Intelligent Energy Europe

COOPENER

DEA

Development and Energy in Africa

Project Summary

RISØ DTU ECN

KITE MFC TaTEDO CEEEZ Centre for Energy, Environment and Engineering Zambia Limited

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Abstract

This Project Summary Report refers to the COOPENER project "Development and Energy in Africa (DEA)" initiated on 1 May 2005. The 30-month project was implemented by Risoe National Laboratory (Technical University of Denmark – DTU[1]), Denmark as project coordinator, in collaboration with the Energy Centre of the Netherlands (ECN), and in partnership with six African Centres:

- Botswana: EECG
- Ghana: KITE
- Mali: Mali Folkecenter (MFC)
- Senegal: ENDA-Energy
- Tanzania: TaTEDO
- Zambia: CEEEZ

The overall objectives of the project were:

- that national energy policy is better informed to take into account the complex linkages between energy interventions and social and economic development, and
- that energy interventions are better designed to contribute to real development needs, especially poverty alleviation and income generation, and otherwise achieving the Millennium Development Goals.

The immediate objectives of DEA were:

- to establish and apply an Assessment Framework for evaluating development and poverty impacts of energy interventions, and

to engage in a dialogue with energy policy makers and other stakeholders on the basis of the framework, with a view to incorporating these issues in energy policy.

DEA comprised three initial components (Stakeholder Consultation, Literature Review and Energy Project Catalogue) which formed the basis for the development of the Assessment Framework. The Assessment Framework was subsequently applied and tested in Case Studies by the six African partner centres. This project summary describes how these five components were undertaken, leading up to the findings of the case studies and the presentation and discussion of the methodology among stakeholders from the involved six countries and others from further afield in Sub-Saharan Africa at a final Regional Workshop.

The technical outputs of the project are available for download at the DEA website: www.deafrica.net.

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Cover: Solar Home System installed at a rural house near Chipata, served by CHESCO, Zambia, photo Gordon Mackenzie

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Preface

Development and Energy in Africa (DEA) is a project under the European Commission's Intelligent Energy - Europe programme COOPENER. Ultimately DEA aims to "support decision makers with the implementation of more sustainable energy policies, …" in line with the key action VKA 11.1 of the COOPENER programme. The project will do this by identifying and quantifying, where possible, the elements of concrete energy interventions that contribute to sustainable development (SD) and systematising this in an Assessment Framework which can enhance policy to promote energy for sustainable development.

The principal aims of the Development and Energy in Africa (DEA) project are (i) to identify and examine the developmental impacts of energy innovations and actions linked to improving energy access and poverty alleviation and (ii) to use the information obtained to improve on-going and future energy interventions through the energy policy makers and institutions in the countries concerned.

Specific energy activities in six African countries (Botswana, Ghana, Mali, Senegal, Tanzania and Zambia) will be examined with respect to development impacts and a methodological framework developed to feed results back into the conception and design of new projects. The Project is aimed at national energy- and development-policy makers, initially in the six participating African countries, but with a view to wider application in Sub-Saharan Africa. The project is also relevant for international and national energy, development and environment practitioners.

1 Introduction

1.1 Background

Access to energy is an essential input in the process of development and poverty alleviation. Better understanding of development-poverty-energy linkages, and embodiment of this knowledge in an operational tool, can contribute to increasing the development and poverty alleviation impacts of energy interventions.

Development and Energy in Africa (DEA) was a project under the European Commission's Intelligent Energy - Europe programme COOPENER which ran from 1 May 2005 until 31 November 2007. DEA aimed to "support decision makers with the implementation of more sustainable energy policies, …" in line with one of the key actions of the COOPENER programme. The DEA project did this by identifying and quantifying, where possible, the elements of concrete energy interventions that contribute to sustainable development (SD) and systematising this in an Assessment Framework which could enhance policy to promote energy for sustainable development.

1.2 Objectives

The principal objectives of the Development and Energy in Africa (DEA) project were

(i) to identify and examine the developmental impacts of energy innovations and actions linked to improving energy access and poverty alleviation and

(ii) to use the information obtained to improve on-going and future energy interventions through the energy policy makers and institutions in the countries concerned.

The project targets national energy- and development-policy makers, initially in the six participating African countries (Botswana, Ghana, Mali, Senegal, Tanzania and Zambia), but with a view to wider application in Sub-Saharan Africa. The project is also relevant for international and national energy, development and environment practitioners.

These objectives were targeted towards six Sub-Saharan countries: Botswana, Ghana, Mali, Senegal, Tanzania and Zambia, although the results of the project are applicable in principle to other African developing countries, and indeed other regions.

The objectives of DEA are in line with those of a number of activities in the area of energy and development initiated in connection with the Johannesburg WSSD in 2002, in particular, the aims of the EU Energy Initiative. A specific role of the DEA project in the six participating countries has been to engage with stakeholders to identify and quantify development impacts of energy interventions, in parallel with a methodological development carried out by the project partners.

1.3 Project design

A central concept in the DEA project design from the outset was that the analysis, the methodological tool and the examples should be based on the latest experience in the field

of outcome and impact analysis and on the expressed needs of the African stakeholders. The target energy interventions were also limited in scope, in order to focus the work, to small and medium-scale energy projects. The latter consideration was also consistent with the origin project idea as a "spin-off" from the UNEP "African Rural Energy Enterprise Development (AREED)" programme.

Figure 1.1 illustrates the original concept, whereby three activities (Work Packages), comprising the Literature Review, the Catalogue of in-country energy projects, and a series of Consultations with stakeholders, feed into, or inform the construction and development of the (Preliminary) Assessment Framework, or PAF. This Framework or methodological approach would then be applied and tested in a number of Case Studies, chosen from the projects in the Catalogue.

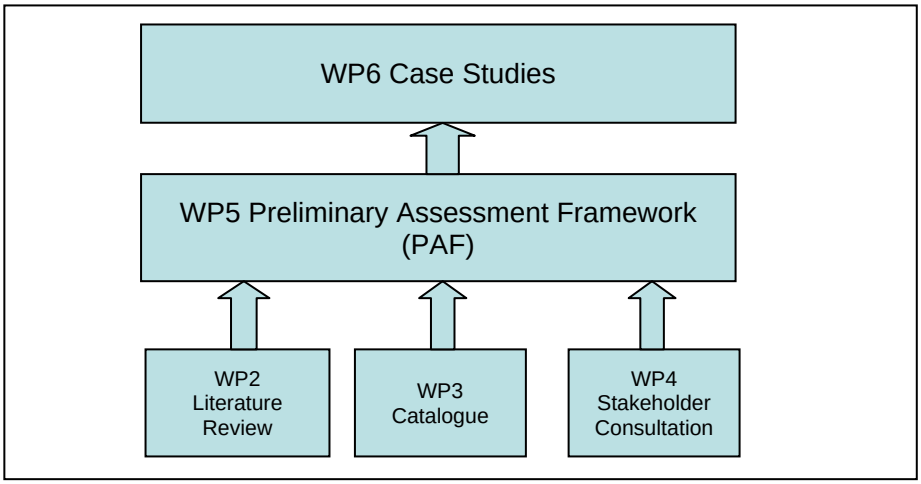

Figure 1.1 The original project concept: WP2, WP3, WP4 lead to the PA, which is applied to the Case Studies.

The results and experience gained in the case studies would then inform a round of refinement of the methodology, resulting in a final Assessment Framework. The schedule for this sequence of activities is illustrated in Figure 1.2.

Towards the end of the project, the subject would be opened for presentation and discussion among a wider group of African stakeholders from countries beyond the initial six: Botswana, Ghana, Mali, Senegal, Tanzania and Zambia

In practice, the project ran essentially according to schedule, apart from some minor delays due to staff changes. This idealised set-up was however modified in the light of other developments, in particular linkage with a parallel activity: the International Monitoring and Evaluation for Energy and Development (M&EED) Group established by GVEP, EUEI, UNEP, DFID, GTZ and other institutions) which was developing a procedure for monitoring and evaluation of energy projects.

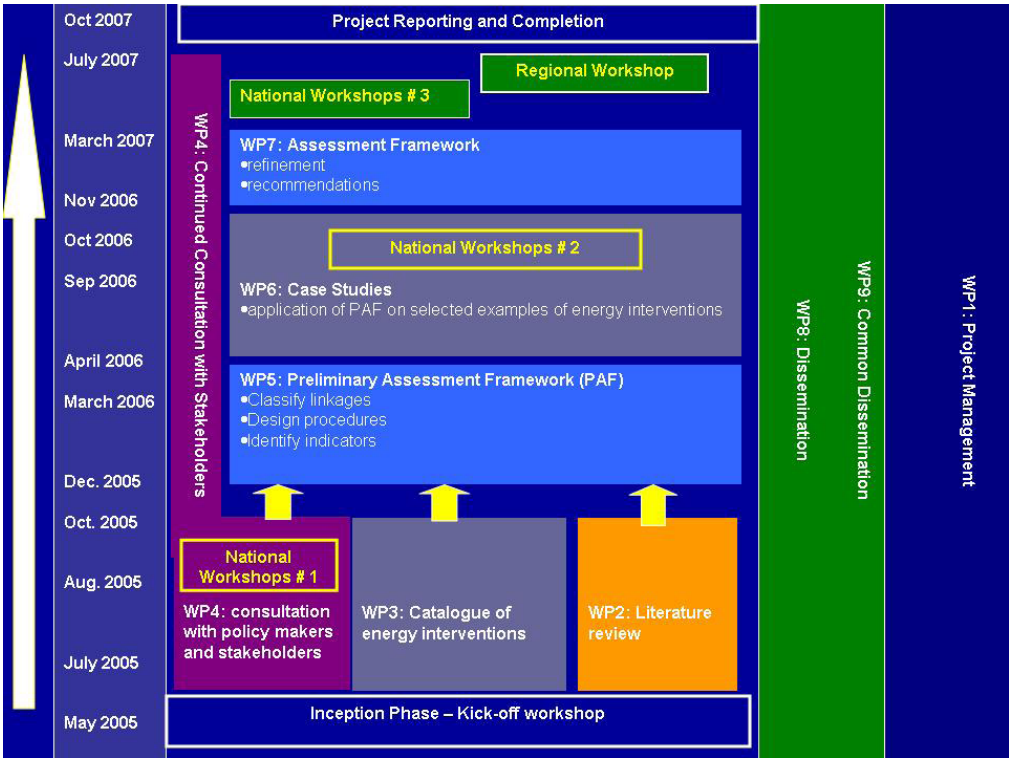

Figure 1.2 Original schedule of work packages, showing timing of National and Regional workshops

While DEA's Assessment Framework is still informed by the three "pillars", the strictly sequential structure was no longer necessary. In particular, convergence on a 4-level causal link approach (described in Chapter 5) as the most promising methodology has meant that the PAF (WP5) and case study preparation (WP6) was able to progress without the completion of the Literature Review (WP2). The methodological development became essentially integrated with that of the M&EED group, as illustrated in the modified project concept in Figure 1.3. The Literature Review component then took on the status of a project output in its own right, rather than an intermediate step towards the PAF.

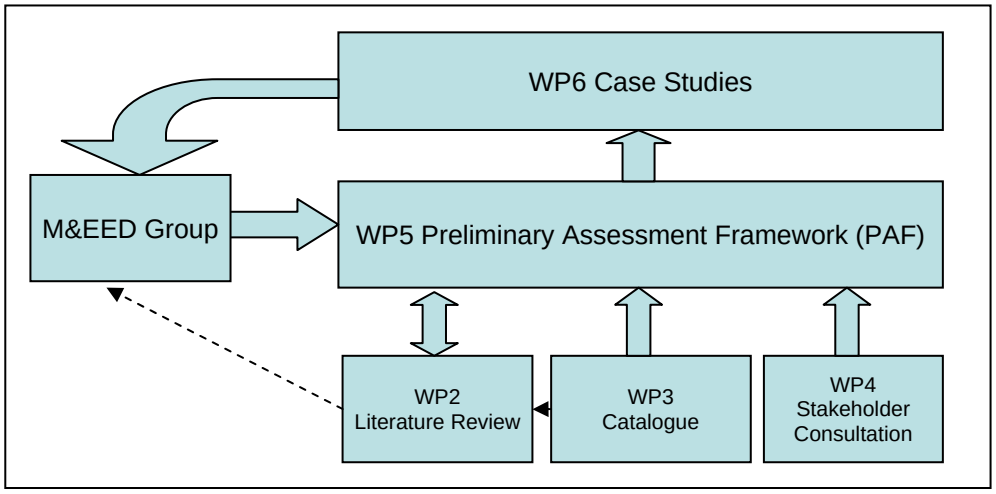

Figure 1.3 Modified project concept: integration with M&EED

The Stakeholder Consultations, Catalogue and Literature Review are described further in subsequent chapters, leading on to the discussion of the Assessment Framework and its application in the Case Studies.

1.4 Project partners

The DEA project team arose out of two activities, both facilitated by UNEP: The AREED[1] programme referred to previously, and GNESD[2]. While there was an interest among the five African AREED partners to develop a parallel activity, investigating the development impacts, at the same time the "Northern" GNESD partners were finding collaborative opportunities. Thus, Risø, ECN and the five AREED Centres, plus a sixth African Centre (EECG from Botswana which has had close collaborative relations with both Risø and the AREED Centres) came together to form the DEA project team and to develop the DEA concept. The concept fitted well with the COOPENER key issues, and a proposal was submitted, with the necessary co-financing available from the core funding of Risø and ECN. Essentially this meant co-funding by the Governments of Denmark and the Netherlands, respectively.

The DEA project team thus comprised:

Risø (Energy for Development)	Formerly Risø National Laboratory, since 1 January 2007 part of the Technical University of Denmark, called Risø DTU – the National Laboratory for Sustainable Energy www.risoe.dtu.dk – based at Roskilde, Denmark. Also host of the UNEP Risø Centre www.uneprisoe.org and the Secretariat of GNESD www.gnesd.org . Risø Energy for Development (EfD) is a collaboration between the UNEP Risø Centre and the Wind Energy Department.
ECN (Policy Studies)	Energy Research Centre of the Netherlands, Policy Studies www.ecn.nl/en/ps/
EECG	EECG Consultants Pty, Ltd – a consultancy based in Gaborone, Botswana
KITE	The Kumasi Institute of Technology and Environment (KITE) is a non-governmental organisation based in Accra, Ghana. KITE specialises in environmentally sound technical solutions and related policy interventions for Sustainable Development. http://kiteonline.net/
MFC	Mali Folkecenter, a non-governmental organisation based in Bamako, Mali http://www.malifolkecenter.org/
ENDA	ENDA-Energie, a non-governmental organisation based in Dakar, Senegal http://energie.enda.sn/

[1] AREED – The African Rural Energy Enterprise Development programme, www.areed.org - The United Nations Environment Programme's Rural Energy Enterprise Development (REED) initiative operates in Africa as AREED to develop new sustainable energy enterprises that use clean, efficient, and renewable energy technologies. These new enterprises can meet the energy needs of under-served populations while reducing the environmental and health consequences of existing energy use, particularly low quality biomass fuels such as wood and dung. The African partners in AREED are KITE, MFC, ENDA, TaTEDO and CEEEZ – five of the six DEA partners.

[2] GNESD – The Global Network on Energy for Sustainable Development, facilitated by UNEP, one of the so-called Type II initiatives formed after the WSSD in Johannesburg. www.gnesd.org , of which Risø and ECN are members, as well as ENDA.

TaTEDO	The Tanzania Traditional Energy Development Organisation, a non-governmental organisation based in Dar es Salaam, Tanzania www.tatedo.org
CEEEZ	CEEEZ - Centre For Energy, Environment and Engineering Zambia Ltd – a non-governmental organisation based in Lusaka, Zambia

1.5 Workshops

Workshops have become a somewhat maligned concept within development circles for a number of reasons. There is no doubt that the phenomenon of "workshop overkill" exists, whereby stakeholders in developing countries spend inordinate amounts of time attending workshops, while the essential business of actually doing the work receives lower priority. It is also common that a high level of participatory activity is reached during workshops, but the follow-up actions seldom materialise. Other potentially negative factors surrounding workshops are the question of continuity of participants attending a series within a project, and the correct assignment of participants according to the workshop topic, and institutional priorities.

With a long experience of workshops in Africa, the project team approached the scheduling and planning of workshops with considerable care, recognising the importance of bilateral consultations and informal meetings between project team and stakeholders in order to maximise continuity and impact of the project. Moreover, the DEA project was initiated shortly after the two EUEI Facilitation Workshops[3] in Ouagadougou (2004) and Maputo (2005), organised by Risø, in which all six African Centres had been involved, and multi-sectoral stakeholder teams from five of the six countries (Botswana was the exception) had participated. Building on the experience and teams from the EUEI workshops provided a sound basis for country involvement.

Three levels of workshop were held:

- Project Workshops: three in all during the project period, at inception, and before and after the case studies. Representatives of all project team institutions participated for 2-3 days, focussing on methodological development, preparation of the case studies, evaluation of the case study outcomes and the performance of the methodology, and preparation of the regional workshop. Workshops were held in Denmark (Risø), Zambia (Fringilla) and Mali (Bamako).
- National Workshops: three in each of the six countries, at beginning, middle and end of the project, focussed on stakeholder awareness, consultation and dissemination of the DEA approach and results. Generally the national workshops were organised and run by the appropriate country partner, though representatives of the EU partners also attended in most cases.
- Regional Workshop: The Arusha (Tanzania) Workshop was the final event of the DEA project. The workshop's purpose was to present and discuss the results of the project in a broader context to stakeholders from the six target countries as well as from other African countries. A total of 57 participants including representatives of 16 African countries attended the workshop.

[3] EUEI Facilitation Workshops and Policy Dialogues http://www.e4d.net/euei/

In addition to the formal workshops, a number of *ad hoc* meetings were held between members of the project team, utilising various opportunities, and country teams eng aged policy makers and stakeholders bilaterally as appropriate.

1.6 Achievements and Milestones

The main achievements of the project were:

- A Catalogue of energy interventions – representing an overview of projects which could provide relevant case studies. In addition the experience gained in specifying and establishing a catalogue of energy projects will be of great use in future activities. A specific lesson learnt in this respect was the importance of recording the operational status of the project, which was otherwise taken for granted.
- A Literature Review on assessment of impacts of energy projects. The review, although originally intended as an input to the methodological development, represents a stand-alone reference work on the subject of monitoring and evaluation and impact analysis of energy projects.
- Consultations with African stakeholders – identifying needs for impact analysis, links between centres and policy makers, and inter-sectoral involvement in discussing energy and development
- Development, testing and documentation of an Assessment Framework
- Case Studies: selected from the country catalogues, carried out following the Assessment Framework, documented and summarised in a Synthesis Report
- Presentation to wide selection of African stakeholders from 16 African countries, at a 3-day regional workshop, identifying needs for further dissemination.
- General: Involvement of African partner centres in methodological development and liaison with national stakeholders, capacity enhancement on monitoring and evaluation (M&E) and impact assessment (IA) in the 6 centres

The project partners suggested a number of "lessons learnt", all based on their own experience in the implementation of the project. Summarizing and consolidating these, the three main lessons learnt are:

- In spite of limited resources for the case studies, the DEA methodology was able to identify and document key features of the impact of energy projects.
- The approach and case studies reawakened an interest in M&E among African stakeholders but also indicated the need to further develop, operationalize and disseminate the approach.
- The importance and benefits of working as a team (EU and African partners) in developing and applying the methodology, which resulted in a real sense of ownership, and allows a more convincing dissemination of the methodology to stakeholders. The prime example of the teamwork was manifested in the 2nd Project Workshop in Fringilla, Zambia.

The following chapters in this Project Summary outline the main components of the DEA project, beginning with the three preliminary activities in Chapters 2, 3 and 4: Stakeholder Consultation, the Catalogue of Projects, and the Literature Review. Subsequently, in Chapters 5 and 6 the Assessment Methodology is described in the form of a summary of the

Assessment Procedure Guidelines and the Case Studies presented, illustrating how the Assessment Framework was applied in the six countries. Finally, the Conclusions of the project are presented in Chapter 7, highlighting the achieved results, lessons learned and the way forward in applying the assessment framework procedure.

2 Policy makers' needs

2.1 Introduction

The consultation phase of DEA along with the Literature Review and the Catalogue of Energy Interventions is designed to inform the development of the Assessment Framework. The consultation process thus engages with national policy makers and stakeholders regarding the relationships between energy innovations and sustainable development, and aims to extract opinions on the needs for an Assessment Framework and on how such a "tool" could contribute to the energy and development process. Although the main objective was to obtain information for input to the Assessment Framework, the consultation process continued throughout the project to keep policy makers and stakeholders informed and to ensure that the project was in line with national needs. The Consultation component includes a set of National Workshops early in the project period to involve stakeholders in the process. This involvement is backed up by informal contacts and consultation, primarily by the African Centres.

The set of National Workshops in the six countries was held between 1 September and 10 October 2005 and proceedings are available on the DEA website www.deafrica.net. In general the workshops achieved their purpose in bringing together a small group of relevant stakeholders to discuss the objectives and methods of the DEA project, and most importantly to gather the views of stakeholders on the links between energy and development and the need for improving the monitoring and assessment of impacts.

Supplementing the set of national workshops, the six partner centres conducted rounds of bilateral consultations with stakeholders, both before and after the workshops. The results of these consultations, together with the deliberations at the workshops, have been compiled by the country team. The viewpoints and issues reported below are primarily extracted and summarised from these country reports and therefore the contribution of the six centres is acknowledged.

2.2 Key issues

A number of common issues emerged from the consultation process, along a few issues which were specific for certain countries, or the particular set of stakeholders present. An attempt has been made here to capture the essential content of the process, bringing out issues which have a bearing on the development of DEA's Assessment framework, the use to which it may be put, and indeed the potential users.

2.2.1 Awareness of energy-development linkages

There is a general appreciation in all the participating countries, at least in the energy sector, of the importance of energy as an input to development. Nevertheless there are barriers

against this importance being incorporated in the policies and programmes of other sectors. There needs to be a broader appreciation of how energy feeds into the development process, not just as a provider of immediate services. Therefore, the causal links between energy and development have to be better understood, communicated and explained. This greater awareness of energy-development linkages, promoted by documented examples and analysis, could be catalysed by the DEA project. In addition, stakeholders indicated that there should be more awareness of energy-development issues at local government level.

2.2.2 Inter-sectoral coordination

An important barrier against energy fulfilling its role as a key developmental input is the poor coordination between sectors in some countries. Better coordination is needed between sectoral institutions, ministries, etc. with regard to policy and budgeting. This would enhance the drive toward greater awareness of energy-development links and encourage more effective use of energy investments. While the DEA project cannot establish inter-sectoral links alone, the existence of the project, in particular building on inter-sectoral group of stakeholders can facilitate an increased awareness and provide evidence of the causal links and possible advantages of more coordination.

2.2.3 The Assessment Framework

The need for Impact Assessment (IA) and Monitoring and Evaluation (M&E) was widely recognised, though it is admitted that they are often not carried out. In some cases there can be a resistance against M&E, especially carried out by external parties. These concerns can be allayed by ensuring ownership and participation by the local institutions, and awareness that the object of assessment is the development impact of interventions and projects, not necessarily the immediate project implementation. With regard to the latter, it assumed that this would normally be an internal function for the individual project while IA (the domain of DEA's AF) goes further and focuses on the longer-term development effects.

Ownership of the procedure (the AF) is important, i.e. who is expected to be the main user of the tool. Issues to be addressed include where the tool is based, for example at the Ministry of Energy or equivalent, participation of other stakeholders, participation and involvement of beneficiaries to the intervention. In this regard, the assessment tool and indicators have to build on local realities and be holistic. On the other hand, the AF does not necessarily have to be a new tool. We should avoid "reinventing the wheel". At the same time, it has to borne in mind that the AF (or DEA) cannot solve all (or any) problems but is merely a catalyst within a process. The important aspects of the process are:

- coordination
- evidence of developmental impacts of energy
- documenting the energy-development causal links
- encouraging stakeholders and policy makers to look beyond the immediate objectives and assess impacts
- involving all relevant stakeholders throughout the process

2.3 Country reports

2.3.1 Botswana

Stakeholder consultations point to the need for energy access in rural areas

Consultation with development stakeholders in Botswana revealed that energy is well understood as a facilitator for both development and improving the quality of life of people in rural areas. In the rural context, the prevalent use of traditional fuels such as fuelwood is considered a threat to health through indoor air pollution and is a contributor to the depletion of woody resources. This calls for alternative energy sources to alleviate the situation.

The stakeholders also consider that transformation from backwardness in rural areas could be achieved among other factors through application of ICT facilities such as radios, televisions, telephones and computers as means of information dissemination and accessing information for informed decisions and improved performance.

Provision of modern energy sources in government institutions for lighting, water heating and powering of appliances facilitates delivery of services particularly in education, police and telecommunications centres/locations.

Energy in the rural areas is associated with saving of lives by powering the necessary clinic/hospital equipment e.g. in maternity wards and operating rooms where uninterrupted energy is needed thus reducing maternal mortality rates.

Energy is realized as crucial in improving productivity and efficiency. For instance rural water supply in Botswana is predominantly from boreholes and requires energy for pumping and distribution. The use and maintenance of diesel engines is recognized as limited in capacity and expensive, and therefore alternative sources of energy for such purposes are required.

Energy supply through the grid as part of rural electrification increases economies of scale in rural development sectors, which small supplies such as diesel generators cannot achieve due to their small-scale capacities.

The stakeholders however realize the threats posed by turbulence in fuel prices considering that all oil products are imported and the high level electricity imports now standing at 70%.

In overall terms, energy is seen as creating opportunities for development in rural areas particularly for the youths and for community participation, reducing drudgery and adding value to rural products if they can be processed.

Stakeholder Dialogue at workshop

Throughout the discussions, it was apparent that energy interventions are often driven by energy policy objectives and are implemented with minimum coordination with other development sectors. The same is true in “development sectors”, where projects were driven by immediate needs, e.g. for a school in a particular area. Here the consideration of the availability of electricity or water is a secondary planning issue. The reason given was that Ministries’ budgets are often not coordinated so that they can take account of projects from different ministries that could have a complementary or “leveraging” effect. For instance if rural electrification was targeted for some villages, and the Ministries of Education, Health etc would be ready to connect their institutions in those villages, this

would yield immediate positive impacts on development. Similarly, if the Ministry responsible for SMEs initiates entrepreneur development at the same time that the villages are being electrified, this could result in creation of business e.g. welding and hence improved employment and incomes in the villages. Stakeholders concurred that more institutional coordination is desirable for both energy and development interventions to make the desired impacts.

In summary, the deliberations of the stakeholders pointed to:

- Lack of institutional coordination in the design of either energy or development interventions.
- Lack of policy coordination among the development and energy sectors
- Uncoordinated budgeting that could enable leveraging of efforts in achieving development objectives.
- A project like DEA would not answer these issues but would be a vehicle that would bring stakeholders together in a dialogue to discuss how sectors could collaborate. When such collaboration (albeit informal) is established, issues of policy coordination and related budgeting would also be eventually achieved.

The stakeholders present felt that the Energy Affairs Division (EAD) should be the focal point for energy interventions under DEA and is thus better placed to coordinate other stakeholders to ensure that future energy interventions are coordinated with interventions of development sectors such as water, agriculture, health, education, wild life and tourism etc.

2.3.2 Ghana

All stakeholders acknowledge the importance of impact assessment in providing information on project impacts to guide policy formulation. However, impact assessments have not been integrated into the activities of the various institutions. Stakeholders also acknowledge that an Assessment Framework will be useful to their operations if it is designed to be simple, easy to use, and flexible and can be used within the existing resource and information constrains.

Policy Planning, Monitoring and Evaluating (PPME) units within the institutions generally lack the necessary human resource capacity to be effective. Consequently, the DEA project may need to include capacity building in basic principles of programme evaluation as well as training in the application of the Assessment Framework.

There is the general perception that project evaluations need to be carried out by an external entity reporting to a higher authority (e.g. project funders or government) on project performance. It is not seen as a tool for programme staff to know how their programmes are performing so that they can improve on them and build institutional capacity. This perception may pose serious challenges to the use of the Assessment Framework as staff may not be inclined to use the tool. In addition, Project staff may be reluctant to apply the framework for fear that failures may be exposed and their careers suffer as a result. It is therefore important for the DEA project team to emphasize the importance of the framework as a tool for staff to learn from the success and failure of their programmes in order to improve their own performance.

There are a number of external factors (e.g. political interference) that could affect programme performance which are not easily captured in an assessment study. Therefore

the framework should be able to identify the impact of such external factors on project performance.

Impact assessment should be participatory, involving beneficiaries, local authorities as well the national level institutions. It is usually the best way of assessing how the programme is related to community and local needs.

Most stakeholders make no distinction between the immediate outputs of a programme (e.g. physical infrastructure) and the long term outcomes arising from these outputs (development impacts). Since most of the interventions are project based, project evaluation seems more focused on the immediate outputs. This is reasonable since projects are expected to deliver certain outputs over a specified timeframe. However, the project-based approach does not give adequate priority to evaluating development impacts of interventions which are expected to occur in the medium to long term. Meanwhile, project staffs usually try to relate project outputs to development on the basis of limited information. A well functioning assessment framework would make it easier to relate project outputs to development impacts in a transparent and systematic manner.

2.3.3 Mali and Senegal

The workshops in the two Francophone countries, Mali and Senegal, were held in close succession. Similar messages emerged from the two workshops and these are merged in the following synthesis. Three types of message emerged from the consultations and workshops. These addressed the issues of

Perception: How the stakeholders perceive energy as a factor in development, as well as how they perceive the project (and how the project perceives the stakeholders?)

Approach: What will be the added value of DEA?

Caution: DEA is just a project and cannot address all the complex issues relating to energy and development so one should be cautious and not be tempted to over-sell DEA, etc.

Message # 1 (Perception)

Energy is seen as an agent of change. Stakeholders are in general aware, at least in principle of the linkages. However, energy needs to be looked at in a more holistic light beyond practical activities such as water hauling, provision of heat, food processing etc. This means more intersectoral coordination and collaboration is required, and an appreciation of energy feeding into development in many ways, rather than just providing the immediate energy service. In particular energy should be seen as an agent of social development and its impact on poverty reduction. This is an argument against terminating the energy-development causal link "too early" before the downstream effects are registered.

Message # 2

In spite of #1 (or maybe because of it) the causal links between energy and development are still unclear. There is a need for an assessment framework tool to measure the impacts of energy initiatives on development. The causal link between energy and development has not been accurately measured, though whether this is at all possible remains to be seen.

Message # 3:(Approach)

The assessment framework should seek to build from existing tools and evaluations rather than reinvent the wheel. The DEA Approach should seek to be holistic. This would mean looking at projects critically in order to evaluate the contributing factors for success and failure. In fact, we tend to learn more from failed projects than the successful ones.

Message # 4

The baseline has to be built on local realities. The assessment framework should take into account local realities with verifiable indicators especially since a number of development indicators are not reflective of contextual experiences of developing countries

Message # 5

The institutional ownership or anchoring (*in French: "ancrage institutionnel"*) of DEA would to a large extent determine its policy success.

Message # 6

Application is the key determinant of success. The tool is as good as its application.

Message # 7

It is important to build on the synergies – between national initiatives in different sectors as well as international efforts, such as GVEP, REEEP, GNESD, etc. The assessment framework or tool is important but the synergies between the different sectors should be an all-encompassing aspiration of DEA.

DEA should seek to exploit the cross cutting nature of energy as the latter is present in every productive sector.

Message # 8 (Caution)

The assessment framework is not enough to address the huge disparities between different social groups caused by energy poverty. DEA and its AF can at most be a catalyst or facilitator for increased national awareness of energy as an important development input, and in encouraging inter-sectoral coordination. Real progress requires real actions. DEA should guard against over-selling itself, or letting itself be perceived, as a solution to energy problems.

Message # 9

The quality of information available on energy-development impacts is severely limited. This means that the quality of processed information coming out of the AF has to be critically considered before feeding on to stakeholders. Success of DEA/AF depends on the quality of information that is fed to policy makers.

Key Questions:

- What (dissemination) strategy should DEA use to convey the message to policy makers?
- How accurate/viable would the assessment framework be?

- Why would this AF be different from the multitude of evaluation tools?
- How would we distinguish energy interventions at micro and macro level?
- Who would own the project from an institutional perspective?
- Who would be the main users of the AF?

2.3.4 Tanzania

National priorities

The overall national energy policy (2003) objective is to provide an input in the development process by establishing efficient energy production, procurement, transportation, distribution, and end-user systems in an environmentally sound manner and with due regard to gender issues.

Through the National Strategy for Growth and Reduction of Poverty (NGSRP), 2005, energy priorities are highlighted as:

- Liberalization of power sector
- Promotion of appropriate off-grid technologies and indigenous energy sources.
- Increasing the proportion of rural and urban population with access to electricity,
- Expedite implementation of power projects according to the power System and Rural Energy Master Plan and finalize restructuring of power sector reforms, including speeding up of energy sector reforms especially formation of Rural Energy Agency and Rural Energy Funds.

Policy makers' suggestions

Energy is an important input in the poverty reduction efforts and therefore there is need to link it with other development initiatives and opportunities. For this to happen, the awareness of decision and policy makers has to be raised regarding the importance of energy to other sectors (education, health etc.), and also capacities of non-energy sectors on how to integrate energy in development plans initiatives should be strengthened.

Energy poverty and the lack of services it can provide for cooking and heating, electricity and transport fuels continues to hamper development, particularly rural areas. Therefore the use of energy to provide these critical services that underpin the MDGs must be reflected in national policies, strategies and actions.

With biofuels becoming a worldwide competitive fuel alternative due to rising oil prices, there is an urgent need to realistically consider, model and measure the impact of biofuels on the global climate and environment, the global energy market and on sustainability, i.e. social, environmental and economic sustainability,

Emerging conversion technologies could make biofuel production cheaper, much more efficient (energy + GHG) and not dependent on single crop types. Hence energy policy must support long-term biofuel supply options and the related technologies.

Renewable energy systems provide a practical and substantial opportunity for decentralised energy sources to combat poverty through wealth creation, developing sustainable energy supplies and working towards meeting the MDGs.

Non policy makers' suggestions

A major barrier to the representation of energy needs in decision-making is that energy is not represented in district level government structures. Energy has to be seen as a key for social and economic development. Therefore a multi-sector approach with participation from the grassroots to national level taking into account sustainable development will have significant impact in provision of rural energy services and addressing poverty issues

Concerted efforts at all levels (village to national) geared towards increased access to modern energy services are needed in order to address the central goal of improving welfare and living standards of people, particularly, in rural areas.

The Ministry of Energy and Minerals should put in place effective mechanisms and capacity for disseminating information to stakeholders on energy policies, strategies, legal frameworks, and other energy initiatives.

An institutional framework for effective linkages between the Ministry of Energy and Minerals, regions, districts and grassroots need to be instituted in order to effectively address rural energy issues.

Local/grassroots participation in planning, assessment, and implementation of strategy to address sustainable energy challenges should be employed in rural energy initiatives and dissemination of best practices.

Incorporation of sustainable rural energy technologies aiming at improving the living standard of people should be facilitated at district and grassroots level development plans.

The Government should put in place an effective information, education, and communication mechanism to enable information flow from national level to community levels and vice versa.

2.3.5 Zambia

The following points have been extracted from the record of discussions at the First National Workshop in Zambia.

- There is a need for constant interaction between stakeholders and policy makers
- Provision of energy should target productive uses
- There should be a high level of involvement in the DEA process on the part of policy makers
- There is need for information on how energy interventions affect GDP, balance of payments, poverty alleviation, clean water supply to rural and peri-urban areas etc.
- All available units in Government should be used as channels of information to policy makers (e.g. units such as department of planning in the Department of Energy).
- The Ministry of Information should be involved in future consultations and workshops
- There is need to work with NGOs on the ground.
- There will be need for training and capacity building in the use of the DEA Assessment Framework

- Way Forward: Need for the increase in the number of stakeholders invited in the future workshops

2.4 Conclusions

Stakeholders at all the workshops displayed an overall enthusiasm for a project such as DEA that seeks to measure the causal links between energy and socio-economic development. Likewise, there is a recognised need for an appropriate tool that can accurately and authoritatively link energy to poverty alleviation.

The overall feeling is that energy projects need to be linked to other sectors and that DEA could help facilitate the process of looking at energy projects in a multisectoral manner through focussed groups such as multisectoral committees by working closely with partner institutions within a multidisciplinary framework.

There is general feeling that “policy matters” but participants feel that much depends on the quality of the information conveyed to policy makers and the manner in which this is done. Policy makers have the capacity to change the current status quo but we need to find ways of reaching them so that they can take on board key emerging findings emanating from the field. Policy maker and stakeholder involvement is seen to be very important, and a larger and broader involvement of policy makers should be encouraged in future DEA workshops.

DEA has set itself an important task. It needs to work very closely with all the partners and other stakeholders to reach its objectives and also find ways of ensuring that energy projects can be measured accurately in relation to developmental impacts. This goes beyond the lifetime of DEA so that the project should attempt to leave behind a process which can be continued by the involved stakeholders and institutions. In other words, the sustainability of the DEA approach is important.

3 Literature Review

The focus of the DEA project rests with *demand side impacts* of energy interventions. The project's literature study aimed *inter alia* to derive an impression of the extent to which theories can help us predict such impacts and where to look for such impacts. In very general terms, the energy *supply* sides in developing countries face two overriding problems. Firstly, there is a widespread production and use of traditional energy sources, which pose several types of problems. Secondly, the access to modern energy sources is very unevenly distributed (Barnes and Floor, 1996). Approaching development impacts from a demand side perspective one wants to keep in mind however, that what is specifically in demand is not fuels or access to energy sources. It is *the services that energy may provide*, such as lighting, cooking, space heating, or pumped water (Muleguetta, Dunnet, Khennas, and Rai, 2006).

In order to identify development impacts one would wish to understand *how end-users benefit from the access to such services*. For the latter purposes, this abbreviated introduction to the DEA literature study provides primarily a brief account of the rather comprehensive Sustainable Livelihoods Approach (to development impacts from energy provision). For further guidance as to where development impacts may be found, the second subsection of this chapter discusses studies that claim evidence of links between improved energy provision and the Millennium Development Goals. Finally, a commonly applied set of methods applied to substantiate development impacts are those that fall under "Impact assessments". That set of methods is the topic of the third subsection of this chapter.

3.1 Theories and models of linkages between energy and development

3.1.1 The sustainable livelihoods approach

The Sustainable Livelihoods Approach (SLA) represents a way of organizing, understanding and working with the complex issues surrounding poverty, which can be modified and adapted to suit local circumstances and priorities (Muleguetta *et al*, 2006). The framework can also be used as a tool for designing livelihoods evaluation as a conceptual framework for identifying influences and interactions as a 'checklist' for designing indicators of change; and as an aid to analyzing, understanding and structuring relevant data.

SLA has also been used extensively in development impact assessments of various sectors. DFID has developed a SL framework to see how these impacts can be enhanced by providing "empirical proof" of results and impacts of energy projects to the livelihoods of the poor. The aim of this section is to discuss how the Sustainable Livelihoods Approach (SLA) can be applied in practice in the assessment of energy sector interventions. In the words of Chambers and Conway (1992) "a livelihood comprises the capabilities, assets (stores, resources, claims and access) and activities required for a means of living". A livelihood is sustainable when it (i) can cope with and recover from stress and shocks; (ii) can maintain or enhance its capabilities and assets; (iii) can provide sustainable livelihood opportunities for the next generation; and (iv) contributes net benefits to other livelihoods at the local and global levels, in both the long and the short term. The central conceptual and methodological aspects of the approach are discussed below.

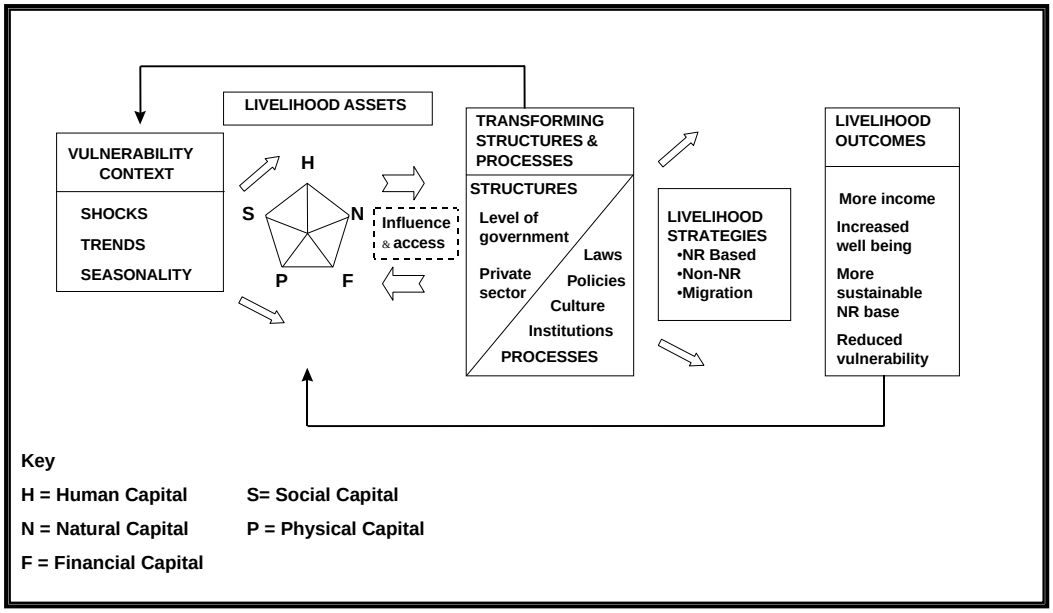

Figure 3.1 The Sustainable Livelihoods Framework

Key concepts and terminology

The theoretical model underlying the SLA assumes that each person/household in a community is able to achieve a *livelihood.* The model is illustrated in Figure 3.1 and each of its core concepts will be reviewed below. It is furthermore assumed that *livelihood resources* are available subject to a particular vulnerability context. Further, pertaining *institutions and processes* are thought to enable or constrain the achievement of sustainable livelihoods for different groups of people as they design their *livelihood strategies* which are subject to all of the above and yield *livelihood outcomes*.[4]

[4] In the practical application of the model it is also assumed that the achievement of sustainable livelihoods can be assessed through relevant "outcome indicators".

Livelihood assets/capitals	Description
Human Capital	Skills, knowledge, ability to labour and good health that together enable people to pursue different livelihood strategies and achieve their livelihood objectives.
Social Capital	Social resources upon which people draw in seeking for their livelihood outcomes: networks and connectedness. Social capital is often determined through birth, age, gender or caste and may even differ within a household.
Natural Capital	Natural resource stocks from which resource flows and services (such as land, water, forests, air quality, erosion protection, biodiversity degree and rate of change, etc.) useful for livelihoods are derived.
Physical Capital	Basic infrastructure and producer goods such as affordable transport, secure shelter and buildings, adequate water supply and sanitation, clean, affordable energy and access to information.
Financial Capital	Two main sources of financial capital can be identified: Available stocks comprising cash, bank deposits or liquid assets such as livestock and jewellery, not having liabilities attached and usually independent on third parties Regular inflows of money comprising labour income, pensions, or other transfers from the state, and remittances, which are mostly dependent on others and need to be reliable.

Table 3.1 Elaborations on the types of capital recognized in the Sustainable Livelihoods Approach

Livelihood resources

Livelihood *resources* are often referred to as assets or different types of 'capital'; natural, human, social, physical, and financial capital. An accurate and realistic understanding of people's strengths (i.e. their "assets" or "capital") is crucial to analyse how they endeavour to convert their assets into positive livelihood outcomes (Bebbington, 1999). Among the five categories of assets financial capital is probably the most versatile as it can be converted into other types of capital or it can be used for direct purchase (achievement) of livelihood outcomes. However, financial capital tends to be the asset least available for the poor, which makes other capitals important as substitutes. The different types of capital are discussed in more detail in Table 3.1 and presented below as applied to the role of energy in livelihoods generation.

The Vulnerability Context

In an energy setting the vulnerability context is represented by structural conditions that will set the conditions for energy requirements and opportunities. Such conditions identified in the literature relate to geography, population density, trends in governance and in technology, and to shocks.

Geography: The geographical context determines various aspects of energy access and availability e.g. the extent and form of the biomass resource, the availability of falling water, wind, insulation, and other sources of energy such as coal, oil, gas, geothermal energy. Geographical conditions will also affect both the choice of energy infrastructure such as pipelines and power distribution, as well as the cost of improving such structures.

Relative location or remoteness can add to the costs of all energy supply options but it can increase the relative attractiveness of renewable energy supply (such as micro-hydro and photovoltaic systems) relative to other options that require transportation of fuels. However,

for the latter options one should not overlook the cost of frequent visits from urban-based technicians required to maintain such systems.

Climatic conditions, which are derived from geographical location, determine the needs for energy end-uses such as space heating or cooling. The need for energy also fluctuates in relation to seasonality, which encompasses e.g. variations in temperature; agricultural seasons and availability of raw materials. Transport-dependent costs of installing and maintaining infrastructure or delivering fuels, equipment and spare parts, and maintenance vary according to the season. Energy supplies that depend on, for instance, water, biomass and wind also vary by season. The moisture content of biofuels and their combustion characteristics are also affected by the season.

Population density: The population density in a particular area can affect certain conditions like market size, costs and prices. For instance, load density, or the amount of the service used or purchased along an electricity line, or the choice of a kerosene distribution route are major determinants of unit costs and prices. Low densities favour modular options such as photovoltaic systems over grid extensions. Rapid changes in population put particularly pressure on the sustainability of biomass and other fuel systems

Trends in governance and in technology: Trends in governance and politics determine the threats and opportunities for poor people access to energy services. Political promises of grid electrification may undermine people's willingness to invest in alternative decentralized options.

Technological trends in recent years involve massive technical innovation that has altered people's ideas of what is possible. Improvements in small-scale energy conversion technology have increased efficiency and reduced costs, particularly with photovoltaic cells, but also small fossil fuel engines, wind generators, micro hydro biogas, and biomass gasification. The use of gas for power generation using gas-fired combined cycle gas turbines has meant that electricity can now be generated on a relatively modest scale at costs that are competitive even with the largest coal-fired plant, reducing the power of natural monopolies.

Shocks: Major energy-related shocks have tended to be associated with the availability and price of oil products, which affect both the micro and macro economy. All energy delivery systems are vulnerable to natural and man-made disasters, to war and conflicts.

Livelihood assets

A number of linkages between livelihood assets and energy can be conceived. Below some of the conceivable linkages are presented as pertaining to each type of capital.

Natural capital: The main natural capital asset of poor people in developing countries is likely to be biomass that can be used as a fuel such as wood, twigs, leaves, crop residues, dung and human waste. Other energy-related natural capital assets include falling water, wind, and solar insulation. However these sources require other forms of capital to convert them into useful energy. The sustainability of the sources is affected not only by their use as fuel, but also by changes in land use. For instance, fuelwood becomes less available when land is cleared for food production. However, changes in land use that improve access can also induce exploitation of local natural resources.

Social capital: Networks and social relations often determine individuals' access to:

- natural resources - e.g. fuelwood from a particular location

- energy-conversion technology that is owned by others - grain mills, baking ovens, machines for preparing land or irrigation pumps
- other people's skills - electricians, engine repairers; and
- information about technical or managerial alternatives

Human capita: Healthcare, education, communication can be improved as a result of energy for lighting, pumping, refrigeration and communication. Access to skills is also required for many aspects of energy service delivery, and for some aspects of energy use.

Physical capital: The productivity of labour and other inputs into commercial or domestic production can be enhanced by access to energy sources and end-use technologies such as stoves, lamps, household appliances, machines, and radios. These technologies convert energy into a useful form that enables inanimate energy to replace the drudgery of human labour. In some instances it is also conceivable that access to these conversion technologies may decrease the costs of (or time spent on) production and product prices Also transport services can be improved through access to reliable and reasonably priced fuels.

Financial capital: Improved income and lower prices help improve financial capital. Thus, cheaper and more convenient fuels in association with conversion technology devices that improve productivity would enhance this type of capital. However, in the absence of hire-purchase or down-payment schemes, the "lumpiness" of investment into energy conversion devices means that poor people often cannot accumulate enough cash to buy them, even though there would be considerable cash savings over the medium-term future. The same applies to lower prices associated with bulk purchase of fuel, e.g. when kerosene is often bought by the cupful. Modern renewable energy conversion technologies share a similar characteristic in that high initial capital costs militates the benefits of lower recurrent fuel costs relative to fossil fuel based technologies.

Institutions and Processes

In an energy setting, linkages with institutions and processes can be conceived of at the national, local and community government levels, as well as the micro levels such as firms, NGOs, legislation and gender relations.

National government: The responsibility for the supply of electricity and for the regulation of all the energy supply industries – such as electricity, fossil fuels, and much of the monetized wood and charcoal markets – often rests at this level. National government is also responsible for much of the "enabling environment" required for efficient public and private sector development in the energy service industries. The government is the main source of subsidies of energy related services, for energy price control and for energy taxes, and the taxes on imported energy conversion technology. It is the main regulator determining the type of ownership and degree of competition at each part of the energy supply chain.

Local government: Responsibility for smaller scale energy infrastructure, and particularly the rate and direction of grid extension, is often found at this level. Transport infrastructure, which affects the availability, reliability and cost of fossil fuel delivery costs, is in most cases also under the influence of local governments. Similarly, local government is also responsible for regulation and permits associated with small-scale energy retail businesses,

such as electricity supply to rural bazaars, the production and sale of charcoal; access to communal resources such as water for hydro power; and "way leaves"[5] for electricity.

Community: The mobilization, organization and development of schemes to introduce decentralized energy supplies – such as diesel mini-grids or micro-hydro - and in the regulation of such schemes often take place at this level.

Firms The main providers of energy services are often found at this level, as are also, often in partnership with government, the suppliers of energy related infrastructure. Small and micro firms are likely to be the main actors in the supply and use of energy services that are used by poor people, such as informal retailers of electricity in urban slums, sellers of kerosene, candles and charcoal.

Non-governmental Organizations: NGOs can play important role in interventions to improve energy services at the local level for instance through the introduction of appropriate energy technologies, organizing community-based initiatives to meet locally defined energy needs. NGOs represent important sources of technical and other information and are sometimes restricted by funding inclination or expertise to a limited range of technical options.

Laws: Regulation of the provision of energy services, including public health and safety, is done through legislation. The same applies to contract tender procedures for infrastructure construction and monopoly powers of the state and utilities in the supply of energy services.

Gender relations: Women are the main users and suppliers of energy at the household level in poor communities. Women's empowerment may result from reduced indoor air pollution, reduction of time consuming tasks such as fuel and water collection, milling, grinding, food preparation, and other productive tasks. Improved lighting can provide safer night-time environment, access to the outside world through radio and other information and communication technology, better light for reading and other night-time tasks and less frequent pregnancy. The poverty impact of energy-related interventions will be largely determined by the end-use technologies that are adopted, and the impact on gender relations will in turn depend on the extent to which women are empowered to choose.

Livelihood Strategies

New or improved livelihood strategies may arise when time is saved and allocated into new activities due to the access to improved energy services or from fuel switching. Two examples at the household level are the use of improved biomass stoves that reduce cooking time or improved and extend lighting, for instance when electrical light replaces candles or kerosene, which facilitates the conduction of tasks during evenings.

In the best case the improved livelihoods may become self-perpetuating process, when increased production efficiency that results from improved energy services yield earnings that allow households to pay for improved energy services. Opportunities can arise from an assortment of technologies ranging from agro-processing to the use of mechanical devices or household appliances in small and micro enterprises.

Further, a strategy that involves households pooling energy demand can alert decision makers to required local economies of scale associated with energy supply technologies. Such technologies would involve grid connections - including investment in transformers and distribution systems - and instalment of micro hydro generators or small diesel engines,

[5] Permission to cross, or a right of way across, land; also, rent paid for such right.

as well as the acquisition of mechanised transport services. Pooling efforts may also yield political or commercial pressure to gain access to energy services that improve not only home production or household consumption activities, but also community facilities in the field of health, education, outdoors lighting for security purposes as well as access to information and communication technologies.

Livelihood Outcomes

Despite the reservations referred to above, the most common livelihood outcome mentioned in the Sustainable Livelihoods literature is income. More income may come from the sale of energy services, from energy related productivity gains, from energy related expansion of supply options and quality, i.e. doing things that are impossible without in animate energy, or from extending the working day through improved lighting, and from better access to fuel based transport.

Other outcomes that also result from energy interventions would be captured by the wider concept of increased well-being. Such outcomes encompass reduced indoor air pollution from the use of improved fuels or improved stoves or the reduced burden from fuel collection and processing when electricity is provided. Better lighting in schools and street lighting may increase education. Health conditions in the population will benefit from medical services that utilize improved lighting, refrigeration of vaccines, and communication will improve health. Access to information through radio, television and other information technology will improve well-being through a sense of inclusion in the "modern" electrified world.

Furthermore, households' vulnerability may be reduced in a number of ways. Energy-driven irrigation may result in a more stable water supply, which would also have positive health impacts. Better lighting and the supply of less flammable fuels may result in an increased sense of security. Improve food security, when energy services render production based on a wider range of raw materials, agricultural output from mechanisation and pumped irrigation, post harvest processing, improved storage and fuel based transport. An associated diversification across a greater number of crops or income sources may reduce financial risks. In the long run households may also benefit from a more sustainable use of natural resources when "mined" biomass is replaced by more convenient, efficient /or renewable fuels.

3.1.2 Energy and development — aggregated micro effects with multiplier effects and increasing returns

As mentioned, micro level impacts from improved energy services may aggregate into macro effects and yield increasing returns to scale. Theoretical models of such effects have been reviewed by Toman and Jemelkova (2003). These effects are derived from the traditional economies-of-scale notions that are assumed to apply in early stages of industrial development. However, these models also bring into light the importance of (aggregated) small-scale impacts from energy provision in rural development, with enhanced production capacity as associated with better education, less drudgery and better health, as well as more home-business opportunities.

The authors refer to two theoretical approaches within which energy availability contributes to the expansion of economic activity with multiplier effects. Firstly, if energy availability increases incomes, this would raise consumption from the baseline level, which increases production and incomes by the classic, Keynesian multiplier effect from increasing demand.

Secondly, it is argued that energy input in itself, as well as the time-savings it may give rise to, yields increasing returns to scale in industrial production at early development stages. The authors proceed to discuss multiplier effects from other, non-energy inputs and illustrate how investments in energy provision yield disproportionate returns at different stages of economic development.

Some specific links through which small-scale impacts may accumulate to generate multiplier effects are:

- reallocation of household time, especially by women, into education or income-generating activities
- greater flexibility in time allocation as activities extend into the dark hours of the day
- health-related benefits from e.g. reduced indoor air pollution, access to clean water, and refrigeration
- enhanced productivity in education
- economies of scale in industrial activities
- utilization of more efficient capital stock with modern technology;
- decreased transportation and communication costs, which yield improved access to information and markets

These channels represent both supply and demand side effects, as well as a mix of opportunities that could arise with improved energy services. The authors stress however, the importance of tracking demand-side benefits of energy availability, since the effects reside not only with improvement in quality of life, but with increased production possibilities of the entire economy. The authors conclude with an encouragement of empirical studies into both the extent of multiplier effects of energy provision and into the causal linkages between energy and development, especially in countries at early stages of development (Toman and Jemelkova, 2003).

3.2 Empirical substantiation of links between energy and development

Two events have, perhaps more than anything, contributed to putting energy on the poverty alleviation and development agenda. Those events are the United Nations Conference on Environment and Development (UNCED) in 1992 and the World Summit for Sustainable Development (WSSD) ten years later. Especially the World Summit motivated international NGOs, donor organizations and various branches of the United Nations to prepare documents, which state the institutions' respective stances on energy's role in development and in the alleviation of poverty (UNDP (1992), ESMAP (2000)).

Many of these documents propose and illustrate important roles for energy in improving Third World livelihoods through facilitated water access, health and education services, as well as through the enhancement of agriculture and preservation of biodiversity. With the widespread adoption of the Millennium Development Goals (MDGs), several documents of similar kind also prescribe crucial links between energy services and the accomplishment of those goals (Modi, McDade, Lallement, and Saghir (2005), DFID (2002), UN-Energy (2005)). Over time, documents like these have come to reflect an increasing realization, as

pronounced in DIFID (2002b), that energy in a developing country context needs to be understood as not primarily being about technology provision, but of understanding the impact of energy on the livelihood opportunities of the poor and how the poor value and use energy.

Yet, in many such documents it is not clear whether proposed links between energy and development have been substantiated or are simply hypothesized. However, quite a few studies do exist, which present evidence of a number of development impacts, although the specific causal relationships are rarely disclosed. Below we therefore provide a non-exhaustive discussion of some documents of the above type that link improved energy services to the effort of achieving the Millennium Development Goals.

In this section we therefore present studies with substantiated impacts on the MDGs, separated for each of the goals. In order of appearance the boxes list interventions with evidence of impacts that contribute to: (i) the reduction of extreme poverty and hunger; (ii) the achievement of universal primary education; (iii) gender equality and empowerment of women; (iv) reduction of child mortality, improvement of maternal health and the combat of HIV/Aids, malaria, and other diseases; and (v) environmental sustainability. In summary, there is a fairly rich literature of findings, claiming to provide evidence of impacts on MDGs pertaining to poverty, gender inequality and health issues. Fewer studies, however, present impacts on education and environmental impacts. The relative magnitudes of evidence should perhaps not be read as energy provision being of less importance in the latter cases. The lesser amounts of evidence may also relate to the greater difficulty in monitoring progress towards those goals.

3.2.1 MDG 1 reduction of extreme poverty and hunger

The findings in Table 3.2 can be summarized as examples of how modern energy (i) allows the uptake of novel and/or additional income-generating activities; (ii) promotes greater efficiency in the production of prevailing activities; and or (iii) frees up time from unpaid tasks into income-generating activities. Some studies point to income generated for those producing or running equipment used in the project. While these incomes would be observed, they may not, however, affect the majority of the targeted groups.

Intervention/project	Evidence
Manufacturing, distributing and using improved Upesi cook stoves in Kenya.	Cash savings among users and income generated for stove producers and distributors. Saved health expenditures among users (Njenga, 2001)).
Production and use of biomass briquettes in Malawi.	Increased income for briquette producers and time saved from not having to collect firewood (Mabona, 2001).
Provision, production and use of battery operated lamps in Bangladesh.	Increased income from extended business hours and increased quality of life through better lighting (Khan, 2001).
Improved shea butter production process with motorized plate mills in Ghana.	Daily production capacity increased by 200 percent (Mensah, 2001).
Improved fish smoking with an LPG-fired oven in Ghana.	Reduced fuel expenditure (Mensah, 2001).
Operation and use of multifunctional platforms in Mali.	Increased production or value added from manual work. Increased income from larger production volume. Increased trade opportunities (Burn and Coche, 2001). Reduced time spent milling cereal and de-husking rice. Increased production and consumption of food (Anderson *et al*, 2005). Reduced working hours for women. Reduced risk of family members foregoing evening meals. Time and released for productive agricultural or other income-generating activities. Alleviation of seasonal financial stress through diversification into non-farming income-generating activities. Cash received by MFP operators(Brew-Hammond and Crole-Rees, 2004).
Rural micro hydro projects in Nepal.	Income generated by participants through productive activities using electricity, including setting up micro-enterprises (Rana-Deuba, 2001).
Using and distributing solar PV system, including loan programme in Uganda.	Improved efficiency and quality work in income-generating activities (Sengendo, 2001)).
Geothermal power project in Kenya.	Increased tourism, businesses, income and improved infrastructure (Mariita, 2002).
Rural electrification programme in Brazil.	Most income indicators showed positive correlation with access to electricity in 1991 but the correlations were considerably weaker in 2000 (Berg *et al*, 2005).
Installation of biogas digesters for cooking and water heating in rural China	Among families with biogas digesters, per-capita energy consumption is 25 percent lower and consumption of fuel (stalk and straws) is almost 50 percent lower, than among those without (REN21, 2005).

Table 3.2 Interventions with evidence of impacts on MDG 1 – reduction of extreme poverty and hunger

3.2.2 MDG 2 the achievement of universal primary education

Several of the seven studies referred to in Table 3.3 point to the beneficial impacts on children's home study conditions of having access to electrical light. Other studies point to the freed up time for children who are employed in income-generating activities as well as increased expenditure on school fees from income generated thanks to modern energy.

Intervention/project	**Evidence**
Manufacturing, distributing and using improved Upesi cook stoves in Kenya.	Increased income helped to pay children's school fees and reduced children's dropout rates (Njenga, 2001).
Provision, production and use of battery operated lamps in Bangladesh.	Increased hours of studying at home for children and adults. Families with school age children show significant interest in purchasing lamps (Khan, 2001).
Operation and use of multifunctional platforms in Mali.	Lower drop-out rates among school children. Greater proportion of children entering secondary school (Anderson, Fracchia, Lang and Porcaro, 2005). Reduced employment of children (especially girls) for domestic activities thus increases school attendance and performances (Brew-Hammond and Crole-Rees, 2004)).
Rural micro hydro projects in Nepal.	Electricity improved children's studying conditions (Rana-Deuba, 2001).
Rural electrification programme in Brazil and the Philippines.	Literacy rate and gross enrolment ratio show a positive correlation with access to electricity (Berg, Díaz-Wionczek, Gelman, Granof, and Porcaro (2005), Blanchard, Porcaro, Shigeoka, and Yokota (2005)).

Table 3.3 Evidence of impacts on MDG 2 – achieve universal primary education.

3.2.3 MDG 3 gender equality and empowerment of women

Table 3.4 presents the studies that demonstrate impacts on gender inequality through energy interventions. Considering that energy is in many cases a substitute for human labour, and that women in developing countries are burdened with a disproportionate share of that labour (World Bank, 2004), one should perhaps not be surprised by the multitude of findings pertaining to this MDG. However, while some impacts pertain to reduced drudgery or time saved among women, other impacts such as reduction of reduction in of indoor air pollution, which results in diseases to which women are more exposed, increased income, social status, and school participation among girls appear. A component of several projects was also to equip women with skills for running businesses.

3.2.4 MDG 4 improvement of health and disease combat

In addition to the reduction in diseases from indoor air pollution, a number of health related impacts from energy provision are recorded in Table 3.5. An indirect impact from increased income among women seems to be improved child health. Projects that improve food security and nutritional intake also boost health in target groups. In several cases, the electrification and simultaneous provision of equipment to rural health clinics are associated with improved health conditions. Although possibly quite costly, some programs of the latter type have been large and thus affected great numbers of people.

Intervention/project	Evidence
Use of improved cook stoves in Kenya.	Reduction in risk of getting acute lower respiratory infections (ALRI) and acute respiratory infections (ARI) in adult females (Ezzati and Kammen, 2002).
Manufacturing, distributing and using improved Upesi cook stoves in Kenya.	Women who participated in the programme generated income to support their families. The use of improved stoves reduced ARI and conjunctivitis in mothers by 65-67 percent. Time savings for women of approximately ten hours per months from the use of improved stoves (Njenga, 2001).
Production and use of biomass briquettes in Malawi.	Women who were trained for briquette production were also trained in entrepreneurship, and business management skills. Increased income by women lead to greater support from husbands. Decisions on how to spend the additional income at the household level rest with the women. Women became able to mix and interact socially more freely (Mabona, 2001).
Provision, production and use of battery operated lamps in Bangladesh.	New opportunity for women to earn a living. Women who participated gained more control over their time through the allocation of time to project activities and to housework (Khan, 2001).
Improved shea butter production process with motorized plate mills in Ghana.	Female workers' arduousness was reduced through the use if motorized plate mills (Mensah, 2001).
Operation and use of multifunctional platforms in Mali.	In addition to being trained to run the machinery, MFP operators (generally women) were taught how to keep records, manage bank accounts, and perform general maintenance. Operators developed functional literacy and numeracy. Women gained more time for rest or other housework. Women earned income from previously unpaid manual work since MFPs allowed for larger production volumes (Burn and Coche, 2001). Increased girl-to-boy ratios in primary school. Increased proportion of girls entering secondary education (Anderson et al, 2005). Reduced working hours for women by two to six hours per day. Cash received by MFP operators (usually women). Reduced risk of family members foregoing evening meals reduced the social tension within the household. Reduced employment of children (especially girls) for domestic activities thus increases school attendance and performances. Women were trained by the project to read and count (Brew-Hammond and Crole-Rees, 2004).
Rural micro hydro projects in Nepal.	Livelihoods of women and their families were vastly improved as a result of income-generating activities. Attitudes towards women changed in areas and in ethnic groups where the status of women traditionally was very low. Women in the community organizations are emerging as leaders and decision makers inside the programs, in the community and finally in their households. Women have reduced drudgery household tasks and increased productive and community roles (Rana-Deuba, 2001).

Table 3.4 Evidence of impacts on MDG 3 – promote gender equality and empower women.

Intervention	Evidence
Use of improved stoves in Guatemala	Reduced acute lower respiratory infections (ALRI) in young children as well as improved respiratory and cardiovascular health in women (Smith-Sivertsen *et al*, 2004) .
Use of improved cook stoves, fuel switch from wood to charcoal and change of cooking location, in Kenya.	Reduction in ALRI and ARI in infants, adult females and adult males (Ezzati and Kammen, 2002).
Manufacturing, distributing and using improved Upesi cook stoves in Kenya.	Reduced ARI and conjunctivitis both in children under five and in mothers (Njenga , 2001).
Improved shea butter production process with motorized plate mills in Ghana.	Reduced exposure to smoke through the switch to motorized plate mills (Mensah, 2001).
Operation and use of multifunctional platforms in Mali.	Improved drinking water quality (Burn and Coche, (2001), Anderson *et al*, 2005). Increased income by women improved children's health. Increased food security improves health and both work and study capacity (Brew-Hammond and Crole-Rees, 2004).
Geothermal power project in Kenya.	Better nutrition has improved health in participants. Provision of a health centre by the project. Improved water supply as the community members extract water from two water tanks provided by the project (Mariita, 2002).
Rural electrification in the Philippines.	Health indicators (birth assisted by doctor/nurse) show a positive correlation with access to electricity (UNDP, 2005).
Installation of solar PV panels in rural clinics in Burma	An estimated 54 000–90 000 people have benefited from the eighteen illuminated clinics since August 2003. The solar systems allow medics to address night time emergencies, have proper lighting for medical procedures, and use electric medical devices and laptop computers (REN21, 2005).
Installation of solar PV panels in rural clinics in Cuba. The clinics which were equipped with various types of medical equipment and radiotelephones.	The health situation has improved greatly. The average birth rates have decreased from 5–6 children per woman to 2–3 which has also reduced the infant mortality rate (REN21, 2005).
Provision of solar PV to pumps in the Dominican Republic and Honduras.	The project has provided clean water, to communities otherwise dependent on distant, contaminated surface water sources. Costs worked out at $.004 per litre, compared to the $.007 per litre charged for water delivered by private truck (REN21, 2005).

Table 3.5 Evidence of impacts on MDGs 4 to 7 – reduced child mortality, improved maternal health and combat of HIV/Aids, malaria and other diseases.

3.2.5 MDG 5 Environmental Sustainability

In Table 3.6, reduced indoor air pollution appears, juxtaposed to reduced greenhouse gas emission and reduced deforestation, as impacts on the MDG for environmental sustainability.

Intervention/project	Evidence
Use of improved cook stoves in China.	Reduced indoor air pollution (TSP and CO) and GHG emissions (Edwards, Smith, Zhang, and Ma, 2004).
Production and use of biomass briquettes in Malawi.	Reduced deforestation and the utilization of waste reduced environmental burdens of the city (Mabona, 2001).
Provision, production and use of battery operated lamps in Bangladesh.	Reductions in indoor air pollution and in fire hazards (Khan, 2001).
Using and distributing solar PV system, including loan programme in Uganda.	Reduced deforestation and emissions of GHG. Use of solar lanterns helped to improve indoor air quality (Sengendo, 2001).

Table 3.6 Evidence of impacts on MDG 8 – ensure environmental sustainability

3.3 Impact assessments and evaluation of energy interventions

According to the OECD Development Assistance Committee's "Glossary of key terms in evaluation and results based management", an *evaluation* is defined as "The systematic and objective assessment of an on-going or completed project, programme or policy, its design, implementation and results." In close accordance with the DEA project objectives, the aim of an evaluation is to "determine the relevance and fulfilments of objectives, development efficiency, effectiveness, impact and sustainability". Information provided from an evaluation should furthermore be credible, useful and enable the incorporation of lessons learnt into the relevant decision–making processes (DAC-OECD, 2002).[6]

Over the last decade or so, donors have increasingly attempted to assess the impact of their programs, so as to ensure that their funds have been well spent. A methodological shift away from more costly large-scale exercises discussed in the previous chapter, with science-like sample surveys and statistical analyses, is discussed by Hulme (2000). Based on the increasing use of multi-method "impact assessment" studies and participatory methodologies, the same study provides lessons for future impact assessments from the field of microfinance programs. An international group of experts, assembled by the Global Village Energy Partnership (GVEP), is already taking some of the lessons into account for the compilation of a "short-guide to Monitoring and Evaluation in Energy Projects".[7] The

[6] Distinctions are made between intervention *inter alia ex-ante* and *ex-post* evaluations. Evaluations are undertaken of development *programmes* as well as of *projects* (which may or may not be part of or sum up to programmes). Evaluations may be conducted by someone *external* or *internal* of the implementing organizations. The *credibility* of an evaluation depends largely on its extent of *independence of political or organizational pressure* from those responsible for the design and implementation of the intervention (DAC-OECD (2002)).

[7] The short-guide is available in English and French at http://www.gvep.org/gvep_c.aspx?id=146

GVEP guide also draws on previous evaluations of energy interventions and on guidelines produced by the German "Gesellschaft für Technische Zusammenarbeit" (GTZ) and the Imp-Act Consortium of the Institute of Development Studies (IDS). The latter are respectively designed for studies of technical cooperation projects and microfinance interventions.

In the light of the guidelines already in existence and that under production, this chapter will provide a brief account of the underlying concepts, theoretical frameworks and broader considerations in evaluation studies. In doing so, we draw closely on the structure and content of Hulme (2000) with supplemental detail from other work. As a first step we present the "result" and "impact" chains for *theoretical modelling*. The two chains could be interpreted as attributing differing precise meanings to "impact". That difference could in turn suggest a deeper methodological compartmentalization between "results monitoring" and "impact assessment". This is however, not the case. In order to avoid such misunderstandings, the first section also introduces the reader to the most central concepts and definitions.

While analytically non-trivial, the theoretical modelling with chains is however, one of several components to a conceptual framework for evaluation. That framework, in turn, is not the sole determinant of the study's final design, including data collection and analysis methods, which also depends on the precise scope and objectives, the context and the available resources, and ambitions to affect policy and practice. The following subsections therefore comments on other considerations that go into the design of impact assessment studies and presents criteria for the effectiveness of impact assessments in light of the many different factors that affects its design.

3.3.1 Theoretical modelling and terminology

The theoretical evaluation model known as the *impact chain* illustrates the overall objective of an evaluation, whether large or small-scale. This model will be introduced in the first subsection below, in which we shall attribute "impact" its intuitive, everyday meaning, similar to "effect", and consider *impact assessment* as synonymous of project evaluation. Another commonly applied modelling tool is the *results chain* which illustrates a causal sequence to achieve desired objectives of a development intervention. (As we will be made increasingly more explicit, the issue causality in impact assessment is not a minor one. However, for the illustration of modelling techniques, the different notions of causality will be momentarily sidestepped.) The model places the intervention and its effects in a broader context of influences, which allows the "impact" concept to take on a more profound meaning. Since the elements of the results chain also form the basis for many other evaluation concepts, an intervening subsection between the two models introduces some of the key concepts in evaluation.

The "impact chain"

Behind virtually all development interventions lies an assumption that the effort will induce changes in human actions towards the achievement of some desired outcome. The impact-chain model refers jointly to individuals, enterprises, households, populations, or policymakers as "agents", who in turn may or may not have been subject to – or experienced

– the intervention in question. It is furthermore assumed that some variable, key characteristic of the agents, their behaviour, or their circumstances exists, that can be related to the intervention's desired outcome. In the case of an intervention to improve water access, such a characteristic could be, for instance, per village incidences of dehydration among infants. The objective of impact assessments is to capture difference in the values of those key characteristics between the outcomes on agents that *have* experienced the intervention and those that have *not*. The impact chain is illustrated in Figure 1.2 (Hulme, 2000).

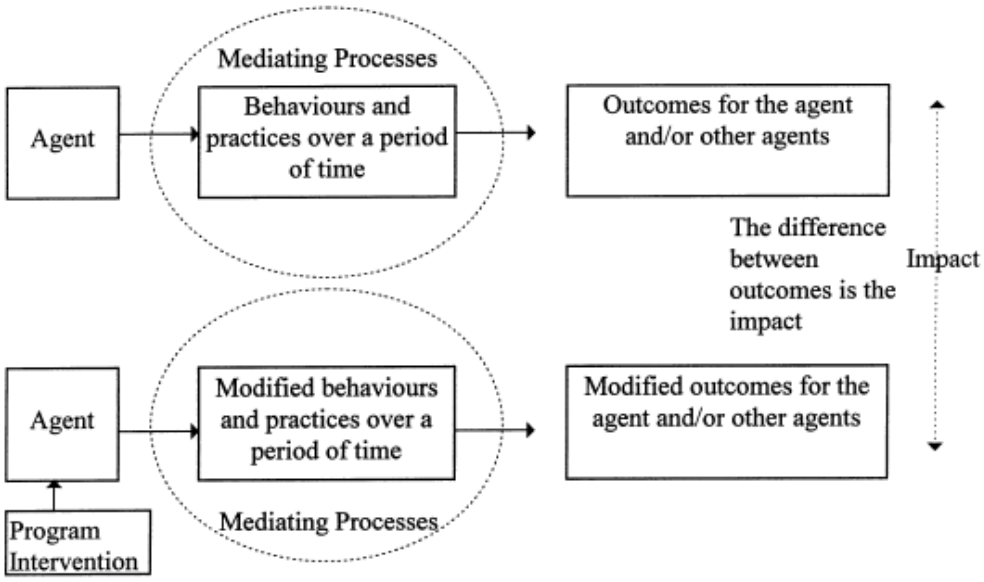

Figure 3.2 The impact chain [source Hulme(2000)]

The previous chapters have contained several examples showing that the link(s) between energy and development or poverty reduction are many and complex. Establishing causation within the general setting of household energy use in developing countries is thus not a straightforward task. In Chapter 4 the consequences of exposure to energy-induced improvements in living standards were mentioned. It was mentioned that such consequences become more difficult to attribute to energy, the further downstream from the energy intervention they are found, since other factors may also come into play. For instance, in the fields of health status or educational attainments, energy access may have considerable consequences. But across time and space, variations in, for example, vaccine availability or teaching aptitudes affect results. The same phenomenon is depicted in the figure and will be revisited in connection with the results chain below. Here, all long-term changes in agents' behaviours or practices, induced by the intervention, are thought to be affected by specific characteristics of the agent and his or her specific economic, physical, social and political context. The processes by which the agents' characteristics and contexts affect the intervention outcomes are termed "mediating processes". Given the complexity of the user-side of energy in a third world context, it follows that the final results of these processes are very difficult to predict (Hulme, 2000).

It is worthwhile to consider also that variations in contexts may affect both the agents that *have* experienced the intervention and those that have *not*. Hence, without a record of such changes, the impact attributable to the intervention may become biased. An intuitive

example of the latter would be that good rainfall (context) can have affected both sets of agents' incomes (impacts). Increased incomes could be due to altered crop diversification (behaviour), which in turn may result *also* from improved access to price information via media operated by electricity. The operation of media may finally be facilitated for instance by a solar home systems programme (intervention). As we shall see, the more complex conceptualization of the results chain allows links of causality to disperse in different directions, whereby an "*effect*" from an intervention can be a *cause* of further effects.

The elements of the results chain and key evaluation concepts

A results chain can be thought of as a set of hypotheses of the linkages between an energy intervention and its possible impacts. The chain makes our assumptions about those linkages explicit and is suitably visualized with its strategic elements as a set of arrows arranged in a direction of causality from left to right. By deconstructing the chain into several levels and gathering proof of the linkages between each level the investigator can assess the plausibility of a proposed link between energy interventions and observed social, economic and environmental changes (GTZ, 2004). The results chain thus stipulates the necessary causal sequence to achieve desired objectives of a development intervention. It begins with *inputs*, moving through the other "strategic elements", *activities* and *outputs*, and culminates in *outcomes*, *impacts*, and *feedback*. In some agencies, *reach* is part of the results chain"[8] (Hulme (2000), DAC-OECD (2002)). As related to a development intervention, the strategic elements are individually defined as:

- Inputs: the financial, human, and material resources used
- Activities: actions taken - or work performed for the mobilization of resources - in order to produce specific outputs
- Outputs: resultant products, capital goods and services, as well as resultant changes relevant to the achievement of outcomes.
- Outcome: The likely or achieved *short-term and medium-term effects* of an intervention's outputs. Not a strategic element itself, an *effect is* a "change intended or unintended due directly or indirectly to an intervention"
- Impacts: produced *long-term effects* that may be positive and/or negative, primary and secondary, direct or indirect, intended or unintended.
- Feedback: *transmission* of findings generated through the evaluation process to parties for whom it is relevant and useful so as to facilitate learning (for instance, collection and dissemination of findings, conclusions, recommendations and lessons from experience).
- Reach: beneficiaries and other stakeholders

[8] The inverse of this chain is the *results framework* which is a "programme logic that explains how the development objective is to be achieved, including causal relationships and underlying assumptions." Associated with the results framework is the *logical framework*, "a management tool used to improve the design of interventions, most often at the project level. It involves identifying (inputs, outputs, outcomes, impact) and their causal relationships, indicators, and the assumptions or risks that may influence success and failure. It thus facilitates planning, execution and evaluation of a development intervention."

Furthermore, outputs, outcomes, and impact are referred to as *results* which give rise to the related term *results monitoring*. Such monitoring signifies "a continuing function that uses systematic collection of data on specified *indicators* to provide […] indications of the extent of progress and achievement of objectives and progress in the use of allocated funds". An *indicator* is defined as a "quantitative or qualitative factor or variable that provides a simple and reliable means to measure achievement, to reflect the changes connected to an intervention, or to help assess the performance of a development actor" (DAC-OECD (2002)). Hence, as related to the illustration using the impact chain in the previous subsection, an indicator would be a measurable key characteristic of the agents, their behaviour, or their circumstances, that can be related to the intervention's desired outcome. One operational objective of the assessment is thus to capture differences in indicator values between agents that have experienced the intervention and those that have not.

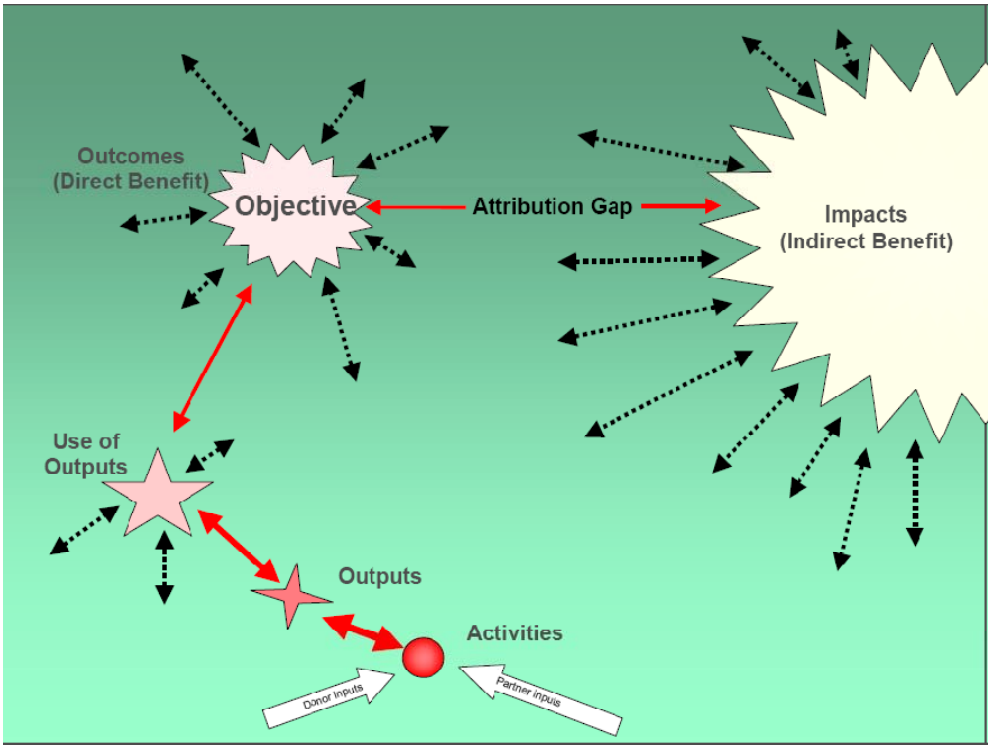

Figure 3.3 The results chain "Use of Outputs" as an element between Outputs and Outcomes [source GTZ (2004)].

Modelling causality in energy interventions and the attribution gap

Figure 3.3 shows the links in the results chain depicted in a complex "real-world" context. As can be seen, causality in the context of the results chain should not be confused with a linear sequence of causes and effects. Attribution of results to the energy intervention up to the level of outputs and use of outputs is relatively easy in most cases. From an empirical perspective, if a causal relationship between outputs and observed development changes can be demonstrated, the project can make a credible claim to development as a direct benefit (GTZ, 2004).

The attribution problem is further illustrated through Figure 1.3. In reality, causality may disperse in different directions and that an effect from an intervention can be a cause of

further effects. This is illustrated in Figure 1.4. Input in the form of a diesel engine, brought by an energy project, yields shaft power for the extraction of water as output. The pumped water is an output. The pumped water serves as one of several inputs into an agricultural project, which could yield higher incomes. A parallel health project aimed at reducing dysentery also utilizes the pumped water as an input, with pipes and education to promote the use of potable water. In combination, the three interventions may bring about development impacts in the form of improved living standards (GVEP (2007)). However, the figure does not illustrate contextual influences such as

- ground water levels and diesel availability on the water output
- weather on agricultural production
- access to agricultural markets and prevailing prices on farm income
- spare or replacement parts and repair skills for water pipes

Each of these four influences forms part of the context of the separate projects and may seriously complicate the attribution of development impacts to the diesel engine.

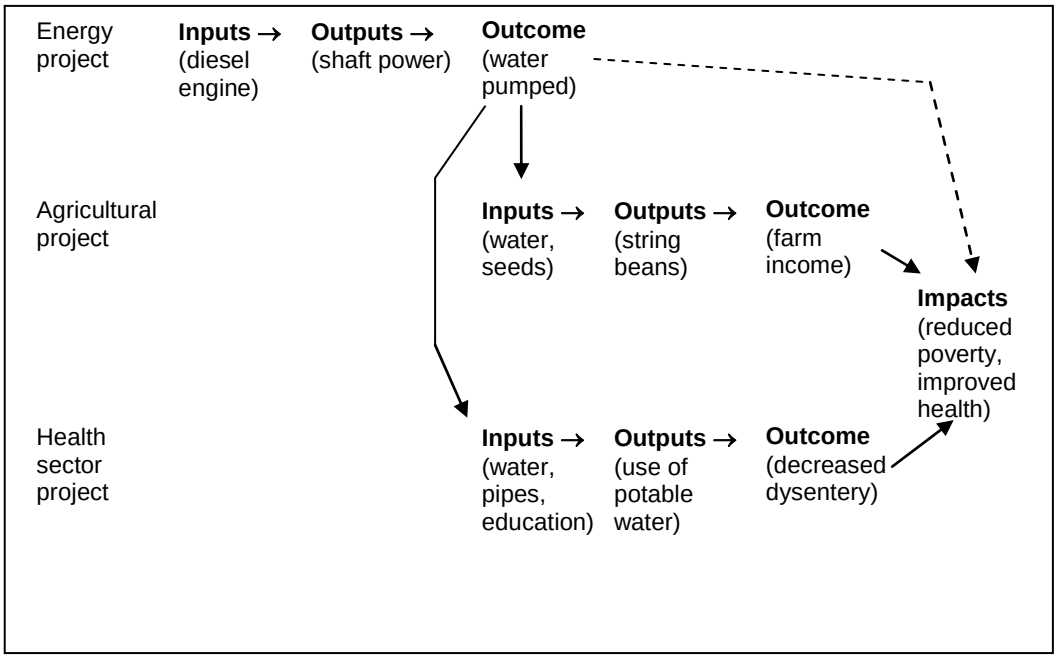

Figure 3.4 Results chains in interaction - outcome from an energy project as input into other interventions

3.3.2 Considerations in the design of an impact assessment study

Quite naturally, all studies whether based on quantitative and/or qualitative methods must pursue rigor. While all impact assessment share a general, underlying conceptual framework, the design of such a study, must also address the following questions:

- What are the objectives of the assessment?
- How is the information to be used and by whom?
- What level of reliability is required?
- How complex is the program, what type of programme is it, what is already known about it?
- What resources (money, human and time) are available?

Hence, there are several parameters that define the sphere within which an impact assessment's pursuit of rigor takes place. Spelled out in some more detail these parameters encompass:

- the objectives
- data collection methods
- cost and financial resources at hand
- the human resources available and respondent motivation and representation
- ambitions of influence on policy and practice

In line with the DEA project's ambition it will be assumed that an impact assessment will have the objectives both to *prove impacts* and to *improve future interventions*. Each of the

other parameters will be introduced below, after a brief account of the underlying general framework of an impact assessment.

The elements of a conceptual framework

Most large-scale impact assessment exercises with long timer horizons are built around an explicitly identified conceptual framework at their heart (Khandker, 1998; Sebstad, Neill, Barnes and Chen, 1995; Schuler and Hashemi, 1994). On the other hand, smaller scale exercises are usually more of a common-sense type. Hulme (2000) lists three main elements to a conceptual framework:

- a model of the impact chain
- the specification of the level/unit for impact assessment
- the specification of the types of impact that are to be assessed

Based on a model of the impact (and/or results) chain, the choice of unit(s) or level(s) for assessment is made. The selection commonly involves one or several of: the *household*, the *enterprise* or the *institutional environment* in which the agents operate. With respect to the type of impact looked for, the number of (indicator) variables that can be identified is almost infinite. Two general criteria for the selection of such variables are that they must be *defined with precision* and must be *measurable*.

Two classes of indicators are the *economic* and the *social*. The former encompasses changes in income, levels and patterns of expenditure, consumption and assets (an advantage of which is that they do not fluctuate as much as other economic indicators) (Barnes, 1996).The social indicators encompass, for example, educational status, health service access, nutritional intake levels, anthropometry, contraceptive use, control over resources, involvement in household and community decision-making, levels of participation in community and/or social networks, as well as electoral participation. Another useful distinction in this context is that of "domains of change" and "`markers of change", examples of which would be respectively household income and amount of income, number of income sources or seasonality of income (Sebstad et al. (1995), Hulme (2000)).

Finally, often the exact indicators used will be affected by the choice of methodology. This raises problems especially in the case of multi-method approaches where it may be difficult to maintain a single definition of an indicator across all methods applied. Further, as a rule, impact assessors should always seek to keep the number indicators to a manageable number rather than attempt a comprehensive approach which may have adverse effects on both the data quality and on study relevance.

Data collection methods

For the assessment of intervention impacts, the investigator would apply an *impact assessment tool*, defined as "a mechanism of obtaining the answer to certain questions or revealing certain information about impact that we are looking for". Impact assessments are not fundamentally different from other research, in the sense that it is the search for answers to research questions, which determine the appropriate mix of research methods or tools. It follows thus, that the extent to which an investigator adheres to one of the paradigms in the previous subsection will affect the choice of data collection methods. The key issue in

selecting methodologies or tools is however, to approach research with flexibility and with a good grounding in the issues to be investigated (Simanowitz, 2001).

With the introduction of participatory approaches the range of available data collection and knowledge creation methods for impact assessment studies has increased. Each of the methods of sample surveys, participant-observation and PLA has a different pattern of strengths and weaknesses. (A more detailed account of impact assessment tools is found in Simanovitz (2001) and Rai (2005) provides a fuller account of participatory approaches for impact studies of energy programmes.)

The data that can be collected is however, often very limited. It is therefore important to first undertake qualitative research so as to determine which indicators provide the most accurate reflection of the type of impact information that one wishes to gather. The tools selection process therefore also involves a close look at the kind of data a particular approach will produce and to consider how that data should be processed and analyzed. A common mistake is to select indicators based on an insufficient understanding of the processes one seeks to assess. The starting point in any impact assessment should therefore be analysis (Simanovitz, 2001).

As indicated above, the key methodological concern is the *mix* and *combination* of methods most appropriate for the study at hand, rather than the choice of one, unique method. This choice is obviously subject to considerations of resources available and the context at hand. Nonetheless, a trend at least within microfinance assessment, appears to be towards efforts to combine the advantages of representativity, quantification, and attribution in sample survey approaches, with the humanities' or participatory approaches' abilities to uncover processes, capture the diversity of perceptions, views of minorities and unexpected impacts (Hulme, 2000). At one extreme end of the range of methodological mixes one could find an ambition to prove impact for policy or major investment purposes. An example at the opposite extreme could be to independently corroborate the impact and strengthen implementation aspects of a small-scale programme. In the first case the mix would probably entail a large scale, longitudinal sample survey, supplemented by triangulation from the other methods. In the latter case, a mix of rapid appraisal and small-scale survey would likely suffice (Hulme, 2000).

Financial considerations

Drawing on verbal reports, Hulme (2000) provides the following guidelines for study costs. Impact assessments which utilize the scientific approach method to prove impact may cost in the range of US$500,000 to US$5 million, depending on the number of sites studied. On the other end, high quality, rapid appraisals of impact on individual sites, by qualified investigators can yield useful findings for improvement purposes at costs in the interval between US$5,000 and US$10,000. Some useful points of observation from the author's scan of the microfinance literature are:

- The costs of studies intended to produce authoritative evidence exceed what most agencies can afford and the timescales involved would render results that are historical rather of operational relevance.
- The notion that qualitative and participatory methods are cheap appears somewhat misguided

- The validity of findings from most studies would be best served by triangulation of sources and the utilization of a mix of survey, qualitative and participatory techniques. Attempts to achieve a representative sample survey on a limited budget are likely to have a negative effect on data quality and sample representativity.
- Project monitoring by programme staff make high-quality impact assessment feasible at moderate costs, since the need for primary data collection is relatively low.

Human resources – staff and respondents

In developing countries the recruitment of qualified personnel for interviewing, collating, analyzing and write up impact assessments is a core challenge. Different studies often compete for the people, which puts these individuals under great strain and is not met by an increasing supply of qualified individuals. Efforts to build impact assessment capacity in developing countries are therefore strongly supported by Hulme (2000).

On the respondent side, the issue of how to persuade respondents to spare the time for an interview, and provide accurate and honest answers, is an important one. Different strategies are needed for programme beneficiary and control group respondents. As a rule of thumb many researchers suggest that interviews should be concluded within one hour and that one and a half hours should be seen as the absolute maximum for an interview.

Beneficiaries usually accept that being part of a programme comes with "answering questions". The quality of the data still depends on the respondents' understanding of why they are being interviewed and their being given the opportunity to ask questions before the interview. In dealing with control groups, motivation may become an issue, especially if longitudinal data is collect. Even if a first interview has some novelty and amusement value, the provision of some reward to interviewees should be considered to promote data quality and for ethical reasons. Finally, participatory and rapid appraisal methods often stimulate respondents by their inherent social interaction. However, in conducting PLA exercises, care must be taken to observe who has turned up and who has *not* come to the meeting. Additional focus groups or interviews of non-attendees are often required (Mosse (1994), Mayoux (1997)).

3.3.3 Affecting policy and practice with impact assessments

A very limited influence on subsequent decision-making is a problem inherited by impact assessment studies from the evaluation studies of previous days. Hulme (2000) proposes the following ways to address this problem:

Impact assessors need to devote more time to the use of their studies and device dissemination strategies aimed at decision-makers, with short, user-friendly documentations combined with appealing presentations and strategic cups of coffee

Considerable thought must be put in to the timing of findings. Impacts on policy and practice decrease with the length of time between data collection and findings presentation. The Global Development Network has examined characteristics of research that successfully energy policy in five African countries (GDN, 2006). Among the important factors were timing – policy is most receptive to research input at early stages of formulation – and

relevance to broader policy issues, such as macroeconomic or poverty reduction strategies. While beyond the scope for this survey, the Overseas Development Institute has undertaken considerable on Research and Policy in Development (RAPID), with thematic foci on how policy-makers can best use research, how researchers can best use their findings in order to influence policy; and how to improve the interaction between researchers and policy-makers.

The people often best positioned to affect the performance of interventions are programme managers. The influence of impact assessments on this category of stakeholders is likely to increase with their sense of co-ownership of findings. The latter can be enhanced through paying careful attention and incorporating their ideas into the design of impact assessment studies.

3.3.4 Effective impact assessment

Drawing on Little (1997), Hulme (2002) considers impact assessment ``...as much an art as a science...". The scientific facets of impact assessments pertain to standards of measurement, sampling, and analytical technique, thus the fields in which statisticians and econometricians specialize. With respect to the "art" aspect, there are three dimensions to any given impact assessment exercise;

- the judgments about its design with respect to resources at hand, objectives and setting
- the *process of arriving* at the most appropriate blend of assessment methods
- the evaluators' insight into the ways in which results may influence policymakers and intervention managers

Quite naturally, all studies whether based on quantitative and/or qualitative methods must pursue rigor. However, the first point in the list above states parameters under which that rigor must pursued. Hulme (2000) defines a measure of *effectiveness* of an impact assessment on how well it "achieves a fit" between its objectives, resources and context. The author groups approaches that are likely to fit common clusters of these parameters, ranging from impact monitoring and validation, via "simple" and "moderate" approaches to more complex ones.

Impact monitoring and validation

An alternative to an impact assessment study is to rather to strengthen the internal impact monitoring capacities of the implementing body. Quality control of this information can be achieved by using external monitors for validation purposes. One advantage of this approach is the increased likelihood that findings will be used due to the involvement of programme staff in the assessment of achievements. Often the approach would involve the collection of readily available data by pre-existing internal monitoring and research units, supplemented with easily accessible data on services users, their purposes and opinions, through focus groups, short interviews and rapid appraisal.

A simple approach

The central methodological feature of this approach is the use of a variety of methods, usually involving a small-scale survey supplemented with information on a comparison group that could be rapidly identified. In the absence of a baseline study, recall methodology

would be utilized. The ambition with this approach would be to provide timely information at relatively low cost about programme impacts directed to programme managers and "country-based" donor staff. Reliability is moderate, at best, and the major objective is to evaluate the current understanding of impacts and contribute to improvements in the operation.

A moderate approach

The moderate approach involves considerably higher costs and reliability in terms of statistical inference rather than triangulation, with longer delivery time. Focus is both on proving impact and improving programs, with policy-makers and senior programme managers as audience. A significant survey with at least two visits and an adequate control group would constitute the core of the methodological mix. Rapid appraisal techniques, participant observation and case studies would be used for context assessments and cross-checking materials.

A complex approach

This approach aspires to high levels of reliability with regard to causality attribution and the focus is exclusively on the impact proving orientation, through the application of statistical and econometric data analysis. Delivery time of findings would be twice as long as for the moderate approach, with four to six years after its launch. A very carefully constructed, large-scale sample survey, capturing all key characteristics of the client population, with a rigorously selected control group would constitute the heart of the methodology. The number of households visited would be in the vicinity of one thousand, with at least three visits to each over two years. A set of related studies on institutional performance would be conducted .The budget this kind of approaches would typically exceed a million dollars, with considerable data collection, processing, and analysis costs.

4 Catalogue of Energy Projects

4.1 Summary

The catalogue of energy projects lists key energy interventions implemented in the last five years in each of the six partner countries of the DEA project. A total of 42 projects across the 6 countries were described in the catalogue of energy interventions. Details on the objective and scope of the intervention, monitoring and evaluation data and its social, environmental and economic impacts are included in the catalogue.

The geographical scope of the interventions ranged from village-level projects to national programmes. Most interventions concerned village-level projects (10) or regional programmes with village level projects (14). There was one international programme, 15 national policies and programmes and 2 interventions specifically targeted to one city.

Of the 42 energy interventions described in the catalogue, 18 did not have a baseline study conducted before the implementation of the intervention. The remaining 24 interventions had some form of baseline, either in the form of a market study, a feasibility study or a detailed baseline study. Monitoring data is available for 31 interventions, although it is not always clear what type of monitoring data this exactly concerns. Mostly, it seemed not to concern impacts.

It was difficult to get good data for the interventions on the impacts and on the budgets and project expenditures. The first was due to the general lack of good quality monitoring data on impacts. This underscores the need for a reliable impact assessment tool.

While not all data could be gathered for all interventions and while not as many interventions were catalogued as initially intended, the catalogue nonetheless provides a good overview of relevant energy interventions in each of the project countries. Furthermore, it provides a good basis for choosing relevant case studies for further impact assessment using the assessment framework developed within the DEA project.

4.2 Purpose of the catalogue

The key result of DEA is an assessment framework for analysing the development impacts of energy interventions. This assessment framework should be not merely an academic procedure, but one that helps stakeholders in Africa to design better targeted energy interventions. The assessment framework is therefore constructed in a bottom-up approach, which takes actual projects in six African countries as the basis for developing the assessment framework. This ensures that the assessment framework is closely aligned with national stakeholder interests and development priorities. Moreover, stakeholders are actively involved in the project through a series of national stakeholder workshops.

As a first step to developing the assessment framework a catalogue of energy interventions for six African countries was set up. This catalogue lists key energy interventions implemented in each country within the past five years. Details on the objective and scope of the intervention, monitoring and evaluation data and its social, environmental and economic impacts are included in the catalogue.

The catalogue serves multiple purposes. It provides:

- An overview of key energy interventions in six African countries.
- Candidates for detailed case studies in applying the assessment framework.

Developing a catalogue of energy interventions can be an ambitious exercise. Here the ambition has not been to be exhaustive in terms of cataloguing all interventions and their key data. Rather the intention has been to gain an overview of the key interventions that have been implemented in the past 5 years and to gather as much information as possible on key indicators of the project. An indicative amount of 10 interventions per country was taken as a guideline for the amount of interventions. Furthermore, the partners were provided with a questionnaire that listed the data that the project aimed to include in the catalogue.

4.3 Scope of energy interventions in the catalogue

4.3.1 Geographical scope

The distribution of catalogued energy interventions among countries is given in Table 4.1, and Figure 4.1 shows how the interventions are distributed across rural, peri-urban and urban areas.

Table 4.1 Number of energy interventions described in the catalogue per country

Country	Number of interventions
Botswana	9
Ghana	9
Mali	10
Senegal	5
Tanzania	5
Zambia	4
Total	42

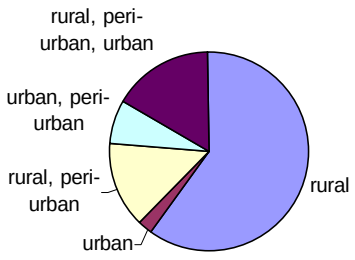

Figure 4.1 Number of projects in rural, peri-urban and urban settings

The energy interventions described in the catalogue have a varying geographical scope. While most interventions concerned village level projects (10) or regional programmes with village level projects (14), there was one international programme, 15 national policies and programmes and 2 interventions specifically targeted to one city. Three of the interventions described were national government policies rather than concrete energy projects. The

national catalogue entries thus describe a broad range of interventions in different countries, in different development contexts and with varying geographical scope.

4.3.2 Baseline and monitoring data

A key factor in investigating the development impact of energy interventions is the availability of a baseline study and monitoring data. Of the 42 energy interventions described in the catalogue 18 did not have a baseline study conducted before the implementation of the intervention. The remaining 24 interventions had some form of baseline, either in the form of a market study, a feasibility study or a detailed baseline study. Monitoring data is available for 31 interventions, although it is not always clear precisely what type of monitoring data this concerns. Most monitoring data seems to refer to internal project monitoring rather than impact monitoring. For enterprise development projects often only the internal financial accounting data is available as monitoring data. Often monitoring is done in an informal way through site visits of project managers or programme officers. In some interventions monitoring is based on a participatory approach that involves the stakeholders around the intervention.

4.4 Energy end-use sectors and services

The interventions described in the catalogue can be categorized according to the end-use sector and services they target. Three end-use sectors can be distinguished: 1) households, 2) village-level public services - often community-based initiatives - and 3) small businesses. Each of these end-use sectors uses energy for different services. The three major classes of services that can be discerned are: 1) cooking and heating, 2) lighting, communication and cooling, and 3) productive uses, including water supply. Figure 4.2 describes the relation between the end-use sectors and the energy services. While all sectors can in principle use energy for all the mentioned energy services some links are stronger than others. Most interventions that target households, for example, focus on cooking and heating services. However, cooking and heating services are hardly ever targeted in interventions at the village or community level or interventions in relation to enterprise development (dotted arrows).

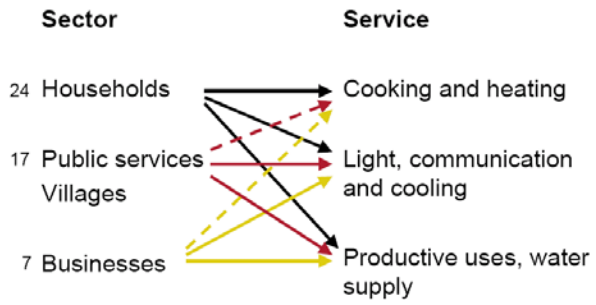

Figure 4.2 Energy end-use sectors and services

4.5 Types of interventions in the catalogue

The catalogued interventions can be categorised according to four main types, which are listed in the first column of Table 4.2. Examples of concrete projects from the catalogue are provided in the second column. Of the 42 interventions 7 interventions focused on fuel improvement and efficient use, 12 concerned fuel substitution, 7 concentrated on motive power provision and 20 were electrification projects and programmes, of which the majority concerned off-grid electrification. Several interventions targeted fuel efficiency and substitution or motive power and electrification at the same time.

Table 4.2 Types of interventions in the catalogue

Type of intervention	**Example from catalogue**
1. Fuel improvement and efficient use 2. seeking to enhance the quality of the fuel, the efficiency of fuel use and a reduction of environmental impacts of the fuel chain.	• Sustainable fuel wood forest-management and forestation • Improved stoves
3. Fuel substitution 4. seeking to move consumers up the 'energy ladder' using cleaner and higher quality fuels with less impact on the environment	• LPG marketing Briquette production and distribution • Charcoal production and distribution • Kerosene promotion • Jatropha oil production and marketing • Biogas promotion
5. 3. Motive power 6. seeking to provide motive power for productive uses	• Multifunctional platforms • Solar and wind water pumping
7. 4. Electrification 8. seeking to provide access to electricity services	• Grid electrification • Solar home systems • Solar PV for schools, hospitals and public lighting • Hybrid mini-grids

4.6 Data issues

The project partners in the six countries gathered a significant amount of data on 42 interventions in total. Originally, the project had aimed for about ten interventions per country in the catalogue. The reasons that several countries ended up including fewer interventions in their part of the catalogue vary. In some cases there simply weren't that many relevant interventions. However, in some cases the full potential of the catalogue was not realised and more effort could have been done to include more projects in the catalogue. Particularly in Botswana, Ghana, Mali and Senegal the listed interventions appear to give a good reflection of relevant energy interventions going on in the country over the past 5 years.

Some of the partners experienced difficulty finding certain data. In particular, it was difficult to obtain data on project expenditure and budgets and on the impacts from the interventions. The latter is due largely to a lack of systematic monitoring. Often monitoring provided only qualitative data or was absent altogether. This seems to reinforce the need for an impact assessment tool such as the DEA project is developing.

Generally, the data that was gathered for this catalogue is suitable for gaining a general overview of the kind of interventions implemented in the last 5 years in most of the partner countries. Moreover, the data gives an idea of the impacts that are expected from the interventions. At the same time it is recognized that the quality of any of these data is very limited and that in most cases a full impact assessment would be required to establish whether these impacts have actually materialised. The purpose of this catalogue, however, was to do a general scoping of energy interventions in the six partner countries. For that the information provided in the annexes is suitable.

4.7 Conclusions

This catalogue provides an overview of key energy interventions implemented since 2000 in each of the six partner countries in the DEA project. The purpose of this catalogue is to generate an overview of key energy interventions and their potential impacts, as well as to provide candidate interventions for detailed case studies on the impacts of these interventions. While the catalogue did not succeed in cataloguing quite as many interventions as it intended, the information provided in the catalogue is certainly suitable for the purposes outlined above. The catalogue as a whole covers a broad range of interventions using different technologies, focusing on different end-uses and being implemented a different geographical scales. Together these catalogued interventions provide for a good pool from which the project can choose six interventions (one in each country) for a detailed case study on their impacts.

5 Assessment Procedure

5.1 Introduction

Like many development projects, energy interventions aim to promote the development of economic, social and environmental conditions in developing countries. Project teams are often faced with the need to demonstrate that a contribution to such development has been made. Hence, the need arises to plan for the assessment of the project's impact. The proposed procedure is a step-by-step approach to building project-specific impact assessments for small- and medium-size energy interventions. The procedure has been developed and applied by the DEA project team in collaboration with the Monitoring and Evaluation of Energy for Development international working group ("the M&EED group").[9]

The user-side of energy services in developing countries is complex and characterised by a high degree of diversity. The diversity originates in varying availabilities and costs of energy from various sources and manifests itself not only in differing end-uses, but also in differing mixes and levels of fuels consumption for similar purposes. Households, enterprises, and institutions would also differ in their abilities and willingness to invest in new technologies, as well as in energy-related preferences, traditions and behaviours. Consequently, energy supply and demand patterns are often specific to regions, districts, settlements within districts, and to users within settlements. Energy impacts on livelihoods must thus be considered within this total context (Hulme, 2000).

The complex and varied circumstances that we wish to study requires that our research methodologies are devised to deal with the specific context at hand. With this document, we aim to supply some guidance to the Impact Assessment (IA) study approach. One benefit of this methodology is its high degree of flexibility and adaptability to differing circumstances. The need for specificity in study-designs however, sets a limit to how much detailed advice can be provided by a general guide like ours. The purpose of this introduction is to show why this limitation exists and to provide an idea of the detail of advice that we can provide.

An IA exercise can be thought of as undertaken in two stages; a design stage and an implementation stage. The design components of an IA study would encompass a conceptual framework, a selection of data collection methods, and a research plan for the implementation stage. The implementation involves the collection of data, data analysis and drawing of conclusions, and dissemination of results to stakeholders. All IAs share a general, underlying conceptual framework, the specification of which is started by addressing the following questions:

- What are the objectives of the assessment?
- How is the information to be used and by whom?
- What level of reliability is required?
- How complex is the programme, what type of programme is it, what is already known about it?
- What resources (money, human and time) are available?

[9] This document draws on the MEED group's "Guide to Monitoring and Evaluation for Energy Projects". The MEED Group is facilitated by the Global Village Energy Partnership (GVEP). Readers are advised to download a copy from http://www.gvep.org/gvep_c.aspx?id=146.

The answers to these questions also affect the exact choice of data collection methods and the actions on the research plan. The conceptual framework typically has three main elements;

- a model theoretical model of the expected impacts of an intervention
- a specification of the level or unit for the IA (e.g. individuals, households or villages)
- a specification of the types of impacts of interest (e.g. health, income or education)

The choice of units or level for assessment is made on the basis of a model of the project's impacts. The types of impacts of interest are likely to vary from intervention to intervention. Consider for example three different projects that in turn generate irrigation, lighting and refrigeration services. In the first case one could hope for impacts in the form of increased agricultural production, in the second extended work or study hours, and in the third improved vaccination facilities. However, even with a clearly specified focus, the challenge remains to decide upon the specific, variables with which to measure achievements or changes associated with the intervention. (Hulme, 2000).

Turning now to the data collection methods, for the assessment of intervention impacts the investigator would apply an "impact assessment tool", defined as "a mechanism of obtaining the answer to certain questions or revealing certain information about impact that we are looking for". Quite naturally all studies must pursue rigor, irrespective of their specifics approaches are based on quantitative and/or qualitative methods. IAs are not fundamentally different from other research, in the sense that it is the search for answers to research questions, which determine the appropriate mix of research methods or tools.

A key issue in selecting methodologies or tools is to approach the research topic with flexibility and with a good grounding in the issues to be investigated. Given the typically scarce resources available for an IAs, the data that can be collected is often very limited. Resources can therefore be saved by first undertaking desk studies and qualitative research, so as to determine which (quantitative) indicators most accurately reflect the type of impacts one wishes to assess. The tools selection process therefore also involves a close look at the kind of data a particular approach will produce and to consider how that data should be processed and analyzed (Simanovitz, 2001).

To summarize, there are several issues that affect the design of an impact assessment's design. In some more detail these issues encompass:

- the study's objectives; its content and type of information compiled for a specific audience and purpose.
- the model of the intervention and its impacts
- data collection methods selected with consideration of the above and of the cost and financial resources at hand
- the human resources available and respondents' characteristics, motivation and representation
- ambitions with respect to influencing policy and future practice

These considerations translate into the following ten steps in an impact assessment procedure:

Design stage:

- Identify the stakeholders of your project and their IA needs.
- Define/delimit the intervention and your focus on the intervention.
- Illustrate the project and model its conceivable impacts
- Choose indicators for each element of the results chain.
- Specify the appropriate data collection methods for each link.
- Construct a research plan and discuss it with your stakeholders.

Implementation stage:

- Collect data.
- Analyze the data.
- Draw conclusions and write report.
- Present the results to your stakeholders.

Starting from below, it follows from the discussion in this section, that the choice of data collection methods is contingent on a number of study-specific circumstances in the design stage. The methods by which the data are analysed and the conclusions reached depend on the applied data collection methods. Finally, the means by which results are presented to stakeholders are also very specific to each individual case.

By now, the reader would appreciate how these circumstances would vary from study to study. In this document, we therefore focus on the assessment procedure's design stage. We in large assume that the audience will either themselves have the fieldwork experience or will be able to access such expertise. We would strongly recommend the use of this guide in a small group of individuals with differing, at best overlapping, insights in the fields of energy supply, fieldwork methodology, and livelihood generation on the specific location at which the intervention takes place. In our experience, the synergies in group work are invaluable to the IA exercise.

5.2 Modelling project impacts – theoretical concepts and illustrations

It is useful to think of impact assessment as a branch of *project evaluation*. A formal definition of such an evaluation is "the systematic and objective assessment of an on-going or completed project, programme or policy, its design, implementation and results". The aim of an evaluation is to "determine the relevance and fulfilments of objectives, development efficiency, effectiveness, impact and sustainability". Finally, the information provided from an evaluation should be credible, useful and enable the incorporation of lessons learnt into decision–making processes (DAC-OECD, 2002).

When attempting to conceive of causality running from energy to development, the term *chain* is often convenient to use. In the literature review section of this document we discussed two such chain metaphors. The first, the *impact chain*, illustrated the aim and fundamental assumptions of IA studies. The other chain, the results chain, we use below as a device for systemizing and disentangling your hypotheses about linkages between energy and development. This chain is used in order to identify separable, observable "links" between factors brought in by (or to) the intervention and eventual, downstream effects on living standards. The primary objective of this section is to provide you with a familiarity of these, separable links - or *elements* - of the chain, so as to enable you to construct your own chains. Before turning to each of the chains, we will spend some time on the general issue of modelling impacts from energy interventions.

5.2.1 Energy projects – why model their impacts?

The assessment of economic, social and environmental impacts of energy interventions is very complex and context specific. The identification and attribution of impacts of energy projects present a number of significant challenges as compared to projects in sectors such as water agriculture, health or education. In assessing energy impacts we must consider that:

Energy does not in itself, for example, quench, feed, house, or clothe people. Rather, energy services facilitate and improve the provision of water, food, houses or clothing. Consequently, the chain of causality that leads from energy to improvements in people's lives is often longer and more complex than for other projects.

Energy services often bring about improvements in many aspects of life. Electricity, for instance, can be applied in activities such as pumping water, refrigeration of vaccines and/or welding of metals. Thus, IA for energy projects faces the challenge of measuring improvements in more than one area.

End-users' choices of energy sources for specific services are subject to many considerations, such as prices, traditions, the sustainability of provision and end user's income. Hence, the attribution of impacts to energy provision requires awareness of factors that affect choices and may vary over time.

The productive output of any process that requires energy services also depends on all the conditions that affect the specific type of production. For instance, production often requires that many other Inputs, such as appropriate raw materials, precipitation, maintenance skills and transportation to markets (if existing and functioning), are also available. Thus, the attribution of impacts to energy provision also requires awareness of other factors that affect production and, where applicable, marketing outcomes.

The positive impacts of access to energy may often become manifest many years after the project ends. Thus, reliable IA for energy should measure impacts beyond the project life cycle. This makes the documentation of conditions at the beginning of the project important, since it provides a picture of the status quo or a baseline from which to measure progress as well as insights into how energy would be used among end-users.

Referring back to the definition of "evaluation" above and taking these complexities into account, we have thus, perhaps especially in the field of energy, a need for some thinking-aid with respect to interventions. We would wish to systemize interventions into the inputs

brought in and the consequences yielded, into causes, effects, and processes that may intervene between the two. This section is intended as an aid to that matter.´

Before we proceed to the theoretical issues we wish to distinguish between three concepts related to impacts; assessment, monitoring and management. We may think of assessment and monitoring as distinguished by impact assessment (IA) having a wider focus but encompassing only a single data collection occasion, while impact monitoring (IM) has a narrower focus and involves the repeated collection of smaller amounts of data. In the latter case, data collection is often as a process integrated into other routine field staff activities. While this guide deals almost exclusively with IA, the role of IM should not be downplayed. The occasional "snapshot" obtained from IA is, hardly ever sufficient to yield information about sustainable impacts. IM, on the other hand, provides convenient, continuous information which can improve learning and understanding as well as ultimately, if properly designed, ensure that impacts are also managed, not just assessed (Simanovitz, 2001).

As a first step in the account of theory, we present the "result" and "impact" chains for the modelling of interventions.

5.2.2 Illustrating a results chain

It is useful to draw a visual diagram of the results chain leading to the expected effects of the intervention. As will be discussed in more detail below and in later sections, projects need not be very complex in order for a given link of the causal chain to give rise to several causal relationships. The probably best approach to characterizing your project in terms of the causal levels is an iterative procedure, whereby you switch between drawing a causal diagram and describing the characteristics of the various links with words. Generally, the quality of that diagram improves with the amount of detail

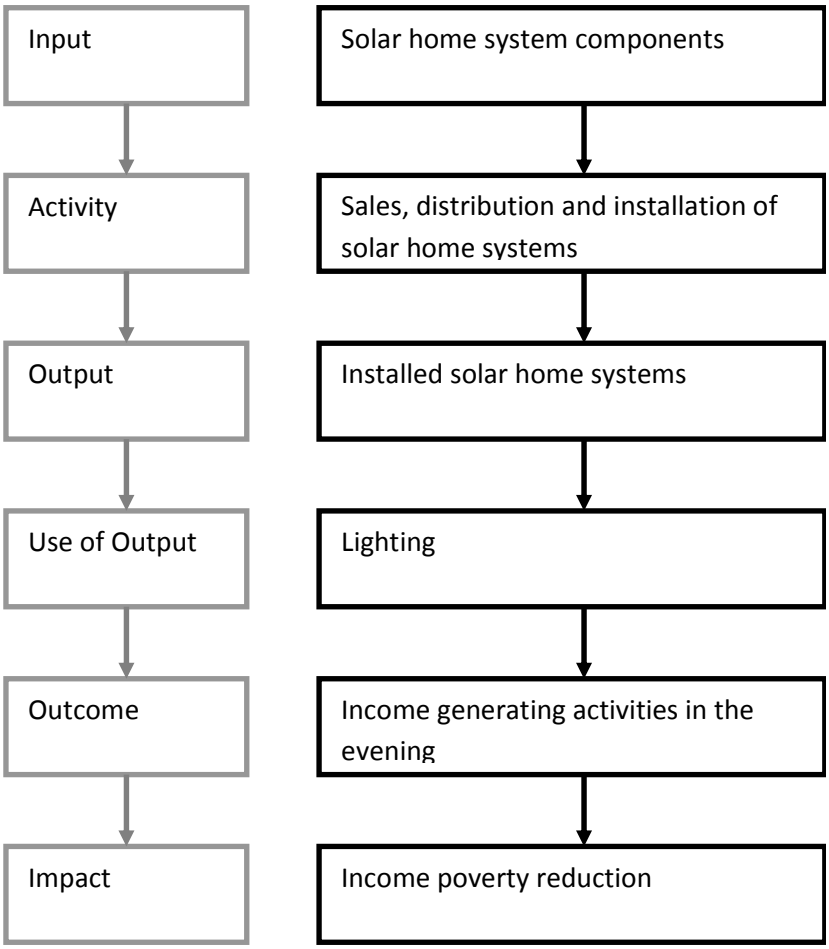

Figure 5.1 A simple results chain for a solar home system project

It is also very useful to construct the causal diagrams in a group exercise with the stakeholders. This facilitates the communication on the expected development changes due to an energy intervention, the different interests of the stakeholders and also the coordination of their Inputs into your assessment. Furthermore, your impact assessment gains ownership of the stakeholders by directly involving them in the assessment design.

In addition to the above four levels, the M&EED group suggests the use of activities - between input and output - which describes what a project does. Another commonly applicable level is the “Use of Outputs” which describes how the outputs are used by target groups or intermediaries. An example of a simple results chain for a solar home system project is illustrated in Figure 1 given for each link.

5.3 Identify your project’s stakeholders

In order to ascertain the relevance of a well-designed, project-specific IA scheme it is important to identify the information needs of the project's stakeholders. Such stakeholders may include:

- domestic public authorities
- stockholders, financial partners
- donors
- donor country public authorities
- beneficiaries/users/clients
- project management team
- the project's internal management team
- women's groups
- community based organisations
- researchers in academia
- yourself

For each of the stakeholders or groups of stakeholders, you need to know:

- what kind of information they want
- the intended use of this information
- how they would like the information to be communicated to themselves and other stakeholders

The IA needs of some stakeholders may be described in grant agreements or in procedure manuals. It is therefore advisable to first study such documents and then follow up with discussions, in order to arrive at a precise idea of what the required information is. If the stakeholders want to understand how the project contributes to national development policy objectives, you may find further information on these policies and their objectives in national development strategy documents, such as a Poverty Reduction Strategy Papers (PRSPs) or international objectives relating to the Millennium Development Goals (MDGs).

A project's development objectives may also be outlined and defined in project documents. The IA process should measure the success in meeting those objectives. One aim of the discussions with stakeholders is also to ascertain consensus on the project's development objectives. An assessor also needs to be aware that, behind a project's concrete explicit objectives, there may also exist assumed and/or implicit, unwritten objectives. Such objectives may only come to light through discussions. Since implicit or unwritten objectives may be used by some stakeholders to determine the project's success, it is important to reveal and become aware of these objectives at an early stage.

If previous assessments have been done, it is advisable to study these as well. If you identify any gaps in the assessment, perhaps your assessment can fill this gap. Alternatively, if you find the evidence on certain impacts in previous assessments a bit weak, you may want to pay particular attention to this in your own impact assessment.

Many impact assessments have also been used in academic papers and literature. It is therefore worthwhile to search academic literature for papers on energy interventions similar to the one you are assessing. For example, much has been written about the effectiveness of solar home system programmes in many countries worldwide. The literature on these

programmes may help you in determining the focus of your assessment or in identifying indicators for your assessment.

5.4 Delimit your focus on the intervention.

In order to devise IA schemes in the format of a four-level results chain, certain information must be assembled and digested, in addition to the needs of the various stakeholders. The final categorization of project features into the levels of the results chain depends crucially on where one chooses to define the start and/or end points of the causality to be modelled with the chain.

Thus, it is essential to define what constitutes the "intervention" and what does not. In that process, the answers to two questions regarding each intervention can be of considerate help. Does the intervention:

- provide energy or improve the utilization of energy with the intention to meet one specific purpose or several purposes?
- involve the provision of energy or improved utilization of energy through one or through several types of technology?

In this context we may think of an intervention as being of "low complexity" if it is intended to meet one objective with one technology. On the other hand, if a project involves several technologies in order to meet several purposes, we may call it a "high complexity" intervention. It is also conceivable that the intervention is not undertaken with a specified purpose, in which case the importance of the stakeholder dialogue increases. Figure 2 is intended to aid the identification of an intervention's complexity. The figure shows four kinds of projects of differing complexity. An intervention involves one or several types of technological inputs and the intervention may be undertaken for one or several purposes. In both aspects, the "several" option is illustrated with two types of technology and/or two purposes..

In rather abstract terms, an intervention can be identified as resembling one of the four in the illustration by its purpose, the investigator is led to consider the usages (outcomes) of the energy services (output) that are associated with the intervention's purpose and the extent to which the technology (input) brings about such services and usage in the context of the intervention

Alternatively, if the technological input of an intervention is known, the investigator is encouraged to identify the sort of energy services (output) that are likely to be derived from each technology (input) and their potential usage (outcome) (example b). We will return to the topic of conceivable uses of energy for specific purposes in the section on assignment of indicators.

Some examples of projects with differing complexity are:

- *Single technology, single purpose* - wind driven water pump with sole purpose for irrigation
- *Single technology, multi-purposes* - rural solar PV charge stations offering battery charging services for cell phones, battery operated lamps, and other battery operated electronics

- *Multi-technology, single purpose* – Solar PV and diesel powered water pumps for rural irrigation

- *Multi-technology, multi-purposes* - grid electrification provides lighting, communication, and entertainment for homes, irrigation for agricultural sector, lighting and refrigeration for health sector and lighting for schools.

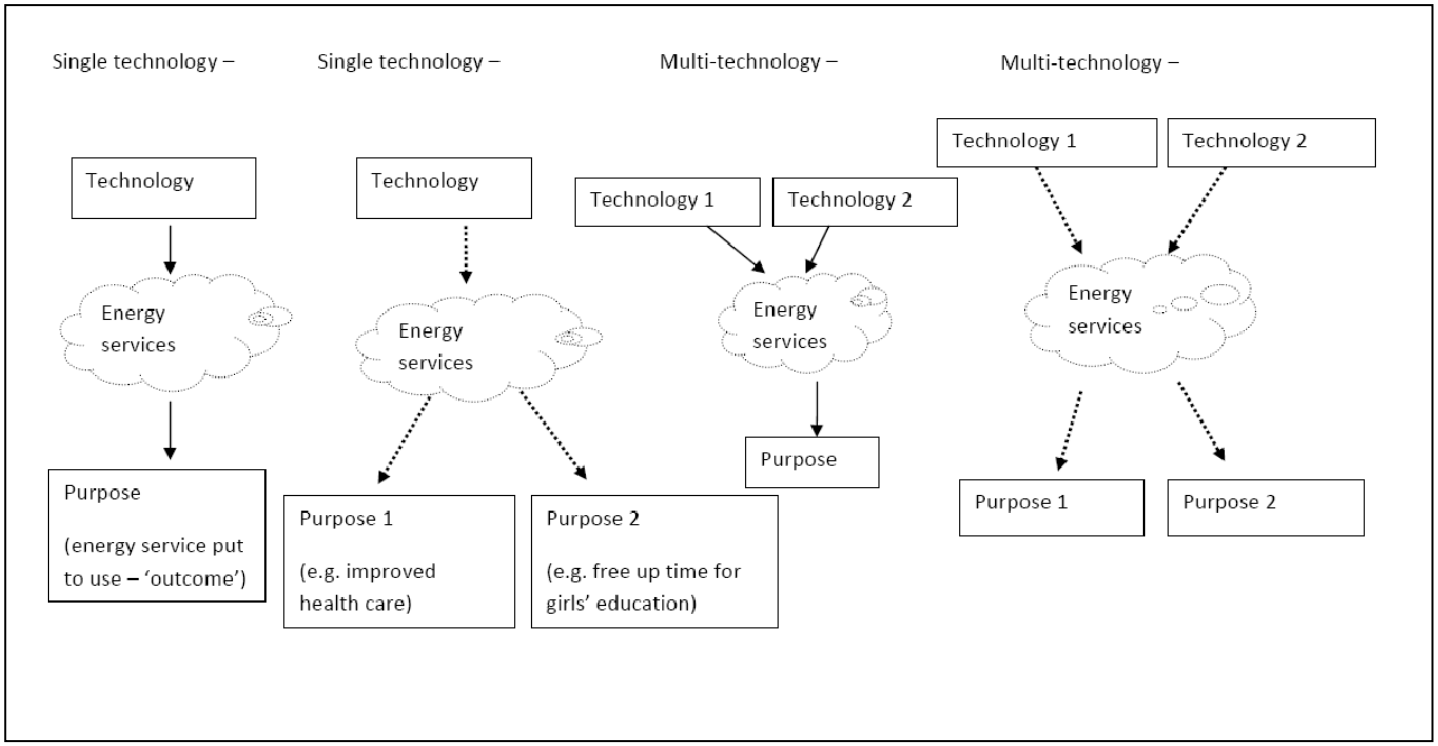

Figure 5.2 Energy interventions as distinguishable by multiplicity of technological input or of purposes

5.5 The results chain revisited – identifying the elements and causality issues

For the aid of project evaluation the M&EED group has developed "Thematic modules". These modules are conveniently built from templates for the links of the results chain. The templates are used here to show the adequate questions to ask at each step of the design stage. In this section we shall concern ourselves with the identification of the links and issues of causality that eventually form each conceived hypothetical relationship.

Name of Input		
General nature of input	Classify the type of input. For instance an input may, depending on the technology, be: **Material**, e.g. : *solar panels, diesel engines, in defining the modalities for competitive bidding for concessions* **Social**, e.g.: *assistance in poles, hydraulic works* **Financial or economic**, e.g.: a g*rant or debt funding for a technology specific financing mechanism, for instance grant and loan to establish a rural electrification fund.* **Institutional**, e.g.: *support setting up village associations for managing a local mini-grid.*	
Who brings the input?	The Input may be brought by the project itself, by another development project, by public authorities, by private actors, or by a combination of these, e.g.: A mini-hydro electrification project may depend on water works to be built independently of the project	
Objectives and units of measure	For example: kW capacity, kWh, TEP, tons, households connected	
Issues associated with the input	Potential issues or problem	Points to be attentive to, preferably solutions
	EXAMPLES: Maintenance Limited energy production Pollution Use of local natural resources Changes in economic conditions Lack of benchmarking Theft	

Table 5.1 Inputs template

5.5.1 Inputs

Table 5.1 above provides a template for characterizing the inputs. There are at least four general classes of inputs; Material (both technical and capacity), Financial or Economic, Institutional and Social. One or several types of input may go into a given project.

It is useful to keep track of who, which organization or authority brings and/or is responsible for the maintenance of the various types of Inputs. This information is useful not least in the context of responding to the impact assessment. Again, in a setting where skills are scarce, it is beneficial to keep track of individuals' names, since specific knowledge may be vested in particular persons upon which rests the responsibility for development effects further downstream. Since consequences of the project may depend on the amounts of input, one may want to measure those amounts and capture the units of measurement of each type of input. (It may however be difficult to measure skills or judicial support.) The units of measurement are also useful for conceiving of indicators, see below. Finally, it is obviously an advantage to try to foresee and list potential complications associated with each input, as these could jeopardize the whole intervention and need be examined. Please note that projects may require several of these templates.

Name of Output		
General nature of output	The output is often an energy service or an energy vector. Three common classes of use are (i) **Domestic**, (ii) **Collective** (e.g. schools, clinics or street lighting (iii) **Productive**.	
Who participates in producing the output.		
What to measure	Apart from the actual output, it may be useful to measure some factors internal or external to the project, which influence the success or the project in question. Such factors may be meteorological conditions or prices of goods that influence energy production. For instance the price of LPG may influence a charcoal /wood stove project.	
Options for units of measure		
Options for indicators	*Name possible indicators and their associated measurement protocols. (The detail pertaining to indicators will be discussed in Chapter 4.)*	
Issues and problems associated with the Output	List of issues or problems in quantifying or qualifying the output.	
	Potential issue or problem	Possible solution for establishing an appropriate M&E scheme

Table 5.2 Outputs template

Note also that it is important to be highly specific when entering inputs. For instance it is not advisable to write just "water" or "water from a creek". Rather specify "water from the 'Clearwater' creek which runs four hundred metres east of the village". The rationale for this amount of detail is that much time and frustration may be saved by first investigating the state or availability of input. Staying with the creek water, if every link down a results chain crucially hinges on the availability of the water, a high priority on the assessor's agenda is to investigate the availability of water from the creek. In the absence of the creek water, the

search for present outputs, outcomes or impacts in this case is likely to be in vain. For similar reasons, one may wish to be specific also with respect to types, brands or versions of input, all of which may yield different consequences. This could be the case, for example, if malfunctioning parts have mistakenly been replaced with spares of a different make.

5.5.2 Outputs

The process of describing the outputs of an intervention is similar to the process of describing its inputs. Table 5.2 provides the template for describing the Outputs. The differences between this template and the previous one are small, but the contents help us ask the proper questions. Outputs are often energy services or carriers. Appliances or devices produced or improved on site may also be classified as outputs.

It is also convenient to consider the user groups of the output goods or services. As an example of how to take into account differences uses of Output we show two causal trees for a rural electrification project in Figures 3 a and b. The first illustration shows a starting point for the process, whereas the succeeding one is a much later version that takes into account different uses of electricity in different sectors of an African country.

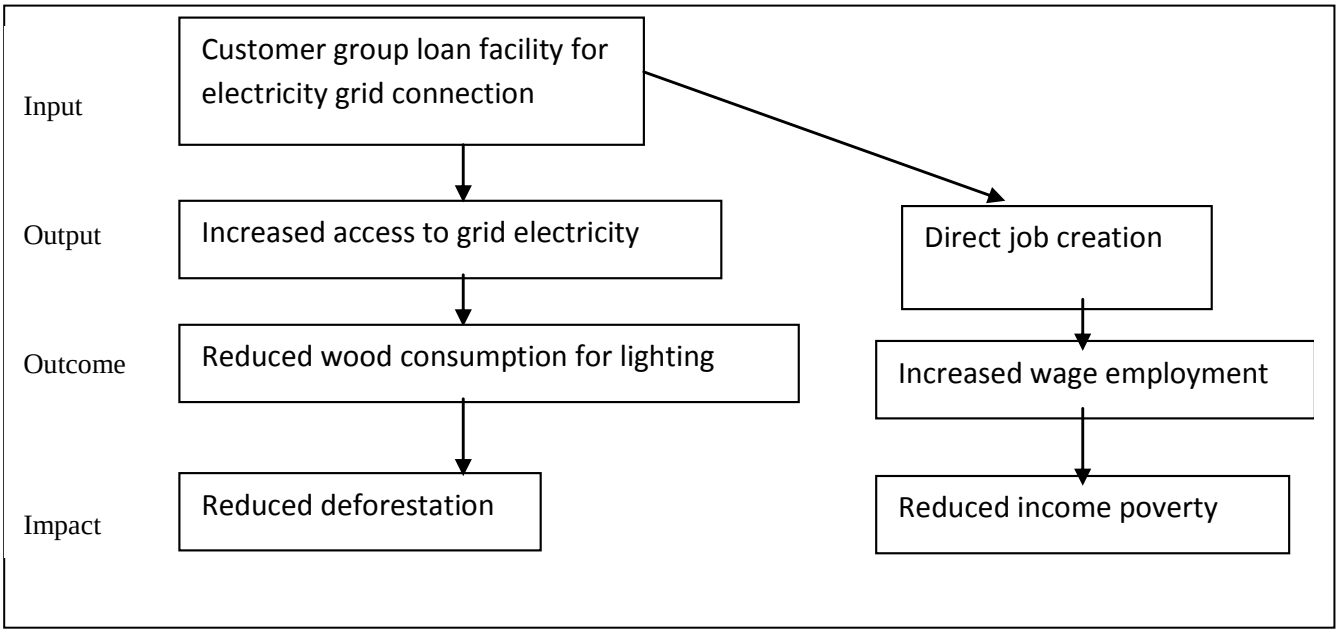

Figure 5.3a First-draft rural electrification diagram

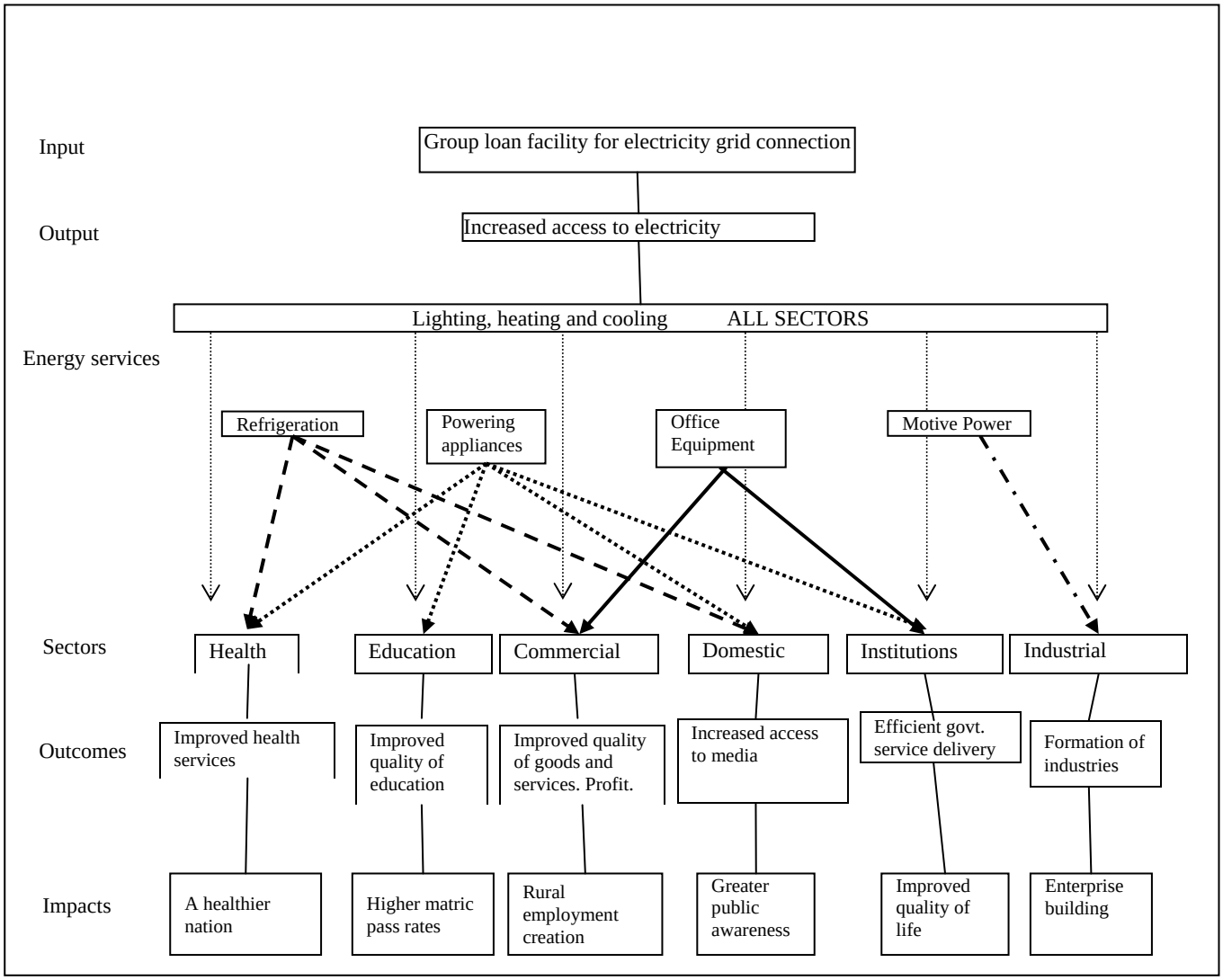

Figure 5.3b Final rural electrification diagram.

5.5.3 Identifying outcomes

This subsection is intended to help you identify the purposes for which energy may be used among project beneficiaries. By improving the quality or availability of energy for those – and/or other – purposes we hypothesize that beneficiaries' living standards are affected. It will be assumed that the final beneficiaries of your intervention are households and their members. We therefore let the "development impacts" to be assessed correspond to the living standards improvements experienced by households, as a consequence of the intervention (If the final beneficiaries were firms the suggested linkages would differ. However, the key message here is the need for a detailed understanding of how energy services are utilized among beneficiaries.) It is implicitly assumed that the household's living standards are affected through its generation of income, through public or communal services, and through its domestic activities. The household is assumed to generate income through wage employment or through production of goods and services – whether for sale or for own consumption - in farming or other business activities. Some conceivable means by which energy services could feature in the domains of households' living standards generation are illustrated in Figure 5.4.

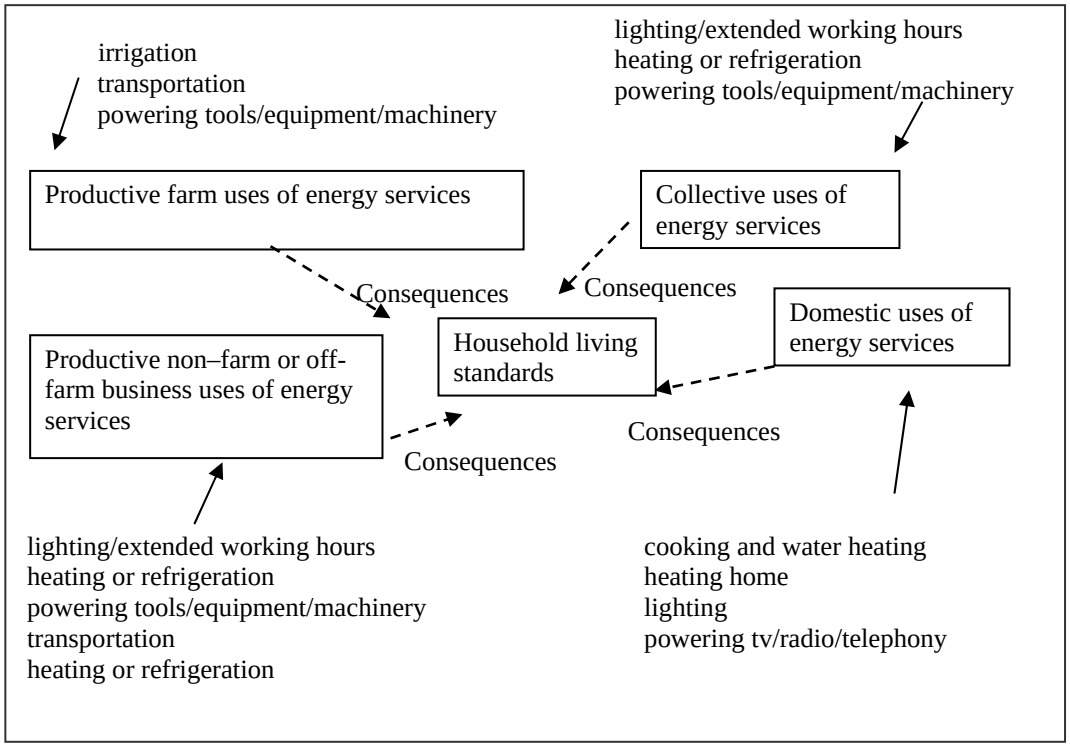

Figure 5.4 Examples of energy services utilization which have consequences for household living standards

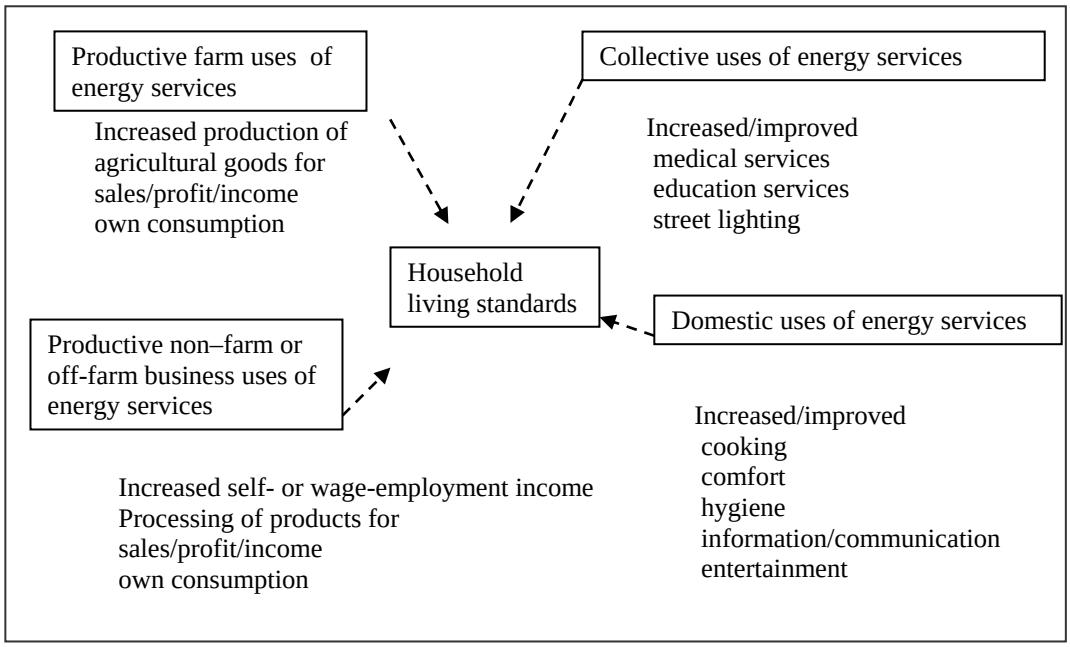

Figure 5.5 Examples of consequences for household living standards from the utilization of energy services

In reality the distinction between what is a farming activity, small-scale business, or domestic activities may be blurred. This could, for example, be the case when grains are milled to flour with a power-driven grinder, where the end-use of the flour may be for both domestic purposes as well as for sale. However, when milled the end-use of the flour may not be identifiable at that stage. For assessment purposes it is however probably more important to first register that energy is used for grain milling and, secondly, that the flour milling is for both domestic and productive purposes. The exact extent to which milling is done for either purpose is of subordinate importance here.

Finally, at the outcome or impact level, the impact assessment scheme will cover consequences in the form of non-energy products or services. The consequences will vary with the type of intervention and the kinds of energy services utilized. Some conceivable consequences of improved energy services in the different living standards domains are illustrated in Figure 5.5.

5.5.4 Impacts and causal complexity

Often the ultimate reasons for interventions are indeed impacts generated beyond the outputs or use of outputs levels. Rarely however, may it be possible to identify a causal relationship that explains how such indirect benefits came about. As an investigator you need to be aware of this "attribution problem". On the one hand, you want to keep development results in view that, especially in aggregation, would indicate progress towards achieving the Millennium Development Goals or your country's Poverty Reduction Strategy. On the other hand, you may need to allocate your (often scarce) impact assessment resources towards what you think are feasible ambitions. The attribution complexities were illustrated in the literature review section's Figure 5.4, which showed how causality can disperse in different directions and an effect from one intervention may be a cause of further effects. Input in the form of a diesel engine, brought by an energy project, yielded shaft power for the extraction of water as output. The pumped water would be an output of the energy intervention, but serves as one of several inputs into an agricultural project, which could yield an impact in the form of higher incomes. A parallel health project aimed at reducing dysentery also utilizes the pumped water as an input alongside pipes and education to promote the use of potable water. In combination, the three interventions may bring about development impacts in the form of improved living standards. In interpreting the figure we may be well served to imagine also contextual influences from

- ground water levels and diesel availability on the water output
- weather conditions on agricultural production
- access to agricultural markets and prevailing prices on crop revenue and farm income
- spare or replacement parts and repair skills on water pipe maintenance

Each of these four influences form part of the context of the separate projects and may seriously complicate the attribution of development impacts to the diesel engine. As some remedy, we propose that where appropriate, draw on local, project or context specific knowledge to identify and take note of relevant outside circumstances, conditions or influences.

5.6 Choosing indicators

When you have constructed the chain and identified the links of interest, the time has come to find ways to measure the changes that your project has incurred. The direct changes or outputs may be easier to measure than outcomes or impacts. As mentioned, development projects sometimes aim to contribute to large national objectives such as improving health or gender equality. On the one hand you may have to try to conceive of measurable indicators that describe these larger, "macro" goals. On the other hand, you will also have to find indicators for the more concrete or "micro" level inputs or consequences that you have identified.

A useful step in identifying indicators for the different elements in the causal tree is to think of a number of research questions for each element. These are in fact the key questions to which you'd like to get answers, and they are specific to the link with which they correspond. The questions can also relate to linkages with other sectors. Further, the questions should provide you with some idea of where or with whom the information you seek rests.[10] In choosing indicators for the links of your results chain you want to keep the following criteria in mind:

- pertinence to your project
- interest for project stakeholders
- ease and cost of measurement or data collection
- the possibilities for triangulation between sources of information

Indicators do not have to be numeric. Indicators may be qualitative. In some cases, information stored as pictures, videos or voice recordings of "anecdotal" information may be the most pertinent indicator formats. In other cases behavioural change or attitude may be an indicator. The rightmost section of Figure 5.6 provides examples of indicators for each level of the solar home results chain from section 5.2.

In addition to the links and national development objectives that you have considered, there are many cross-cutting issues which may be important to the sustainability and success of your project. It is advisable that the following transversal issues are adequately treated, taking into account the needs of your project and your stakeholders:

- gender dimensions and equality; the different impacts of your project on women, men and children of different gender
- discriminatory impacts on community subgroups (according to poverty status, religious affiliation or ethnicity)
- long term viability and project replicability: economic/financial, technical and environmental sustainability - including the impact on GHG emissions, biodiversity, wildlife, forests, and harvests.

[10] The formulation of research questions can also help you in the designing questionnaires and implementing data collection methods. For example, in designing questionnaires, you adapt the research questions to questions you can actually pose and specify them according to the different sources.

- social and cultural acceptability of your project activities
- revenue-creating activities, job creation
- end-user satisfaction
- training and capacity building
- local ownership and participation
- external conditions, not under the control of the project, but which influence project results.

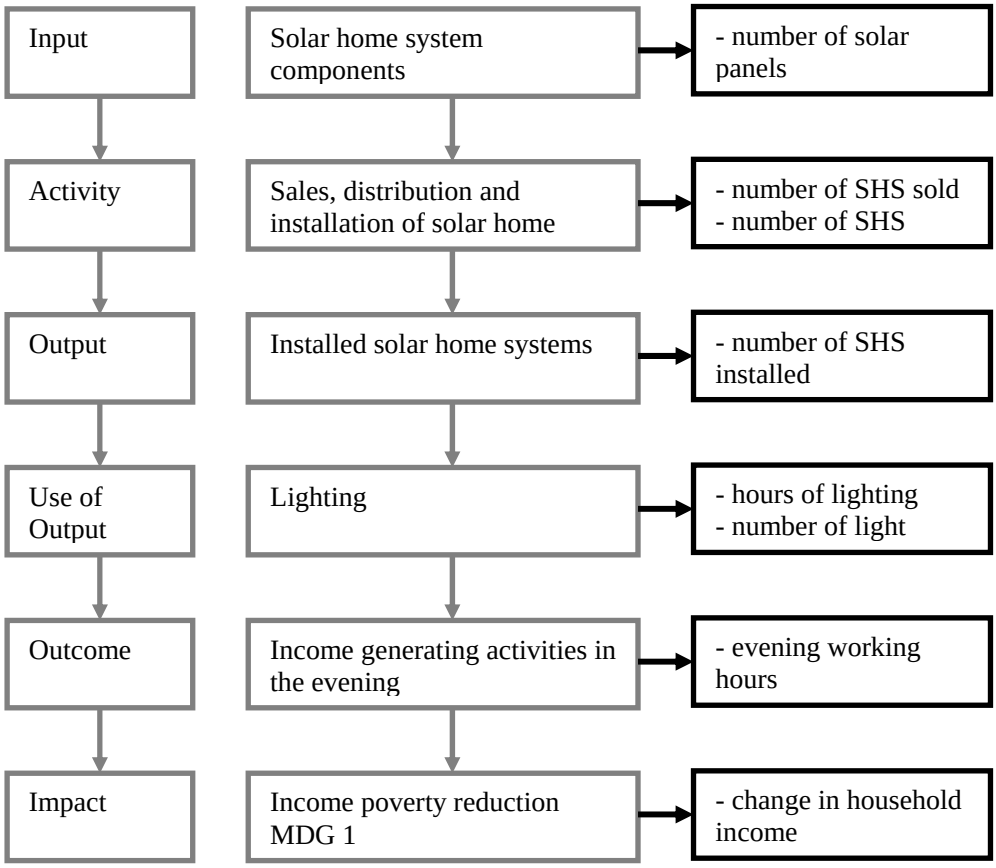

Figure 5.6 Examples of indicators with units of measurement

5.7 Assign data collection methods

In the Introduction section we made a case for the particularity of each intervention. This implies that each project has to be approached with specific methodologies. While fieldwork expertise may be transferable across research themes, the best mix of data collection methods depends crucially on the context at hand. However, it cannot be emphasized enough that the assessment depends crucially on the quality of the collected data. Each indicator is measured using one or more data collection methods. These may be, for instance:

- Physical measurement (satellite data on forest cover)

- Data extraction from public statistics (school attendance or agricultural production)
- Interviews
- Extraction of accounting or administrative data of a public or private organization (ESCO customer records)
- Focus groups and other participative methods
- Household or firm surveys

A long range of participatory data collection and knowledge creation methods exist that can be applied to impact assessment studies. Each of those as well as the quantitative methods has a different pattern of strengths and weaknesses. (A more detailed account of impact assessment tools is found in Simanovitz (2001). Rai (2005) provides a fuller account of participatory approaches for impact studies of energy programmes.)

The data that can be collected in IA studies is however, often very limited. It is therefore important to first undertake qualitative research so as to determine which indicators provide the most accurate reflection of the type of impact information that one wishes to gather. The tools selection process therefore also involves a close look at the kind of data a particular approach will produce and considerations of how that data should be processed and analyzed. A common mistake is to select indicators based on an insufficient understanding of the processes one seeks to assess. The starting point in any impact assessment is therefore preparatory analysis (Simanovitz, 2001).

The key methodological challenge is to choose a mix and combination of methods, rather than to pick one, unique method. The choice is obviously subject to considerations of resources available and the context at hand. Nonetheless, a trend seems to be towards efforts to combine the advantages of representativity, quantification, and attribution in sample survey approaches, with participatory approaches' abilities to uncover processes, capture the diversity of perceptions, views of minorities and unexpected impacts. At one extreme end of the range of methodological mixes one could find those used to "prove" impact for policy or major investment purposes. At the opposite extreme could be to independently corroborate the impact and strengthen implementation aspects of a small-scale programme. In the first case the mix would probably entail a large scale, longitudinal sample survey, supplemented by triangulation from the other methods. In the latter case, a mix of rapid appraisal and small-scale survey would likely suffice (Hulme, 2000).

On the respondent side, the issue of how to persuade respondents to spare the time for an interview, and provide accurate and honest answers, is an important one. Different strategies are needed for programme beneficiary and control group respondents. As a rule of thumb many researchers suggest that interviews should be concluded within one hour and that one and a half hours should be seen as the absolute maximum for an interview.

Beneficiaries usually accept that being part of a programme comes with "answering questions". The quality of the data still depends on the respondents' understanding of why they are being interviewed and utilising the opportunities to ask questions before the interview. In dealing with control groups, motivation may become an issue, especially if longitudinal data is collected. A first interview has some novelty and amusement value. However, for longitudinal studies, the provision of some reward to interviewees should be

considered to promote data quality and for ethical reasons. Finally, participatory often stimulate respondents by their inherent social interaction. However, in conducting these kinds of exercises, care must be taken to observe who has turned up and who has not come to the meeting. Additional focus groups or interviews of non-attendees are often required (Mosse (1994), Mayoux (1997)).

Results chain elements	What to measure?	Indicators	Unit	Source	Data collection methods
Inputs	Solar home system components	- number of solar panels - number of inverters	- solar panels - inverters	- ESCO records - ESCO records	- interview/desk study - interview/desk study
Outputs	Access to electricity	- total number SHS installed - SHSs technically operational - households paying for service	- SHS - SHS - households	- ESCO records - SIDA - ESCO records - ESCO records	- interview/desk study - evaluation report - interview/desk study - interview/desk study
	Esco employment	- jobs - income	- jobs (hours) - Kwacha	- ESCO - ESCO - employees	- interview/desk study - interview/desk study - interview/survey
Outcomes	Use of electricity	- number of appliances per household - types of DC appliances	- appliances - N/A	- households - technicians - households	- survey, focus groups - interview - survey, focus groups
	lighting fuel consumption	- volume of fuel purchased - fuel expenses	- liter/week - Kwacha	- shops - households	- interview - survey
	business hours	- avg. daily business hours	- hours	- shop keepers	- interview
Impacts	Communication	- cell phone charging/availability	- cell phones/household	- cell phone co. - households	- interview/desk study - survey/observation
	Economic opportunity	- employment generation - new businesses - time available	- employment status - Kwacha/household - hours	- households - households - households	- survey - focus groups - survey

Table 5.3 Examples of solar home project causal links, with indicators, units of measurements, data sources and data collection methods

5.8 Fill in the research plan

In this Section we present a stepwise method to create a basic research plan. It is assumed that you have identified the causal links into which you want to investigate, that you have identified relevant indicators and considered the most appropriate data collection methods. These could be stored in the format of Table 5.3 above. In our experience, a graphical illustration (such as a causal tree) of the causal links to support your further thinking.

Table 5.4 below is the first step in converting Table 5.3 into a research plan. From Table 5.3 the columns have been rearranged to shows a list of the various sources and the elements each source should provide information on. The first column identifies the source of information, the second the kind of methods to be used and the third displays the kind of information sought.

Having completed Table 5.4 and before going to the next step, it is wise to reflect on the list and check or discuss whether:

The amount of information expected from each source is realistic in terms of content and amount

Most of the information elements are fed by more than one source, at least the important ones. The results become more reliable by triangulating between different sources and looking at issues from different perspectives.

If needed, you adapt the matrix accordingly.

Source	**Methods**	**Indicators**
ESCO	interview, desk study	number of systems sold
Technicians	Interview	number of systems installed

Table 5.4 Connecting data sources, data collection methods and indicators

The next step in the research plan is to determine, for each source, the percentage of the research population to approach (sample), in order that the survey is representative (sampling). This does not apply to sources like reports, archives etc, but mainly to human sources. If the research needs to be statistically representative this will require relatively large samples. It is difficult to give standards for sampling in this case, but depending on the size of the research population a representative sample is likely to range between 5% and 35% Some examples of sample sizes used in previous case study research and evaluations are shown inTable 5.5.

Source	Size of research population	Sample
people employed through a project	10 (persons employed)	2-3
household surveys	community of 500 HH	30-40 HH surveys
household focus groups	community of 500 HH	2-3 focus groups 6-8 participants each homogeneous groups (men, women, youth separately)
teachers	25 teachers	3-5 teachers

Table 5.5 Typical population and sample sizes in surveys

Source	Method	Sample size	Respondent specification	Resources needed	Duration
ESCO	interview	1	project manager		
Technicians	interview	2	1 new, 1 experienced		
Household	Focus group	3 x 8	1 group women, 1 men, 1 youth		

Table 5.6 Sources, methods, sample size, respondent specification

For case study research it is unlikely you'll use random samples; rather you'll make a stratified sample. This means that in order to maximize the spread you'll aim for a variety within your sample, for example between males and females or senior managers and regular employees. When sampling you could consider including a control group, i.e. a group of people not part of the project or who did not experience the intervention. This only makes sense if you have the resources to address a considerable group otherwise it is merely useful for illustrative purposes. Furthermore note that in order to get a sample of two out of ten you may have to approach 200% (four persons) in order to get two actual respondents, due to availability problems. As a result of the sampling exercise you may include a data collection overview in your research plan which would now look like Table 5.6. The overview in Table 5.6 will be the basis for the data collection planning, which could take the form of Table 5.7.

The final objective of the assessment procedure's design stage, the research plan, is depicted in Table 5.8.

What	When	Who	Remarks
Preparation			
Finish and agree on research plan			
Desk study			
Design questionnaires			
Recruit respondents			
Recruit research assistants (if needed for surveys)			
Prepare focus group discussion (if applicable)			
Elaborate data collection planning			
Data collection			
Continuation desk study			
Interviews (if applicable)			
Focus groups (if applicable)			
HH surveys (if applicable)			
Observation			
Documenting preliminary findings			
Updating people involved in research on preliminary findings			
Analysis and Reporting			
Data analysis			
Report writing			
Discussing draft report			
Finalising report			
Communicating results			

Table 5.7 Overview of research planning.

Link	Elements in your results chain diagram	Indicators	Units of measurement	Source	Data collection methods	Respondent specification	Sample size	Resources needed	Duration	Person responsible for data collection	Date for data collection
Inputs											
Outputs											
Outcomes											
Impacts											

Table 5.8 The empty research plan – outline

6 Case Studies

To apply and test the Assessment Framework described in the previous chapter, case studies on energy interventions were carried out by the six African Centres in the target countries: Botswana, Ghana, Mali, Senegal, Tanzania and Zambia. The six case studies examined the inputs, outputs, outcomes and developmental impacts of a variety of energy interventions, which had been implemented in the countries.

The case studies were planned by the six African case study teams, facilitated by Risø and ECN staff, at a workshop in June 2007, at Fringilla, Zambia. Hence, the process of preparing the case study was termed, 'The Fringilla Process'. The Fringilla Process is taken to mean the process from delimiting the system boundary of the intervention to be studied, constructing the 4- (or more) level causal chain or diagram, translating the causal diagram into assessment tables (fiches) including data to measured, associated indicators, information sources and methods, and culminating in a research plan.

Figure 6.1 The DEA project teams working on case study preparation at the Fringilla workshop.

6.1 The case study selection process

DEA project resources allowed for one case study to be carried out per country, assuming that approximately 2 man months of Centre resource would be used for each. The case studies were selected from the portfolio of projects contained in the Catalogue in such a way that a number of criteria would be fulfilled, such as:

- Covering a range of different types of energy project to test the Assessment Framework
- Relevance to the country stakeholders
- Achievable within the given constraints of the project

- Displaying a sufficient range of potential developmental effects to test the DEA Framework, i.e. non-trivial

The selection was carried out in consultation between all the partners, in part using a weighting scheme to consider the criteria, and eventually the following mix of case studies was agreed upon:

- Botswana: Rural electrification by grid electrification
- Ghana: Rural electrification by grid electrification
- Mali: Women's Renewable Energy Project
- Senegal: Improved Cook Stoves (the PROGEDE project)
- Tanzania: Wind and Solar PV Powered Irrigation
- Zambia: Solar PV Energy Service Companies (ESCOs)

It is to be noticed that two cases of grid-based electrification were chosen. This was justified by the importance of rural electrification and the likelihood of many different developmental effects in the cases. To complement the two grid-based projects, the Zambian study focussed on decentralised solar electrification, based on the energy service company concept charging a fee for service.

Also worth noting is the Mali Case Study, which comprises multi-technology interventions in many locations, complicating the analysis, and requiring a high degree of focussing.

Altogether, the set of case studies provided a reasonable test of the Assessment Framework within the resource constraints of the project.

The individual case studies are summarised in the following sections, bringing out different aspects of the studies, the energy interventions and the national contexts in which they are set. Full details of the case studies are available elsewhere, in the Case Study Synthesis Report and the Country Case Study Reports, all available from the project website www.deafrica.net.

6.2 Botswana: Rural Electrification by Grid Extension

6.2.1 The energy intervention

Rural electrification in Botswana is primarily achieved by providing loans to consumers to reduce the burden of up-front costs of connecting to the electricity grid.

- The rural electrification programme covers villages throughout the whole country and by December 2006 when the case study was completed and reported, 238 villages had been electrified and rural electricity access had reached 37% from a level of 3% in 1996.
- The programme is funded by the Government of Botswana through a consumer loan scheme, the Rural Electrification Collective Scheme (RCS). The scheme has undergone several changes since its inception in 1988 with respect to loan deposits, repayment periods and interest rate. There is evidence that the majority (>80%) of electrical connections in rural areas have been achieved through the RCS programme.
- Rural electrification is continuing in Botswana through the RCS programme.
- The impact assessment of the RCS/RE on development focussed on one particular village (Manyana) which is at the boundary of peri-urban and rural zones.

6.2.2 Selection of the case study location

The choice of Manyana village for the case study was justified by several criteria:

- Proximity (<100km) to the capital Gaborone allowed repeated visits to undertake both interviews and focus groups, and also to verify information, working within the time and resource constraints of the study.
- Preliminary knowledge of the village indicated that several development sectors were active, including health, education, agriculture, communications, SMMEs. This provided a good basis for testing the methodology in different contexts.
- The village had been connected 5 years or more so that there was a good chance that development impacts would be manifest.
- Other criteria, such as social setting and influence of past initiatives and environment, leadership etc., played a role in the choice of location.

6.2.3 Case study methodology

The case study comprised the following activities:

- Reviewing of relevant literature and statistics on connections
- Meeting village authorities to solicit for support.
- Undertaking informal interviews with village authorities and officials
- Administering semi-structured questionnaires to beneficiaries (domestic, education, health, commercial, industry and government)

- Undertaking a focus group at the Chief's kgotla[11] consisting of both men and women
- Estimation of the baseline situation using "recall" since no formal records were available regarding the situation before electrification.
- Data analysis was done using Excel. To yield both quantitative and qualitative indicators

Figure 6.2 Causal link diagram for the Botswana rural electrification case study

6.2.4 Results

The impact assessment showed that:

- There is facility for food preservation, increased literacy and informed population in the homes
- Improved teaching facilities and attraction of qualified staff hence an increase in the quality education provided in the village.
- Improved health systems - through new drugs, lit emergency rooms and staff retention in clinics contributing to a healthy population.
- Commercial businesses have increased their income through introduction of new products and increasing their sales. New industrial SMEs have started as a result of electricity being available in the village. Both the commercial and industrial sectors have increased employment and enterprise building.
- The Village (Government) authority is achieving better service delivery through the use of electric office appliances

[11] A kgotla is a public meeting, community council or traditional law court of a Botswana village. It is usually headed by the village chief or headman, and community decisions are always arrived at by consensus. Anyone at all is allowed to speak, and no one may interrupt while someone is "having their say". In fact there is a Setswana saying that the highest form of war is dialogue (ntwa kgolo ke ya molomo). Because of this tradition, Botswana claims to be one of the world's oldest democracies. (source: Wikipedia)

6.2.5 Lessons learnt

- Full participation of stakeholders is necessary in the design of projects and their Monitoring and Evaluation.
- Impact assessment must relate to national development objectives in order to make sense to stakeholders. Results obtained can be aligned to stipulated objectives & goals in the National Development Plan, Vision and Millennium Development Goals; Poverty Reduction Strategy Papers, etc.
- Value judgement of stakeholders, particularly beneficiaries is an important indicator of impact of projects on development.
- Whilst baseline data is required for impact assessment, some indicators can be established using a combination of the recall method, past studies and statistics.
- The same assessment framework used for assessment of impact on development can be adopted for project design and M&E.
- There is interest among stakeholders to use the assessment framework but its adoption by stakeholders will require some training.

Further details on the Botswana case study are available in the Case Study Synthesis Report, the Botswana Case Study Report and the presentation by the author Peter P. Zhou of EECG Consultants at the Arusha Regional Workshop, all of which are available at the DEA website.

6.3 Ghana: Rural Electrification by Grid Extension

6.3.1 The energy intervention

The National Electrification Scheme (NES) was instituted in 1989 as the Government of Ghana's principal instrument to achieve its policy of extending the reach of electricity to all parts of the country over a thirty-year period from 1990 – 2020. The importance of the NES was seen in the fact that at the beginning of the NES, only about 15% of the total population of Ghana had access to electricity supply. However, for the rural population who from more than 70% of the country's population, access to electricity was only 5%. The goals and objectives of the NES are targeted towards:

1. Poverty reduction, especially in the rural areas;
2. Increasing the overall socio-economic development of the nation;
3. Increasing people's standard of living, especially those in the rural areas;
4. Creating small-to-medium-scale industries in rural areas;
5. Enhancing activities in other sectors of the economy, such as agriculture, health, education, tourism, etc;
6. Creating jobs in the rural areas and thus reducing the rate of rural to urban migration.

Sixteen years down the line however there is growing evidence that not all the objectives have been achieved although through the NES access to electricity nationwide has risen to 54% as at 2005. The case study, examined the impact of the electrification on seven selected sectors of the communities.

6.3.2 Selection of the case study locations

The case study was carried out at three village locations in the Central region of Ghana, with different characteristics regarding amenities and degree of electrification, as follows

- Ekumfi–Otabanadze:
    - Population is about 1000, 1 kindergarten, 1 primary school, 1 junior secondary school
    - drinks borehole water, no bank, no post office.
    - Real access in the community is about 75%.
- Ekumfi–Ekrawfo:
    - Population about 1000, 1 kindergarten, 1 primary school, 1 junior secondary school
    - drinks borehole water, no bank, no post office.
    - Real access in this community is about 40%.
- Ekumfi–Atakwa:
    - Population about 1700, 1 Kdg, 1 primary school, 1 junior secondary school
    - borehole water, no bank, has a post office, private clinic which is about 100 meters away from the community.
    - Real access in this community is about 75%.

6.3.3 Case study methodology

- Reviewing of relevant literature and statistics on connections
- Meeting village authorities to solicit for support.
- Undertaking informal interviews with village authorities and officials
- Administering semi-structured questionnaires to beneficiaries (domestic, education, health, commercial, industry and government)
- Undertaking a focus group at the various community centres
- Baseline used was the recall Method
- Data analysis was done using SPSS. To yield both quantitative and qualitative indicators

6.3.4 Field Methodology

Using a tradition-sensitive approach, the research team on arrival at the communities first approached the Assemblyman and briefed him on the mission and the purpose of the visit/project and its importance. The Assemblyman, then, as tradition-demands gave a prior notice to the chiefs of the three communities through the Unit Committee members. He then led the research team to the chiefs to formally inform them about the project and the assistance that the team required from them. The chiefs then paved the way for the research activities and then dispatched the village ‘gong-gong’ beater to announce and gather the inhabitants for the focus group discussions

Figure 6.3 A sophisticated gong-gong beater (using a megaphone instead of a gong-gong) announcing our arrival and the start of the focus group discussion. This advancement was exhibited in one of the three communities.

Focus Group Discussions (FGD) – In all the three communities, the FGD preceded all the other individual one-on-one interactions and questionnaire administration. This was also to ensure that prior to visiting individuals in their households they would have had knowledge of the research activity as well as shorten the time spent explaining the process to every individual at the household level.

Figure 6.4 Assemblyman introducing research team to the Focus Group

Figure 6.5 Collective (male and female) focus group discussion

Collective FGD (male and female) – A general observation made during the collective FGD was that all the women either gathered and sat behind the men or grouped themselves in a different area away from the men. The women were initially not forthcoming with answers/contributions until after being pushed by the men to do so. Even then only a few were bold enough to come out with answers and contributions. This further enforced the research team's initial plan to have separate FGDs for men and women after the collective one.

Men only FGD first – This discussion was more or less business as usual with the men boldly expressing their views on the impact of electrification on their communities.

Women only FGD – When the women gathered alone, there was a complete change in their attitude from a previously 'timid' position in the presence of their men to a vibrant and aggressive one. It was a little 'chaotic' trying to 'control' them with many of them eager to express their views and answer questions. Intuitively, one of them took the position of a leader and controlled/decided who raised up their hands to answer a question or contribute.

Both the men and women groups were in agreement on the positive impacts of electricity on their communities. They were quick to say that they had a better sense of security and safety (snake-bites have reduced dramatically), improved access to the world and staying abreast with worldwide developments through radio and television, reduced incidences of eye illnesses due to good lighting.

Household visits – After the FGDs, the research team went over to the households to administer questionnaires on individual bases. This further enabled people to freely give their impressions on the impact of electricity both on the communities and their households. A strong observation made here was that because the people had the impression that every household would be interviewed almost all the inhabitants had gone back to their households to wait for the research team. Thus unknown to the research team a number of households had abandoned their chores to wait at home for the team. The negative effect of this was that, by close of the day, people from households that were not interviewed were disappointed.

Figure 6.6 Household one-on-one interview

Figure 6.7 A teacher being interviewed

SMEs – the communities generally lacked many businesses. The few businesses sited in the communities included general 'provision shops ', drinking bars, Hair Salons, and food-vending points.

Figure 6.8 A female owned SME -- Pottery

Education (Schools) – Although all the communities had schools up to the Junior Secondary level, the schools were on vacations at the time of the research so there were no official visits to the schools. Interviews were conducted with teachers who are resident in the communities as well as school children that were available.

Health (Clinics) – none of the three communities had health posts/clinics located within the communities. The third community, Ekrawfo had a clinic located about 300 metres away. This clinic is privately owned and was established about 4 years after the extension of grid electricity to the community.

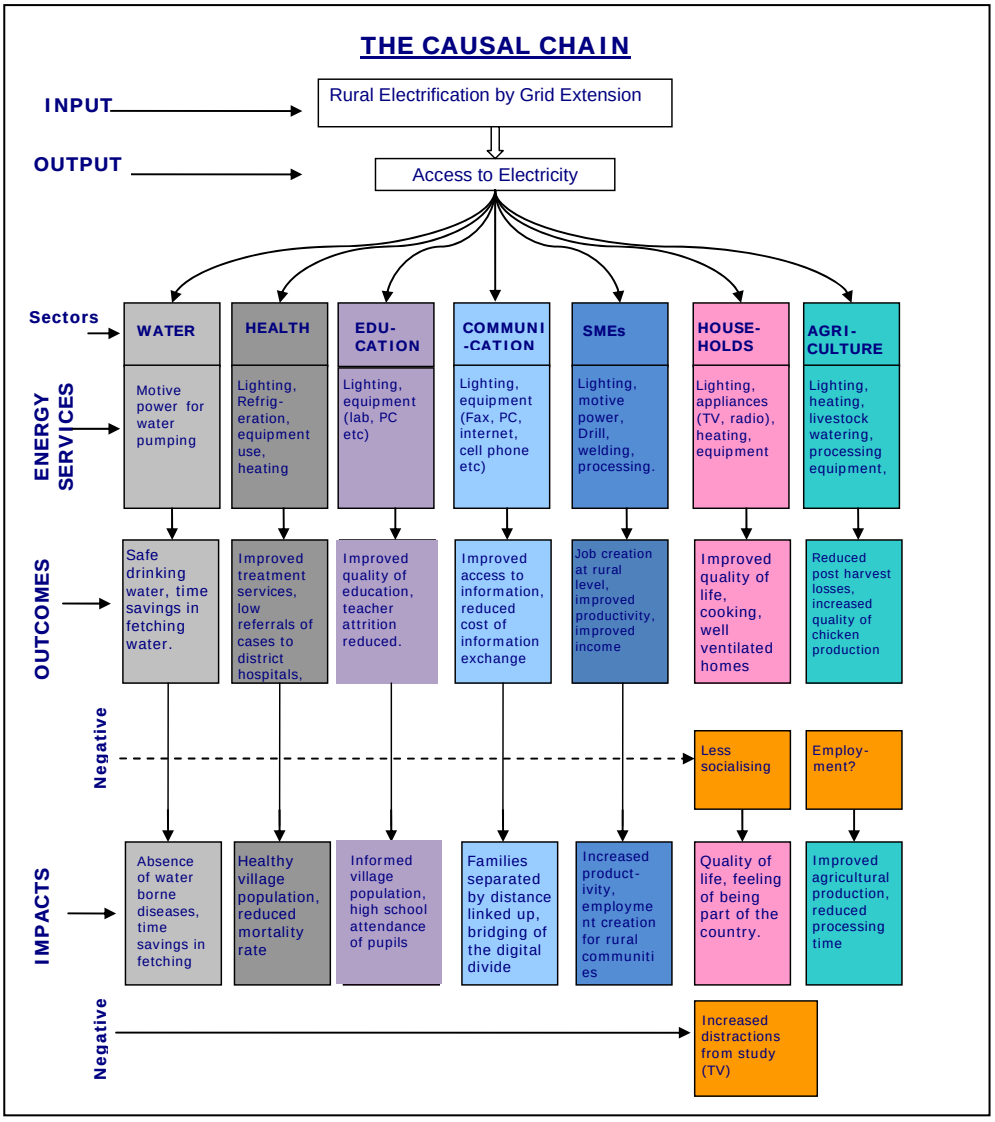

Figure 6.9 Causal link diagram for the Ghana case study on rural electrification.

6.3.5 Conclusions of the case study

6.3.5.1.1 Achieving the goals of the National Electrification Scheme (NES)

Generally, the communities examined under the case study have had some socio-economic gains as result of the NES. There is however an attribution gap in a number of the indicators examined since the communities cannot directly link the changes they have experienced to the electrification. In some case however, some were of the view that there have been negative impacts and outcomes as a result of electrification.

Cross-examining the NES's goals in the light of the study's findings the following conclusions may be drawn:

- **Goal 1: Poverty reduction, especially in the rural area:** Direct poverty reduction could not be firmly established because all the communities were quick to indicate that they were experiencing great hardships and did not consider themselves richer than they used to be. Although it was difficult to firmly establish clear cut poverty reduction as a result of electrification the research team recognizes that any poverty reduction benefits brought about by

electrification could be masked by other factors that have influenced standards of living and hence will not be quick to conclude that electrification benefits in poverty reduction are completely absent. This point was further emphasised by the fact that the increasing costs of living (increase in fuel prices with the corresponding increase in prices of goods and transportation without an appreciable increase in employment opportunities in these communities) have in a number of cases further impoverished the people. To curb this trend, more needs to be done in the areas of employment creation in the rural areas and providing subsidized/special services such as special transport fares etc. that the research team recognises that there are gains in the purchase of these items but these could be social gains which are difficult to quantify in money terms.

- **Goal 3: Increasing people's standard of living, especially those in the rural areas.** Electrification has impacted positively on the living standards in some respect. There is an increased sense of security and safety in the communities. Respondents said that snake bites for instance had dropped drastically. There are increased social activities at night due to lighting. Electrification alongside the provision of other amenities such as potable water (borehole) has improved living standards in the communities.
- **Goal 2: Increasing the overall socio-economic development of the nation.** There is an increase in knowledge in the rural communities as a result of increased means of being in touch with the outside world. Communities are gradually becoming gender-sensitive through education on the radios and television. Rural dwellers are becoming more and more aware of their rights and responsibilities as a result. Electrification has led to an increase in assets ownership such as Television sets, refrigerators etc.it must be noted however
- **Goal 4: Creating small-to-medium-scale industries (SMEs) in rural areas.** Creation of small-to-medium-scale industries had not happened in the communities examined. This in the view of the communities was due to the inadequacy of the electric energy provided by the type of electrification. In the community that had adequate electric energy the number of small-to-medium-scale enterprises had not increased. Other factors for creating SMEs such as availability of capital, well developed marketing systems, were generally unavailable and in cases where available they are not accessible to the rural populace due to the strict and unfriendly conditions attached. It is recommended that in order to achieve this goal, innovative financing schemes and loans should be made available to rural communities and help should be provided to enable business start-ups. Adequate education should be carried out in the communities on the suitability of Single phase wiring for small-scale businesses if the right single-phase motive machinery is used. In situations where the capital for single phase machinery is not available assistance should be provided by way of innovative loans.
- **Goal 5: Enhancing activities in other sectors of the economy, such as agriculture, health, education, tourism, etc.** Some of the sectors had experienced positive impacts as a result of electrification however others had had no direct positive impacts. The water sector for instance had no direct positive impacts, no large-scale farming activities were recorded hence no direct impact on the agricultural sector. Education on the other hand had seen some improvements, through the provision of lights in the classrooms for instance children study at night under the supervision of teachers. Teacher

attrition had reduced as a result. Electrification without the provision of corresponding health facilities does not engender improvements in the health of rural dwellers hence their absence in the communities. This was clearly evident in the communities as the only community which had a private clinic and maternity had been serviced by the clinic. The clinic has been the first port of call to provide first aid, and in some cases complete treatments. Since the establishment of the clinic there has not been a record of maternal death in the communities. Thus there is the need to establish health centres alongside providing electricity to help realize goal 5.

- **Goal 6: Creating jobs in the rural areas and thus reducing the rate of rural to urban migration.** This has been partly achieved, but job creation is now on the decrease. The general lack of SMEs had led to the lack of jobs and the inherent migration of the youth from these communities.

6.3.5.1.2 Electricity as a tool for development

The study highlights in a number of ways the key point that electricity is an important but not sufficient input to development. Other important factors that need to be present to ensure development is achieved are capital/financing, institutions and other infrastructure, such as clinics. There was evidence of health improvement due to electrical lighting (replacing kerosene and candles) but presumably, the persistence of cooking by biomass fuel means that indoor air pollution remains and is a major contributor to illness. This means that for an accelerated increased positive impact in the health sector other initiates that for instance makes available improved stoves or fuel switching need to be implemented alongside the provision of electricity. This holds for the all the other sectors in order to ensure an all round development within the rural communities.

6.3.5.1.3 Adequacy of the Assessment Framework

The tools provided by the Assessment Framework (AF) were used in the case study right through the conception to the reporting stage. The causal chain provided an easy-to-read and easy-to-think-through process of identifying all the relevant areas of the communities that need studied. The AF, guided by the four-level-approach (input, output, outcome, impact) was instrumental in guiding the filing of the Indicator Table. The Indicator Table on the other hand provided invaluable leads on ‘what to measure’, indicators, units, source and data collection methods. This was very useful in developing a good research plan to carry out a budget case study research. The AF is therefore an invaluable tool for carrying out research especially in developing countries.

The AF is adequate for pre-research planning, however researchers would have to know the peculiar needs and requirements of the type of research that is to be carried out and adapt the framework to suit their purposes. Another key issue is the need to have local knowledge on the approach to research methodologies in the targets communities. The lack of prior knowledge on appropriate methods (such as traditional governance structure, gender relations etc in the communities) will have disastrous consequences not only to the particular research team in question but will also create a negative impression about researchers in the minds of the target communities. The research team that undertook this case study had fore-knowledge of these important

methods and applied them in this case study thus the great success achieved in this study.

Comments received from the other stakeholders in the country indicates that the findings of this case study are good enough for drawing lessons that can be applied to similar cases in Ghana and other developing countries with similar circumstances because earlier independent studies that had been undertaken in other communities in Ghana gave similar results.

Further details on the Ghana case study are available in the Case Study Synthesis Report, the Ghana Case Study Report and the presentation by the author Solomon Quansah of KITE at the Arusha Regional Workshop, all of which are available at the DEA website.

6.4 Mali: Women Renewable Energies Project

6.4.1 The energy intervention

The Women Renewable Energies Project (WREP) was an initiative of the Malian Government in response to the International Conference on Renewable Energies, held in Nairobi, in 1981. The Nairobi conference recommended the active involvement of women in the different energy decisions making, because they are the main producers, users, and managers of various energy sources. The WREP aims to promote the utilization of renewable energy to fight desertification and poverty, and to protect the environment. The project also aimed to encourage the participation of women in development programmes, particularly in the energy sector to improve their conditions.

The WREP was funded by UNDP and the Governments of the Netherlands and Mali, and was implemented in two phases: the pilot phase and the implementation phase. The pilot phase started in 1992, and ended in 1995. This phase covered 41 villages in the region of Koulikoro. The positive outcome of this phase motivated the continuation of the project in a second phase which started in 1996 and ended in 2001. This phase is known as the implementation phase and covered 90 villages in the regions of Sikasso and Segou.

The WREP installed 113 solar lighting systems for health centres and literacy centres, 74 solar water heaters in health centres, 27 solar driers for the conservation of perishable fruits and vegetables, 2 wind water pumping systems for small-scale irrigation, and 16 multifunctional platforms running on jatropha oil to relieve women of their arduous workloads. These technologies were installed in 130 villages of the regions of Koulikoro, Ségou and Sikasso. The WREP also provided various literacy training to more than 3 500 women, and maintenance training to 60 local technicians.

6.4.2 Case study methodology

- Reviewing relevant literature project’s reports
- Drawing 4-level causal diagram (inputs, outputs, outcomes, impacts) for each technology
- Designing indicators and data collection procedures
- Conducting field visit in selected villages (Konodimini, Koula, Massala, Somonodougouni, Tombougou, Wolonkotoba, Zambougou) during which

focus group meeting are held with the beneficiaries (health, literacy, village association, women and children)

- Analysing data by categorising them into social, economic and environmental benefits resulting from the use of the five technologies installed under the WREP project
- Environmental impacts were measured by indicators like the reduction of wood fuel consumption and the reduction of CO_2 emission
- Social impacts were measured by indicators like the number of beneficiaries, the improvement of the health centres' services, the improvement of the literacy rate and the alleviation of the women's workload
- Economic impacts were measured by the savings on the expenses for the purchase of wood fuel and kerosene. Incomes generated by the use of the technologies were also used to measure economic impacts.

6.4.3 Causal link diagrams

Since five separate technologies were investigated in the WREP, five separate causal link diagrams were developed. These are shown below in Figures 6.

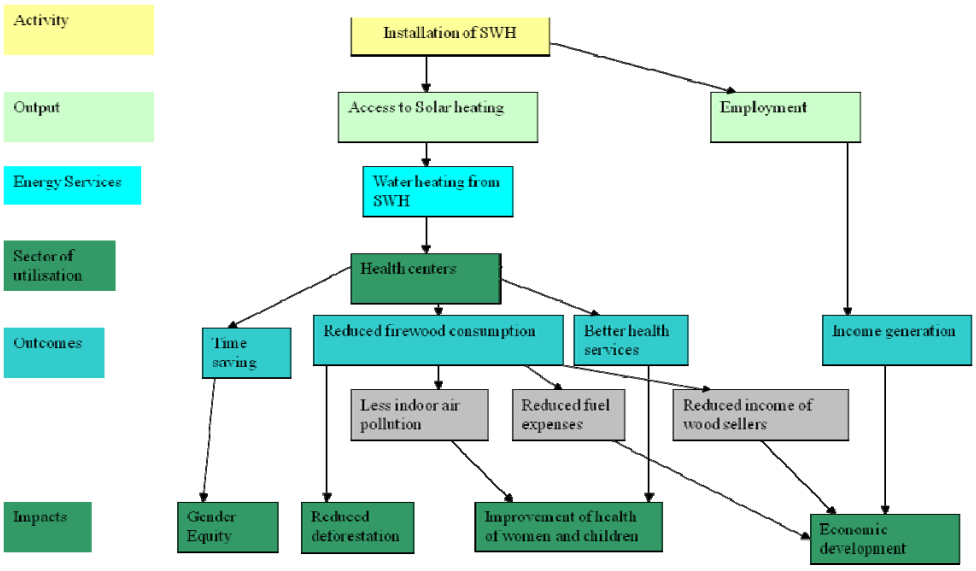

Figure 6.10 Causal link diagram for the Solar Water Heater in the Mali case study

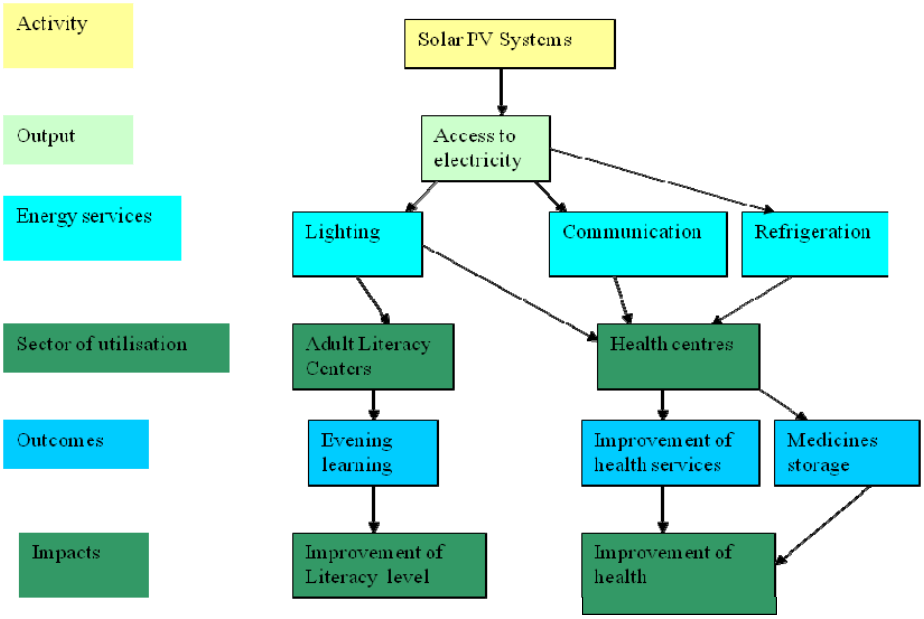

Figure 6.11 Causal link diagram for the Solar PV System in the Mali case study

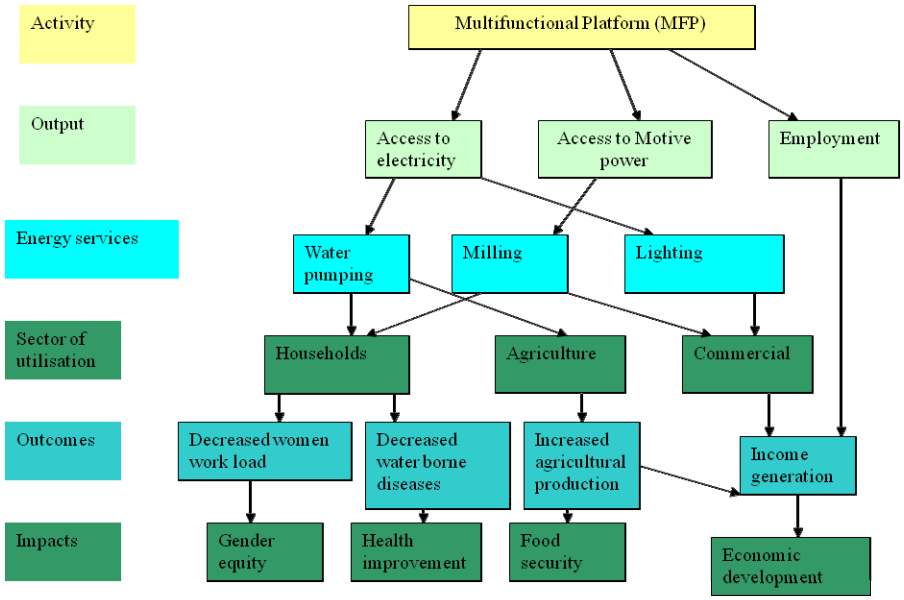

Figure 6.12 Causal link diagram for the Multifunctional Platform (MFP) in the Mali case study

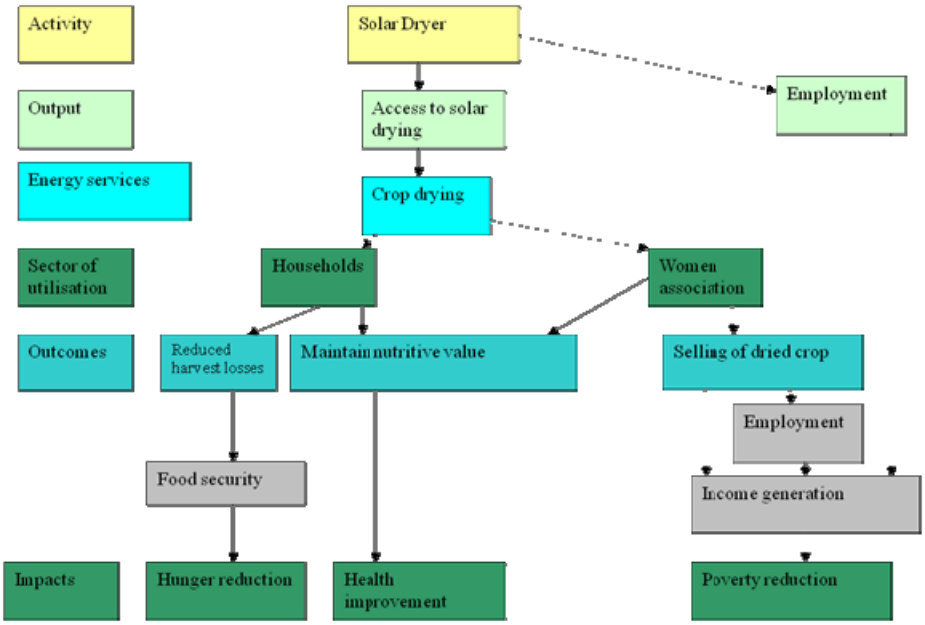

Figure 6.13 Causal link diagram for the Solar Dryer in the Mali case study

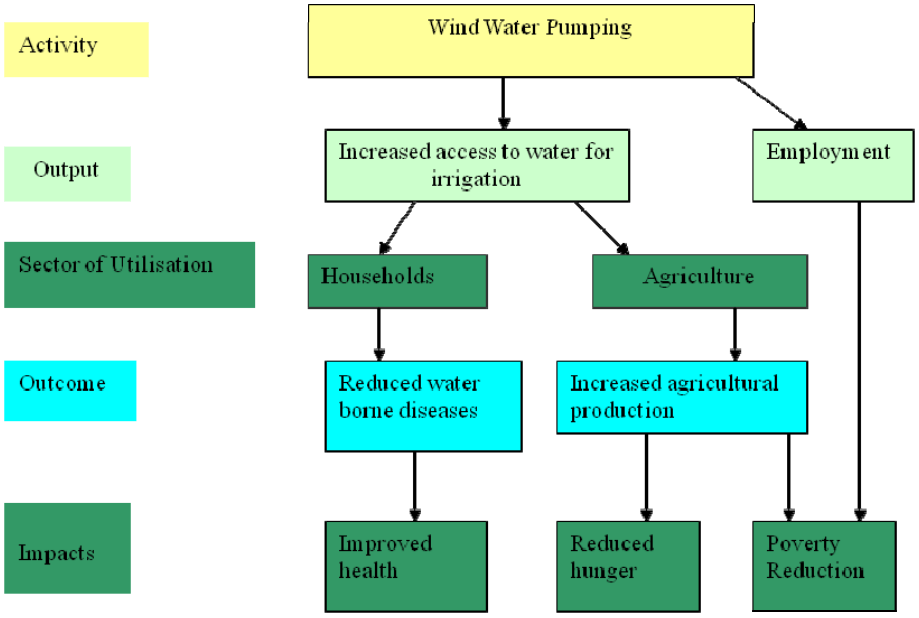

Figure 6.14 Causal link diagram for Wind Water Pumping in the Mali case study

6.4.4 Results

The impacts assessment shows that:

- There are savings on the purchase of fuel wood and kerosene per visit to the health centres through the use of solar water heater and solar lighting system.
- There is income generation for the individuals through commercialisation of garden's produces and dried fruits and vegetables.

- There is income generation for the community though billing of access to the services provided by the different technology installed by the WREP.
- There is reduction of the burden of women through easy access to hot water and modern cereals grinding services.
- There is increase in literacy attendance through better learning environment & extended hours in class at literacy centres.
- There is a reduction in forest resource depletion.
- There is a reduction in carbon dioxide emission.
- There is better health care for mother and child through safe baby delivery at night and access to hot water.
- There is income loss for wood traders due to reduction in demand caused by access to solar hot water.

6.4.5 Lessons learnt

- The case study revealed that:
- Energy project alone has little impact on development but associated to other development project, it will have significant impact.
- The 4-level diagram proved very useful for understanding the development impact of energy project.
- There no universal indicators for impact assessment. The indicators are case specific and therefore the data to be collected.
- Baseline issue can be solved using the combination of the recall method and past studies.
- Stakeholders are enthusiast to use the Assessment Framework and for that they will required training

Further details on the Mali case study are available in the Case Study Synthesis Report, the Mali Case Study Report and the presentation by the author Pierre Dembele of Mali Folkecenter at the Arusha Regional Workshop, all of which are available at the DEA website.

6.5 Senegal: Dissemination of improved charcoal stoves

6.5.1 The energy intervention

The improved charcoal stoves dissemination registered in the demand Management and inter-fuel substitution component of Sustainable and Participatory Energy Management Programme (PROGEDE). This project is implemented by Senegalese authorities with the financial support of the Netherlands government, the GEF and IDA. The improved stoves dissemination on going activity covers all the country area since 1998.

The project is implemented by the Senegalese government (Ministries of Environment and Energy). This improved-stove dissemination component aims to support the

reorganisation and modernization of the charcoal trade to establish long-term supply agreements between rural communities and urban traders.

PROGEDE's objective is "to contribute to the supply of household with domestic fuel on a regular and sustainable way, while ensuring environmental protection and by offering alternatives and options as well as comfort to end users".

Figure 6.15 Examples of charcoal stoves in Senegal: the improved Diambar (Kenyan Jiko type) stove and the traditional Malgache stove.

6.5.2 Case study methodology

- The methods of data collection consisted of inquiries, focus group, observations and crosschecking.
- The inquiry tools used were questionnaires and interviews
- Questionnaires were targeted at the rural and urban households using improved stoves (quantitative data).
- Interviews were conducted with businesses, women association, improved stove manufacturers and retailers
- Health services and some established focus group (women groups).

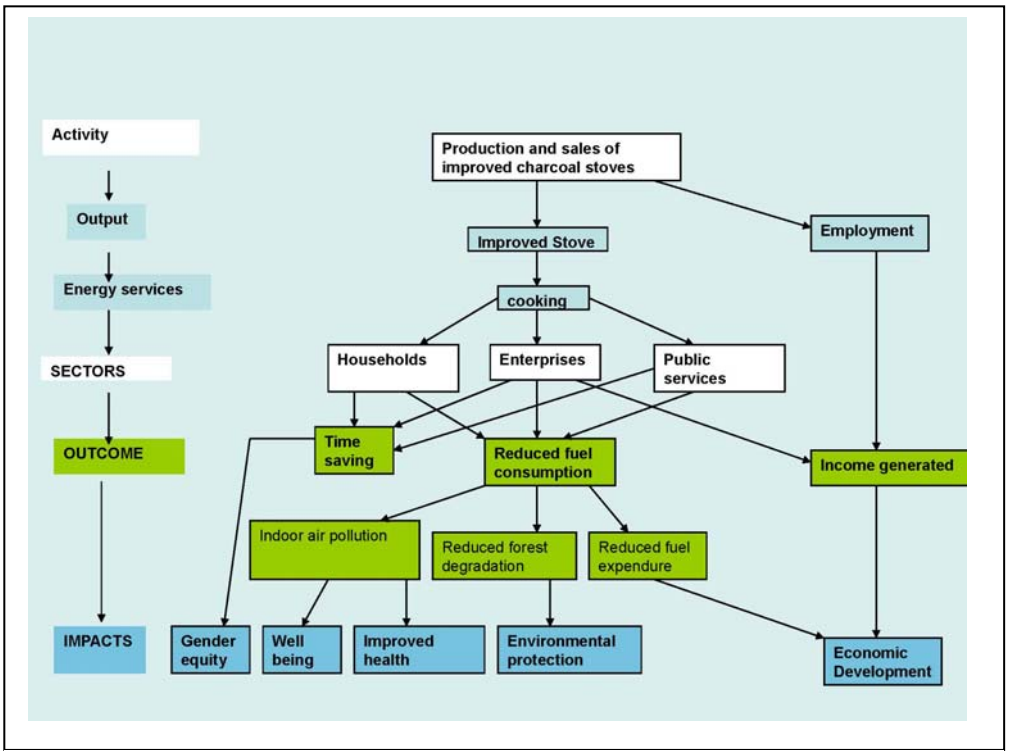

Figure 6.16 Causal link diagram for the Senegal Improved Stoves case study

6.5.3 Results

During the enquiry, the performance of traditional stoves and improved stoves highlighted the real consumption of charcoal, the time for cooking the main meal and the frequency of renewal of kitchen stove. These have been translated into social, environmental and economic impacts of the energy intervention.

Fuel savings: It was found that urban and peri-urban households save at least 1.4 kg of charcoal per day when they changed from the traditional stove to the Diambar improved stove. The cost saving in fuel wood of US$127 per year, including a saving of about US$3 from the avoided cost of replacing traditional stoves. For businesses (primarily restaurants) the financial returns per year amount to US $ 207.

Employment impacts: The stove programme also led to job creation, on the part of the manufacturers of the stoves, an average of 6 employees (income / month, from US $ 22 to US $ 62) while a number of jobs were created indirectly among retailers of the stoves.

Health impacts: In rural areas, 50% of affected individuals currently suffer from respiratory problems, 34% from sore eyes and 16% from other diseases. The average cost of the treatment of smoke related diseases is US $ 3.6 per person per year.

Observation: Tendency to minimize consultations relating to respiratory affections, skin diseases and sore eyes in a number of health centres

Gender impacts: A time saving was observed, both with regard to fuel collection and cooking. For rural women, after installation of the improved stove, firewood collection is reduced to once a week compared to 2 - 3 times per week previously. The time saved in cooking was typically reduced from 1 hour to 40 minutes per average meal.

Other observed benefits were increased participation in group life and increased preservation of the environment.

6.5.4 Lessons learnt

- General satisfaction of stakeholders with the Assessment framework
- Attribution of impact will still be problematic since energy is a cross-sectoral issue.
- Necessity to refer to baselines information (problematic of the availability of data)
- Flexibility of the tool

Further details on the Senegal case study are available in the Case Study Synthesis Report, the Senegal Case Study Report and the presentation by the Senegal country team of ENDA-Energie at the Arusha Regional Workshop, all of which are available at the DEA website.

6.6 Tanzania: Solar/wind powered Water Pumping Irrigation Scheme

6.6.1 The energy intervention

The intervention examined are located in Ukerewe Island in Lake Victoria, a district, Mwanza Region, Tanzania and comprised two irrigation schemes: at Nakatunguru village and Namagubo village, using wind and solar PV water pumping respectively, with the water being obtained from Lake Victoria. The project was funded originally by the UNDP GEF Small Grants Programme, implemented by the Ministry of Agriculture and food Security (MAFS), and managed by local farmers' groups.

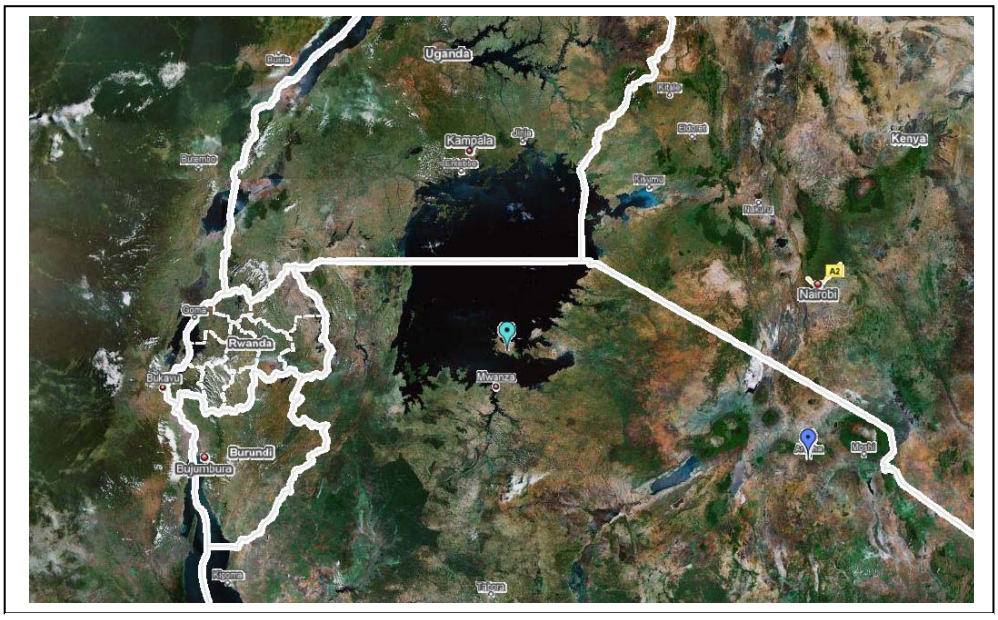

Figure 6.17 Ukerewe Island, in Lake Victoria Tanzania (centre of photo)- courtesy Google Maps.

The irrigation project started in October 2001 and was scheduled to end in December 2003. However performance did not live up to expectations because of a sudden drop

of water on the Lake Victoria, which meant that water was only available for three months.

The Irrigation Scheme Project was selected as a case study topic to test the DEA Assessment Framework, unaware of the fact that it was not actually pumping water. The justification was that the project was directly linked to productive use, in this case agricultural production, and it would be valuable to use the methodology in such an assessment.

Figure 6.18 Project sites on Ukerewe Island: (left)wind-powered irrigation, (right) solar PV powered irrigation.

6.6.2 Case study methodology

As with the other DEA case studies, the preparation took place before and during the 2nd Project Workshop at Fringilla, Zambia, where the preliminary causal link diagram was refined and the assessment procedure followed to develop the research plan. This

- Review of project document
- Conduct physical visit to the project sites
- Administering structured questionnaires with the beneficiaries
- Meet group leaders and district government officials
- Discussions on study findings with focus group (beneficiaries and District officials)

Unfortunately, the country project team was not made aware of the low water level in the lake and the consequent non-functioning of the project, despite consultations with representatives of the project and MAFR. Thus, the case study preparation went ahead and a field trip was undertaken to the relatively remote site. Due to the commitment of resources, the decision was made to by the country team to carry out the field study, to collect whatever information was available, and to analyse and report the findings within the DEA framework.

As can be seen from the causal link diagram, Figure 1, significant developmental and environmental impacts could have been expected if the irrigation scheme had worked according to plan, i.e. if lake water had been accessible, assuming that the wind and solar-powered pumps functioned.

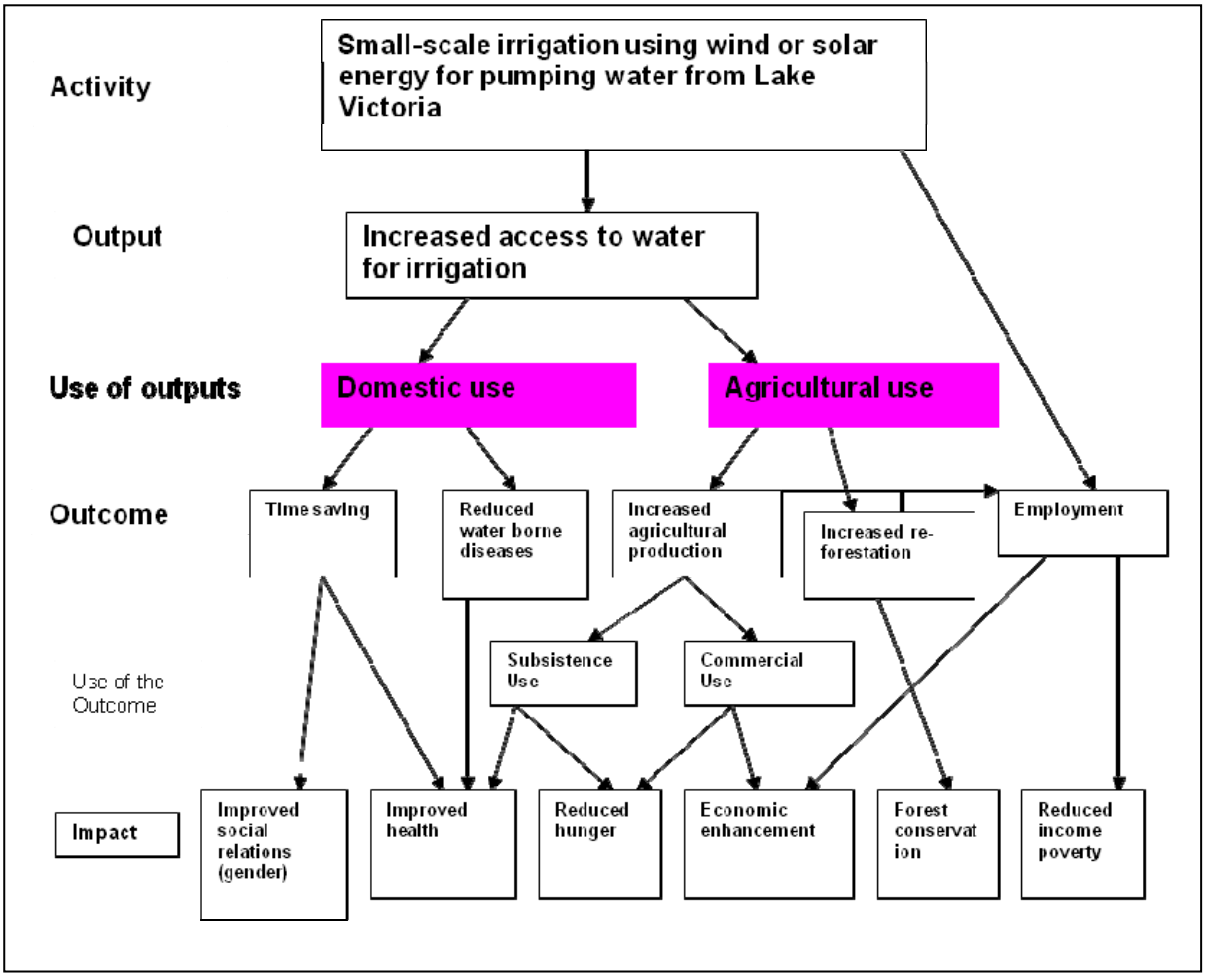

Figure 6.19 Causal link diagram for the Tanzania wind/solar irrigation case study

6.6.3 Results

The irrigation schemes were able to access water for three months in the early stages before the lake water level dropped significantly, due to the effect of climate change and increased demand from the population around Lake Victoria. Hence there was little effect of irrigation on the agricultural production at the sites. Some indirect improvements were detected, associated with training of farmers groups that had been provided in conjunction with the irrigation schemes. These farmers groups were still operational in spite of the lack of irrigation. Moreover, interviews with local farmers indicated that there had been a noticeable change in irrigation practice and agricultural production during the short time when water was available.

6.6.4 Conclusions

There are indications that the situation at the irrigation schemes, whereby the wind and solar-powered pumping equipment was allowed to stand idle for close to 3 years, is due to a lack of clear ownership of the project. This is unfortunately typical of many development projects in Africa. In this case the funding organisation UNDP and the responsible Ministry were apparently unaware of the situation, while the potential

beneficiaries – the local farmers – were unable to rectify the situation, by moving the pumps or by drilling boreholes to access lake water.

The impact of the DEA case study was apparently such as to draw attention to this state of affairs so that action could be taken towards rectification. Major lessons to be learned are to ensure that the project to be analysed is actually functioning before committing resources to impact analysis, and at a more developmental level, to be aware of the importance of clear ownership and participation in development projects.

While the case study was a failure as far as testing the DEA assessment procedure is concerned, it did highlight a failure within the development process, involving communication between a major donor organisation, a responsible ministry and local potential beneficiaries. The Tanzanian project team were merely observers in this process, but hopefully sufficient attention was drawn to the project failure in order to stimulate action from the responsible parties.

Further details on the Tanzania case study are available in the Case Study Synthesis Report, the Tanzania Case Study Report and the presentation by the Tanzanian project team from TaTEDO at the Arusha Regional Workshop, all of which are available at the DEA website.

6.7 Zambia: Solar PV Energy Service Companies

6.7.1 The energy intervention

Large scale introduction of solar PV in Zambia began in the Eastern province in the late 1990s. In particular, an Energy Service Company (ESCO) project was initiated by the Department of Energy of the Republic of Zambia, with funding from the Swedish Development Cooperation Agency (Sida) as a pilot project in Chipata, Lundazi and Nyimba districts. The focus of the project was threefold:

- to identify the conditions for solar PV systems in rural areas
- to locate prospective entrepreneurs
- to help entrepreneurs to get started in the ESCO business.

These first three ESCOs had commenced operations by 2000 with at least 100 solar systems. Market and socio-economic surveys indicated that the selected towns in Eastern Province were not well serviced by national grid electricity but had comparatively wealthy communities with a strong agricultural base. The ownership and insurance of the Solar Home Systems is still with the government of the Republic of Zambia through the Department of Energy.

The project was intended to create a sustainable market by which the people in rural areas would access the services that can be provided by solar photovoltaic technology. Companies in the three districts were provided with solar home systems to enable them start the fee-for-service scheme (Chipata 150, Lundazi 150 and Nyimba 100 solar home systems.) The project had a budget of $160 million for 10 years.

The ESCOs based in Chipata (CHESCO) and Nyimba (NESCO) were chosen for the case study.

Figure 6.20 SHS installed at a teacher's house at Chankhanga Middle Basic School, near Chipata, served by CHESCO.

6.7.2 Case study methodology

The first part of the methodology involved desk study aimed at collecting data related to impacts associated with the selected energy intervention. The second part of the methodology involved collection of data through key informant interviews and questionnaires.

Data collected through questionnaires, targeted the total SHS customer group in Nyimba and Chipata and a sample of independent owners of solar PV who do not belong to the ESCOs' clientele but have been helped by ESCO staff to do the installation and servicing. All the questionnaires administered were responded to, since they were all guided.

The questionnaires were designed using information from the Fringilla approach for each category of the NESCO and CHESO clientele. Closed questions in combination with open ended ones were appropriate for the task. The questionnaires can be found in appendices.

Other methods used for data collection included observations while in the field and desk study from different reports such as the Energy Regulation Board, Department of Energy Private and SEI reports, and the Internet.

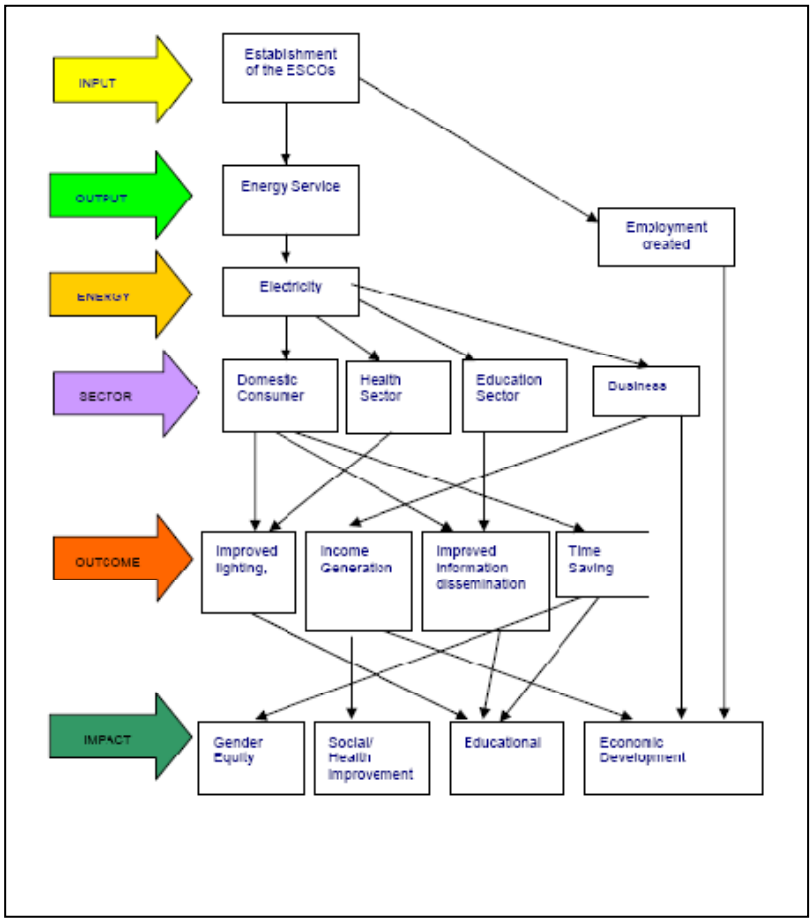

Figure 6.31 Causal link diagram for the Zambia ESCO case study

6.7.3 Results

The introduction of solar home systems (SHS) in some village towns in the Eastern province of Zambia has brought about quite a number of positive changes to the lives of people. SHS provide a non-polluting form of energy as compared to candles, matches, kerosene and sometimes diesel which people used previously. SHS not only provide sufficient light but also entertainment to people through use of television, DVD players, videos and radios. According to the beneficiaries of solar home systems, the introduction of SHS is a form of civilization. People in the rural areas are able to follow current affairs in the country and beyond and make informed decisions in matters pertaining to HIV/AIDS, rainfall predictions by the meteorological department, politics (especially in times of general elections), etc.

The largest cellular phone network provider in Zambia CELTEL has recently extended the network to most parts of eastern province and this has been accompanied by the purchase of cellular phones by large numbers of local people. Since most of the households are not connected to the national electricity grid they therefore depend on solar energy for cell phone charging. This aspect of cellular phone charging is being promoted so much by NESCO as opposed to CHESCO. NESCO has permitted clients to use inverters on their systems, thereby making it possible to have cell phones charged. On the other hand CHESCO has banned the use of inverters because of possible damage to batteries and control systems; as a result clients are unable to charge cellular phones on CHESCO solar home systems. NESCO has had an increase in inquiries to subscribe to them and are anticipating a boom in its client numbers

because of introduction of National Television signal to Nyimba as well as Cellular phone network. A number of people in the town and villages are now buying TV sets which can either be powered by car battery or solar home systems. SHS have thus benefited different categories of people in a unique way.

Farmers use the solar lighting to extend the shelling time of maize and groundnuts, and in some cases the farmers work until very late as late at night doing shelling. This means that farmers can finish shelling quick enough to deliver their harvest to the Food Reserve Agency (FRA) and enables them to be paid in good time for them to begin adequate preparation for the next farming season. If the delivery of harvested crop is delayed, it results in protracted payments, which creates huge problems for the farmers as they are unable to prepare for the following farming season adequately. Thus solar PV lighting provides a means of speeding up the crop harvesting process and ensures quicker payments, thereby increasing efficiency in the agricultural production process and contributing to poverty reduction.

Institutions such as schools, churches and clinics also benefit greatly from the SHS provided by ESCOs. Schools have experience improved pupil performance and increases in pass rates for the grade nine and twelve examinations. The improved school performance is attributed to increased motivation to study in the school because of provision of sufficient light. In some cases some pupils are able to read through the night up to about 04:00hrs in the morning. Teachers also take advantage of lighting in the class rooms to help pupils study at night.

In churches, the church leaders use the light to prepare sermons and also for reading. Lighting at the church also helps worshipers during large meetings to prepare and serve meals in the night.

There is a special case where CHESCO was used to size and install solar water pumping at Mukanda clinic. The clinic owns the system and the water is used in the clinic, by clinical staff houses, and surrounding communities. Before that the water for use in the clinics was drawn by patients from some distance at an open contaminated well. The sanitary condition at the clinic then was very poor and there were many diahorrea cases. Currently, the clinic is enjoying piped clean water supply through solar water pumping.

In households, SHS have benefited the people with sufficient lighting, improved security in the night, and entertainment. Those households who have school-going children have benefited greatly in that the children use the sufficient lighting to study at night, bringing about improved performance in school work.

Civil servants such as teachers and agricultural officers are also beneficiaries of the SHS. Agricultural officers are able to read and write reports at night about their field work, and teachers are able to prepare their material. One case was found where a head teacher uses the lighting to enable him to successfully complete his correspondence studies. This later inspired other teachers in the same school to acquire SHS and pursue their diploma by correspondence.

From the foregoing analysis it can be observed that energy intervention has an impact on the lives of the people and it contributes to development and progress in general.

Figure 6.22 Rural shops with SHS, served by CHESCO.

6.7.4 Discussion and Conclusions

It is clear that solar home systems have immense benefits in terms of impacts on the communities involved, but the biggest barrier is that of the financial sustainability of the business model adopted, combined with relatively low income levels of the consumers. In view of this situation, it is important that an innovative financing mechanism is put in place which could involve the provision of "smart subsidy" on capital investment to enable the entrepreneurs attain financial sustainability during the operation period of the business.

It should be remembered that the Sida-funded ESCO project was a pilot project, designed to ascertain an appropriate business model to suit the circumstances of the region under consideration. It is clear from the results that if the SHS ESCO model is to be sustainable in rural areas of Zambia, taking account of the level of poverty, there must be some form of smart subsidy to the capital cost. A financial assessment by CEEEZ indicates that, for the business to be viable, the capital subsidy should be in the range between 50% to 70%.

Further details on the Zambia case study are available in the Case Study Synthesis Report, the Zambia Case Study Report and the presentation by the Zambian project team from CEEEZ at the Arusha Regional Workshop, all of which available at the DEA website.

7 Conclusions

In spite of limited resources for the case studies, the DEA methodology was able to identify and document key features of the impact of energy projects. At the outset of the project, it was envisaged that a methodology could be developed to assess the impacts of energy projects. Through the literature study, and through detailed examination of examples, the complexities of the links between energy and development have been underlined. The consequences of single actions become increasingly difficult to untangle from other actions, and the general context, as one moves from outputs, through outcomes to impacts. In spite of the inherent impossibility of disentangling the different influences, and attributing impacts to single causes, it is nevertheless possible through a comparatively simple framework to gather and present meaningful information about the effects that energy projects cause. In this sense the DEA project has been successful in providing and demonstrating such a framework.

The approach and case studies reawakened an interest in M&E among African stakeholders but also indicated the need to further develop, operationalize and disseminate the approach. Monitoring and Evaluation and Impact Analysis of energy projects are areas where there is a large amount of interest, and a real need for practically operational approaches. This was indicated through the various stages of consultation with stakeholders, leading up to the final event of the DEA project, the Arusha Regional Workshop. While the need is real, means to carry through M&E and IA are often lacking. Thus continued support will be required, preferably through the engagement of local partners like the six Centres involved in DEA, to institutionalise these functions.

The DEA project illustrated the importance and benefits of working as a team (EU and African partners) in developing and applying the methodology, which resulted in a real sense of ownership, and allows a more convincing dissemination of the methodology to stakeholders. The prime example of the teamwork was manifested in the 2nd Project Workshop in Fringilla, Zambia, described in the workshop report. The ownership by the African teams was also amply demonstrated in the Regional Workshop (Arusha) held at the end of the project.

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