications for energy sector. 'The national policy goal is to meet the energy challenges and needs of the Rwandan population for economic and social development in an environmentally sound and sustainable manner' [21]	Dual priorities emerge from Vision 2020 and the PRS: 1) the necessity for cheap, reliable energy to support economic growth; 2) to be produced through the combination of hydraulic potential and methane gas in order to preserve the environment. By 2020, 35% of the population should have access to electricity.	Rural economic growth stimulation and welfare are clearly articulated as a national priority. Agricultural production is particularly stressed, as this is considered to be a cornerstone to national economic growth.	Poverty alleviation is a core national focus and providing modern energy to households is an important component of this, as is stressed in the MDGs (the PRSP considers that poverty alleviation will come from small business and agricultural initiatives rather than from direct involvement with households).
2	Demand assessment – energy *services* focus.	Current needs of each sector understood – industrial, commercial, residential, transport, agricultural, community facilities (clinics, schools etc). Focus on energy *services* [22] rather than energy *sources* – i.e. "what energy *services* are required?", not "what energy *sources* are required?".	Key issues emerging around demand are: -reliable, adequate electricity supply for industry -biomass dependency of poor households -unaffordability of modern energy by most households -energy for productive uses in rural centres -energy for community facilities, particularly in rural areas (schools, clinics, etc) availability of transport energy in rural areas	The needs of rural areas are for improved education, health care, water supply, access to energy for cooking, access to electricity for income generating activities and support of economic growth. Some of these can only be feasibly supported by electricity supply, others by biomass.	The main needs of households are energy for cooking, and potentially adequate lighting. Other needs may be electricity for media and energy for refrigeration. Here one of the most critical issues is affordability – understanding what households can afford so that supply considerations can try and match household means.

[21] Energy Policy for Rwanda (Final draft) 2004.

[22] For example, by asking 'what energy services are required by the household?', the focus becomes matching the most appropriate energy source for each end-use, for example the most efficient way of lighting may be with solar systems, the most efficient service for cooking may be gas, solar for water heating, gas for refrigeration, solar for drying for income production, small current electricity for ICT and television. That is, there is an effort to meet each need with the most economically efficient service and diverse supplies. Although the answers will sometimes be the same for an *energy service* and an *energy source* focused approach (e.g. with industrial motive power and commercial lighting), in many cases the *energy service* approach allows for more creative, more economically efficient alternatives to the conventional solutions that policy-makers and planners often consider.

Table 2 Components of Integrated Planning - examples on energy provision in rural and urban sectors (cont.)

	Component	Component description	Situation in Rwanda	Assessment	
				Rural Centres	Urban Households
3.	Supply assessment	Various aspects are included here: 1) Technical and financial assessment of different supply options. Energy sectors are usually well-versed in this area. Although this is a demanding and important exercise, many planning processes ONLY consider this component in decision-making. 2) Potential efficiency improvements in existing supply-side – i.e. generation or production. 3) Ensuring resource sustainability – particularly regarding biomass. 4) Considering technological developments and trends.	In general, supply-side initiatives appear to be consistent with national priorities and demand needs assessment. The East-African Scale-Up Initiative and other studies are in process around options in Rwanda such as: -urgent electricity generation capacity -Lake Kivu methane supply -peat exploitation -electricity line extension and upgrading -existing small hydro rehabilitation -small hydro potential development for on- and off-grid supply -efficient charcoal production technology There appears to be insufficient afforestation to meet demand for biomass	1) Technical and financial assessment of different supply options are necessary, including: a. Electricity supply options: rehabilitation of existing hydro plant, mini-grids, national grid extension. b. Electricity connection options – such as electrifying community and processing facilities or including households c. Biomass supply options d. Other options	1) Technical and financial assessment of different supply options are necessary, covering: a. Electricity supply options: connecting households, considering access costs and appliance supply. b. LPG and/or methane for cooking, and potentially refrigeration.
4	Demand-side option assessment	Technical and financial assessment of efficiency opportunities in industrial, commercial, agricultural, transport and residential sectors.	Given the importance of DSM, it is not clear that efficiency potential in all sectors has been adequately mapped and opportunities identified. There is clarity in some sectors: -Industrial energy efficiency: It is recognised that there are opportunities for improvements in this sector, as plants are usually outdated. -Efficient stoves for households to reduce biomass requirements (charcoal and biomass) – as well as improving emissions. -Electricity tariffs are being explored which promote efficiency and maximum demand reduction.	Although there is no existing supply where efficiency could be improved to displace supply options, there may be options to include demand-side considerations to improve overall project impact	Since the focus here is on replacing traditional energy sources with modern energy sources, demand-side consideration are of limited relevance.

Table 2 Components of Integrated Planning - examples on energy provision in rural and urban sectors (cont.)

	Component	Component description	Situation in Rwanda	Assessment	
				Rural Centres	Urban Households
5	Externality costing or weighting	Externalities to be considered are broad-ranging: -Emissions impacts on human health (generation, transport and indoor fuel burning) -Deforestation and land degradation from biomass harvesting -Economic growth impacts from adequate energy supply -Energy sector impact on forex reserves -Education, health benefits from electrification -Welfare benefits of adequate household supply, particularly of poor -Benefits of improved transport fuels, including mobility of poor -Energy infrastructure environmental impact Global emissions impacts	Although there is generally no structured way in which externalities are factored into energy planning in Rwanda, the government is conscious of a range of externalities linked to energy provision, particularly: -land degradation due (partly) to fuel wood harvesting -indoor air quality in poor households -economic growth support by energy supply to industry -economic and forex benefits of exploiting local resources -rural development support via electrification of rural centres -ICT benefits -potential for ecosystem destruction in peat harvesting	Externalities to be considered: 1) Indoor air pollution – small benefit, and only if households connected to elec 2) Woodland denudation – small benefit 3) Poverty – medium benefit (depending on economic stimulus) 4) Improve education – medium benefit 5) Improved health care – medium benefit 6) Improved water provision and treatment – medium benefit 7) Energy for rural productivity – **high benefit** 8) Access to modern energy for households – **high benefit** (if households connected and elec affordable) Increased use of local energy resources – Medium benefit (if local hydro generation used)	Externalities to be considered: 1) Indoor air pollution – **high benefit** 2) Woodland denudation– **high benefit** 3) Outdoor air pollution - small benefit 4) Poverty – **high benefit** 5) Improve education – medium benefit (light for studying) 6) Access to modern energy for households – **high benefit**
6	Security of supply	Risks & uncertainties, energy security issues are also important factors in decision-making.	In the face of recent hydro-station under-performance due to water shortages, Rwanda is aware of the need to enhance security of supply, largely by: -developing local energy resources more fully -regional electricity interconnection	Reliability issues may need to be considered with decentralised generation	This is unlikely to be an important issue for households

Table 2 Components of Integrated Planning - examples on energy provision in rural and urban sectors (cont.)

	Component	Component description	Situation in Rwanda	Assessment	
				Rural Centres	Urban Households
7	Institutional aspects	Since energy is a 'necessary but insufficient' factor in development, maximising the impact of energy initiatives typically involves coordination with other developmental initiatives.	In Rwanda the greatest institutional coordination challenges may be around the following: -coordination around woodland degradation including sectors such as energy, agriculture and environmental protection -transport planning and energy supply rural development initiatives	Since energy is a 'necessary but insufficient' factor in development, maximising the impact of energy initiatives typically involves coordination with other developmental initiatives.	Technical, administrative and customer service aspects may need to be considered.
8	Integration and plan clarification	Central to this component is an adequate system of considering financial supply – side and demand-side intervention information with externalities in a framework which supports national priorities.	There appears to be no structured way of doing this at present, and while many factors have been taken into consideration during the course of energy policy development and Scale-Up Initiative interventions, these are typically not in a consistent framework, and therefore prioritisation of interventions may sometimes be confusing.	It is clear that the externalities are potentially very beneficial in some of the key national priority areas. But benefits are partly dependent on the nature of the potential economy in the focus area and whether it will benefit significantly from energy supply, as well as whether households are included in the energy supply plans for the area. The above illustrative exercise suggests that benefits are such that it is worth allocating resources to the project even where financially not feasible. The benefits would also depend on feasible supply options, as small solar PV electrification options would vary significantly in potential benefit compared with full-scale grid electrification, for example.	The benefits of the energy interventions are likely to be high, and directly in support of MDGs and national priorities. Yet the supply-side assessment is likely to show costs as high, probably unaffordable to the poor. Even if Gas or electricity were available, it must be realised that the poor will probably continue to depend on biomass for cooking, which will reduce the air quality and sustainable biomass harvesting benefits of the intervention. But the nature of the benefits of the poor switching to healthier more convenient fuels are such that it may support a case for a free basic energy policy.

Including externalities in integrated planning

An inclusive least-cost energy service methodology, which compares the direct financial costs *and* indirect costs (externalities such as poverty and environment - indoor air pollution, deforestation, the safety of particular household fuels, and perhaps carbon dioxide emissions) of implementing one option with the direct financial costs *and* indirect costs of other options, is what is needed. There are few precedents of such comprehensive and appropriate instruments which enable planners to consider the impact of one set of choices rather than another on the economy as a whole without engaging in extensive research and modeling exercises. In developing and implementing such an inclusive approach, Rwanda would provide a ground-breaking model for other African countries.

The problematic part of the model is attributing values to externalities. Where financial values have been calculated (however precariously), these may be used. Where financial values are not available, the paper attributes subjective weightings to the externalities in order to illustrate how the method may be developed.

For example the costs and benefits of environmental and poverty considerations could be valued like this:

Table 3: Environmental/Poverty economic costs/benefits rating

Impact, consideration of role of energy in problem or benefit	Economic least-cost implications
Very positive	Interventions to pursue important, even in the face of significant financial cost
Positive	□
Slightly positive	□
Neutral	Financial considerations mainly determine least- cost
Slightly negative	Λ
Negative	Λ
Very negative	Interventions to ameliorate important, even in the face of significant financial cost

Table 4: Matrix of economic cost significance of energy & poverty interventions on environment

Issue	Poverty economic cost/benefit	Environmental economic cost/benefit	Potential intervention areas
Indoor air pollution	High cost	High cost	Access to modern fuels Efficient stoves Education
Woodland denudation	High cost	High cost	Afforestation Access to modern fuels Efficient stoves Efficient charcoal production Education Coordination with other sectors
Outdoor air pollution	Small cost	Small cost	Access to modern fuels Transport vehicle standards Cleaner fuels Efficient vehicles
Poverty – food/energy security, drudgery, convenience	High cost	Neutral	Afforestation Access to modern fuels
Inadequate and unreliable energy supply for industry	High (indirect) cost	Unclear	Adequate electricity supply capacity Reliable supply DSM in industry
Improve education	Medium benefit	Medium benefit	Electrification of rural schools Household access to electricity
Improved health care	Medium benefit	Small benefit	Centralised or decentralised electrification of rural health facilities
Improved decentralization of services	Medium benefit	Small benefit	Electrification of Districts /sector offices
Adequate transport energy	Medium benefit	Unclear	Link with transport planners around fuel distribution in rural areas Adequate public transport Efficient engines
Improved water provision and treatment	Medium benefit	Medium benefit	Electrification of rural centres
Energy for rural productivity	Medium benefit	Neutral	Centralised or decentralised electrification of rural centres Link with transport planners around fuel distribution in rural areas
Access to modern energy for households	High benefit	High benefit	Access to modern fuels (LPG, electricity)
Increased use of local energy resources	Medium (indirect) benefit	May have environmental cost	Lake Kivu methane Peat harvesting Landfill energy

The above are suggested prioritisation criteria. Government and others involved with the energy sector would need to modify these according to their knowledge of the sector. The above, however, does not take into account the financial and other aspects of decision-making, but rather provides the means of weighting the poverty and environmental externalities in the overall

integrated assessment, and gives an indication of how they should be weighted against financial and other criteria.

Through the application of such a framework it becomes clearer where resources should be allocated for optimal national benefit. Since the financial viability of a particular development route may be substantially different to the economic viability, the application of subsidies, incentives or levies can be considered to address such differences. This framework can guide such allocations. Further discussion on this topic is, however, beyond the scope of this document.

5. Planning for least economic cost

Least-cost methodology

Policy-makers and planners inevitably need to make decisions around the implementation of a range of possible options to meet various energy needs. Much of the time these decisions aim to achieve the necessary supply solution for least financial cost.

'Financial' vs 'economic'

Historically, least-cost assessments have tended to be mainly financial – where only direct financial costs and revenues involved with implementing a particular option are considered and compared with direct financial costs and revenues of other options based on market prices alone. While such assessments may be adequate for optimising financial returns for investors, limiting assessments to financial considerations is not appropriate for government, which needs to consider the impact on the economy as a whole, and indeed the country as a whole.

Theoretically, decision-making on projects revolves around the NPV and benefit-to-cost ratio. In general, economic analysis considers as many costs and benefits as possible from the national viewpoint, whereas the financial analysis considers only those relevant to the 'project owner'. In this way the allocation of resources is optimized for maximum benefit. However, an economic analysis can only direct the allocation of resources appropriately if all positive and negative impacts of the project can be 'internalised' in some way. Although some progress has been made in the quantification of impacts in a more disaggregated way (such as shadow pricing of forex and labour, and impacts on health of emissions), some remain qualitative rather than quantitative, and therefore need to be factored into decision-making differently. Typically this is done as an 'after' exercise, but often has disproportionately little influence when compared with financial or more directly quantifiable economic criteria[23].

Dealing with externalities

In the last decade there has been increasing awareness of poverty and environment: factors such as indoor air pollution and deforestation when considering household energy supply, as well as safety aspects of certain household fuels, and, on a global level, carbon dioxide emissions. The consequences of these 'externalities' are recognised as significant, and incur real costs for society. Internationally there has been a steady trend to include some externalities in pricing in accordance with sound economic principles. For example the incidence of pollution taxes has

[23] A crude way of considering social externalities sometimes used is to adjust the discount rate used in the analysis to favour areas where greatest needs are known to exist, such as rural areas – known as a 'social discount rate'.

steadily increased in developed countries, and with help from the World Health Organization, developing countries have begun to count the cost of indoor air pollution. Various methods for quantifying externalities[24] are now in existence. However, particularly in a developing country context, many externalities remain difficult to quantify. Even the leading, multi-million Euro 'ExternE' project which aimed to quantify energy and transport externalities in Europe, could not shed light on the full range of externalities[25] and emerged with significant uncertainties in results for some externalities.

Developing countries particularly have tended to avoid 'internalising' even clearly quantifiable externalities in energy pricing, as the current traditional planning focus still tends to focus on lowest financial cost for a particular energy sub-sector (such as electricity) rather than lowest-cost for the economy. However, the consequences of this are in many cases serious, with environmental and social externalities costing the country dearly in terms of environmental degradation and exacerbation of poverty, amongst other costs. These costs need to be included in assessments in responsible policy and planning decisions if balanced development is to take place. Decision-making based largely on narrow financial criteria is no longer adequate.

Benefits accrued by energy sector interventions are also broader than is reflected by a simple financial cost-benefit analysis, and these too need adequate weighting in the analysis process. Subsidies for such beneficial options are a way of 'internalising' such benefits. The least-cost methodology discussed here provides a framework for such more inclusive, more socially, environmentally and economically responsible assessment.

There is a perception that inclusive assessments such as discussed here are complicated and vague, and consideration of what may be seen as 'soft' issues is best kept completely separate to such assessment processes. But it needs to be stressed that such assessments are dealing with nothing other than real costs, which if not clarified and included in the assessment, will nevertheless be incurred by society. Governments are responsible to see that national resources are guided to be of maximum benefit to the country as a whole. Assessments which extend decision-making criteria beyond just the direct financial are therefore essential.

Quantifiable and unquantifiable externalities

Broadly, costs and benefits can be categorised into three areas:

- *Direct financial costs and benefits* related to the implementation measure – these are usually easy to quantify, and mainstream economic assessments are well versed at dealing with them.
- *Quantifiable 'externality' costs and benefits* – these result from the implementation measure, but are not accounted for in the financial flows of the measure. For example, use of particular fuel in the household contributes to poor indoor air quality, which causes health problems, which can be quantified in financial terms by assessing the increased demands on the health system, child mortality through Acute Respiratory Infections (ARIs) and potentially lost productivity. Forex implications and job creation impacts of various

[24] Some such externality quantification methodologies are 'avoidance cost' and 'impact pathway' approaches.
[25] ExternE: 2003. *External Costs*. European Commission, Brussels.

decisions may also be quantified in this way, albeit with a significant level of uncertainty in many cases.

-*Unquantifiable 'externality' costs and benefits* – these are many, particularly for developing countries. Included here are benefits from facilitating improved education, from promoting mobility of the poor, and of reducing the drudgery and insecurity of poor rural household life, and, on the negative side, of systematic environmental degradation. Because they are difficult to deal with, they are often excluded from least-cost assessments, and may at best be listed as 'externality factors'. Not being able to quantify these costs does not mean they should be ignored, but it does raise questions about how they should be factored into a balanced least-cost methodology.

The above is not new, and has particularly been researched and clarified in many parts of the world over the past decade. In general, the energy sector in developing countries is still faced with many of the issues of a decade ago regarding externality assessment:

> *Three major challenges that face the planner who carries out a quantitative environmental analysis include: 1) the consideration of loadings or impacts that are difficult to quantify or generalize (for example, ecological damage, soil degradation, and aesthetic impacts); 2) large uncertainties in relationships between loadings and damages; and 3) the comparison across seemingly incommensurate impacts (such as balancing human health, ecological, and economic costs and benefits). ... The danger of biasing energy choices towards these options whose environmental impacts are most difficult to assess or quantify – "confusing the countable with the things that count" – must be avoided.*[26]

Yet least-cost assessments remain far from a precise science, and accounting for externality factors inevitably needs to adopt a broader perspective than a purely quantitative one. This paper makes some suggestions in this direction.

6. Enabling factors for application of the least economic-cost energy planning that captures the poverty-environment concerns

Policy environment

In general, the policy environment in Rwanda appears progressive, and the Energy Policy clearly identifies areas of focus in keeping with national priority areas, including alleviation of poverty, reliance of poor households on depleted biomass reserves, the need for a focus on rural development, and the need to support economic growth. However, as pointed out by one analyst, adequate policy is only one of the several important components that need attention:

> *The principal cause of policy failure in Africa, both in agriculture and the rest of the economy, has been the assumption that change of policy and its supporting legislation will be adequate to ensure a successful outcome of the reforms. No adequate attention*

[26] Lazarus M and von Hippel D, 1995. *A Guide to Environmental Analysis for Energy Planners*. Stockholm Environment Institute, Boston. (p7).

has been given to the acceptance of the reforms by the stakeholders, the organisational requirements for the reform execution, and the time needed to implement reforms.[27]

Institutional coordination

As integrated planning of any form makes clear, energy interventions are often part of a more complex solution to developmental issues. While the early energy planners thought that electricity supply would ease a range of household problems and lead to economic growth, for example, electricity now is recognised as a 'necessary but not sufficient condition' for development. Institutional coordination at various levels – policy alignment, strategy integration and implementation – is important for energy to adequately support sustainable development. This is recognised in Rwanda's PRSP.

Amongst the most important areas for such coordination are around transport, where infrastructure planning and urban planning are amongst the main drivers of implementation, and around biomass resources, where the sectors of agriculture, environment, and forestry are key players. Energy sector coordination with these functions often needs to be strengthened.

Impacting on rural development is a potentially complex challenge for government. Energy can support rural health, education, water supply, agriculture and general economic development, as well as facilitating government operations (electrification of government offices) and communications. Coordination is clearly important if rural development goals are to be furthered. Decentralisation of development planning and implementation, in keeping with the stated intention of the government, is also important in this regard, as local knowledge can make all the difference in choosing workable interventions. Some energy functions should also be decentralised accordingly.

Although energy is an important support for economic development, effective strategies to realise growth require a greater focus on access to markets, appropriate finance, and capacity building than on energy provision. Again the need for coordination is apparent if this suite of interventions is to combine in an effective way.

The challenges facing Rwanda to achieve sustainable development and meet MDG targets are significant. The country will need significant international support in this regard. CDM is an energy sector opportunity to draw on international funds, and it may be feasible to constitute methane exploitation from Lake Kivu, or solar water heater programmes in urban areas[28] as CDM projects. These and other CDM opportunities should be explored.

Institutionalising integrated planning

If energy is to help address poverty reduction and environmental degradation, and activities in other relevant sectors are to consider energy-related aspects, integrated energy planning needs to be institutionalised. But integrated planning, which covers the core areas necessary to promote

[27] Mule H, 2004. Institutions and their Impact in Addressing Rural Poverty in Africa. IFAD.

[28] In South Africa, a solar water heater programme in the low-income Kuyasa area near Cape Town has become the first gold-standard CDM project in the world, and has provided an example of how to engage with the CDM.

effective strategy, needs to be undertaken such that it matches existing government and energy sector capacity. Over-ambitious planning frameworks, potentially including modelling exercises and extensive data gathering, are generally ineffective as they are dropped after a short period, leaving the planning process back where it started. So it is important that Rwanda decide on the planning process they will undertake, bearing in mind the capacity constraints of the sector. This process should not lose any of the core components of integrated planning – the decision is rather around the level of detail and manner of engaging each component.

Institutionalising integrated planning generally requires some capacity building within government and other key players of the energy sector. The overall planning process would need to be driven by government, yet with strong participation by stakeholders, including sectors key to environmental and poverty issues. Institutionalising planning may be undertaken in different ways, but at its core is the need for it to become a formal responsibility of the Ministry of Infrastructure.

It is generally best to undertake a focused integrated planning exercise periodically. While integrated planning principles can be adopted in energy decisions on an ongoing basis, key aspects may be lost and important foci diluted over time unless a structured and reasonably complete exercise is undertaken periodically. Every 3 years may be a suitable period. A steering committee may then be set up to oversee the exercise, and should include all players with which coordination is important, as well as all players likely to be involved in, or affected by implementation. Ideally, civil society should be included, although it may be difficult to engage with adequately representative bodies in this regard.

It is advisable to review the prioritisation of externalities as a part of integrated planning, with a particular focus on poverty and environmental linkages with energy, as pointed out in this document.

Important decisions that need to be taken in the interim periods between planning exercises, such as around the implementation of specific projects or programmes, should use the IRP framework mentioned earlier. Objectives and methodology of IRP are entirely in keeping with integrated planning goals. IRP is not institutionally demanding, as it is normally undertaken by the utility or other party proposing a particular infrastructure development. Such players generally have fewer capacity constraints than government. Government's role is mainly to set the framework and parameters for the IRP exercise.

In addition to a more formalised integrated planning focus, it is important that the energy sector players participate in the decision-making processes of other key sectors such as transport, forestry, agriculture and urban planning. Important fora or processes in this regard should be identified and engaged with. This can be of equal importance as inviting these players to be part of the energy planning process, and it enables important feedback to the energy planners regarding the impact of interventions.

7 Conclusion

The impacts of the energy sector on social, environmental and economic sectors vary greatly. Many of the externalities, which historically have not formed part of mainstream decision-making in the sector, are substantial and the consequences of not considering them adequately can be serious for the national economy and for the welfare of the population in general. Amongst the most important of these are the ongoing dependence of the poor on steadily depleting biomass resources, and the health effects of emissions from indoor biomass use.

The Integrated Energy Planning framework presented here is a structured way to include these considerations, although the weighting of the externalities will need to be adapted by the Rwandan energy sector to suit national priorities. Although IEP is generally not applied as originally conceived in the late 1980s, the principles are recognised as a sound means of promoting efficient resource allocation, and have been widely included in national planning processes. A structured integrated planning framework needs to be adopted by the Rwandan energy sector, and needs to match the capacity within the sector to direct and undertake the process. Within this, the environmental and poverty externalities need to take their appropriate place, and an indication of the impact of these externalities has been given in this document, quantified where possible, to assist the energy sector in determining their true significance. This shows that some of the externalities have huge consequences for the country, and need to be given concomitant weighting in decisions.

A further important consideration around the planning process is that key players from other sectors need to be involved in the process, and the energy sector also needs to ensure that they are involved in appropriate fora in sectors such as transport, urban planning, forestry, agriculture and rural development. The energy sector primarily exists to provide services to these and other sectors, and for this reason it is difficult to do this in the best national interest without closer coordination.

Integrated planning, and placing appropriate emphasis on environmental and poverty-related externalities in particular, will ensure that energy interventions support the MDGs and other national priorities as far as possible. In Rwanda, where energy, poverty and the environment are so intimately linked, such integration is of added importance in sustainable development.