

Impact Assessment for Energising Development Projects

Contents:

1	Introduction.....	1
2	Results chains	3
3	Monitoring and impact assessment.....	6
3.1	Indirect Benefits - Indicators and possible sources of information	6
3.2	Highly Aggregated Results - Indicators and possible sources of information	11
4	References	12
	Annex A: Methodologies for data acquisition	13
	Annex B: Detailed results chains of EnDev rural electrification projects.....	17

1 Introduction

Access to energy contributes to the Millennium Development Goals (MDGs) (cp. table 1). The impacts of the energy projects implemented under Energising Development generate changes in the areas where the MDGs are set.

Development Goals: nachhaltig gesicherte Energiegrundversorgung. Wenn Energiegrundversorgung gesichert hat man Einfluss auf Armutsreduzierung.

Impact monitoring makes changes apparent. Such changes are the result of a combined influence of the society's own internal mechanisms of development, and external political, economic and environmental factors, one of which may be a development programme or project. It is quite difficult to tell which factor caused which change, and it is hardly possible to isolate the project's impact from any other influence. Still, impact monitoring is important, because it is a process of learning about relationships. To be more effective and realistic, decisions and project activities should be reviewed from time to time and be adapted to the changing situation. Furthermore, by conducting impact assessments on a regular basis, the mid to long-term sustainability of results and impacts can be monitored.

Chapter 2 describes the results chain - the impact model of GTZ - and formulates results chains for the two EnDev project types 'energy for cooking' and 'rural electrification'. Chapter 3 gives information about the monitoring of impacts: what parts of the results chain are already monitored by the projects and what information has to be newly assessed? Furthermore, recommendations for typical indicators and respective methodologies for data collection are provided. Annex A gives an overview on different methods to be considered for data collection. Annex B contains a detailed overview on potential elements of results chains for EnDev rural electrification projects.

Table 1: Importance of Energy to achieve the Millennium Development Goals

Millennium Development Goal	Role of energy
<p>1) Eradicate extreme poverty and hunger</p> <ul style="list-style-type: none"> • Halve, between 1990 and 2015 the proportion of people whose income is less than one dollar a day • Halve, between 1990 and 2015, the proportion of people who suffer from hunger 	<ul style="list-style-type: none"> • Use of commercial fuels and improved cook stoves can increase agricultural productivity and food security. 95% of all food requires cooking in order to be eaten. • Without access to energy services, people must spend a great deal of time or a substantial part of their income and physical energy on basic subsistence activities rather than on earning money. Any improvement in the quality of the energy and the efficiency of the services, directly and structurally contributes to poverty eradication by saving money and increasing available time for other (economic) activities. • At the local and national levels, a reliable energy supply is essential to economic stability and growth, jobs and improved living standards.
<p>2) Achieve universal primary education</p> <ul style="list-style-type: none"> • Ensure that, by 2015, children everywhere, boys and girls alike, will be able to complete a full course of primary schooling 	<ul style="list-style-type: none"> • Electric lighting increases the number of studying hours, while electricity supply in schools enables the use of educational media and communications including ICT. • Motive power and energy services can boost the productivity of adult labour to substitute for child labour. • Finally access to energy helps attract teachers to remote communities by improving rural living standards.
<p>3) Promote gender equality and empower women</p> <ul style="list-style-type: none"> • Eliminate gender disparity in primary and secondary education, preferably by 2005, and in all levels of education no later than 2015 	<ul style="list-style-type: none"> • Motive power frees women and girls from hours of physical work such as food grinding and threshing. Modern cooking fuels save them from spending hours carrying large loads of fuel woods. This, and electric lighting, increases time and energy available for studying and reading and the possibilities to develop productive activities. • Public lighting adds to security and availability of radio and TV increases the access to gender related information.
<p>4) Reduce child mortality</p> <ul style="list-style-type: none"> • Reduce by two thirds, between 1990 and 2015, the under-five mortality rate 	<ul style="list-style-type: none"> • Lack of energy correlates closely with inadequate health care. Modern fuels and electricity help reduce malnutrition-related mortality by boosting food production and household incomes. They also help reduce waterborne diseases by powering equipment for pumping, boiling and treating of water. Using modern biomass fuels and improved stoves reduces harmful indoor air smoke and the risk of respiratory disease. Access to modern energy is critical for keeping food and water. • Energy is a key component of a functioning health care system. It enables clinics to refrigerate vaccines, operate and sterilize medical equipment. • Energy allows the use of modern tools of mass communication needed to fight the spread of preventable diseases. • Access to electricity helps attract and retain health and social workers.
<p>5) Improve maternal health</p> <ul style="list-style-type: none"> • Reduce by three quarters, between 1990 and 2015, the maternal mortality ratio 	
<p>6) Combat HIV/AIDS, malaria and other diseases</p> <ul style="list-style-type: none"> • Have halted by 2015 and begun to reverse the spread of HIV/AIDS • Have halted by 2015 and begun to reverse the incidence of malaria and other major diseases 	
<p>7) Ensure environmental sustainability</p> <ul style="list-style-type: none"> • Integrate the principles of sustainable development into country policies and programmes and reverse the loss of environmental resources • Halve, by 2015, the proportion of people without sustainable access to safe drinking water and sanitation • By 2020, to have achieved a significant improvement in the lives of at least 100 million slum dwellers 	<ul style="list-style-type: none"> • Emissions from the burning of fossil fuels are major contributors of urban air pollution, acidification of land and water, and the unpredictable effects of climate change. The use of fuelwood and charcoal can be unsustainable when it leads to land degradation from fuelwood gathering and to indoor air pollution from biomass combustion. Environmental damage can be mitigated by increasing energy efficiency, introducing modern technologies for energy production and use, substituting cleaner fuels for polluting fuels, and introducing renewable energy.

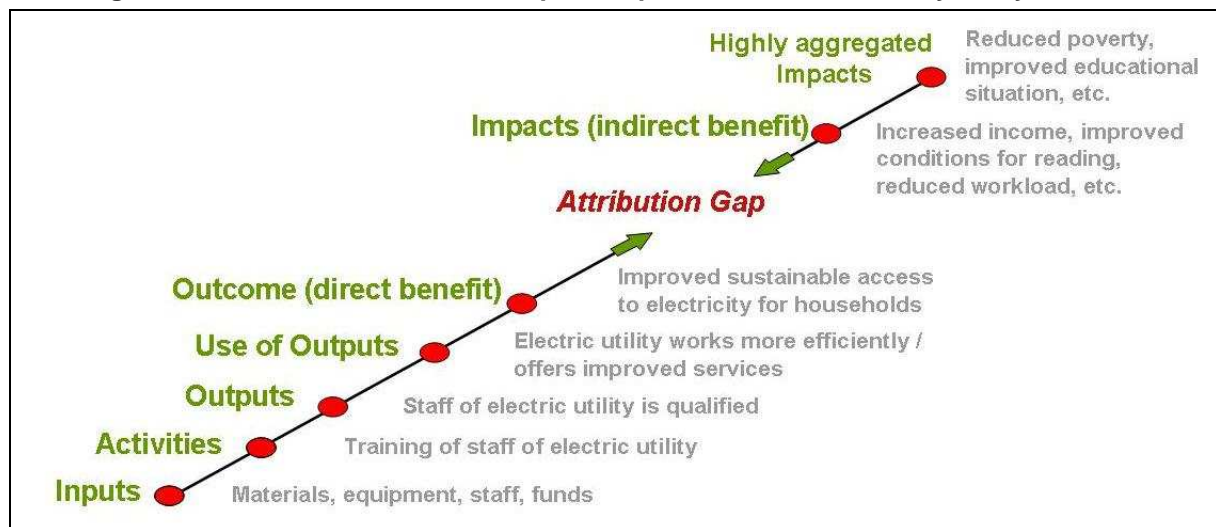
2 Results chains

The general difficulties of assessing development results and impacts lie in the “attribution”, i.e. in the classification of a highly-aggregated development progress for individual projects. This means that the greater the distance is from the individual project/programme activities to the spheres where the impacts take place, the more difficult it becomes to assign causal relationships to development results.

Was sind results? Definition!

The GTZ results model (see figure 1) follows the OECD/DAC evaluation principles and deals explicitly with this well-known attribution problem by including an “attribution gap” as a core conceptual element. Development projects and programmes are resourced through German and partner **inputs**, such as materials, equipment, staff and funds. Using these inputs, the projects launch **activities** such as advisory services, trainings, funding, or accompanying measures (e.g. awareness and marketing campaigns). Due to these activities **outputs** are generated, which might occur as qualified institutions/organisations, availability of sufficient financial resources of partner organisations or supporting measures in place. These outputs are then utilised by the respective target groups (**use of outputs**), e.g. leading to efficient processes and improved services of institutions/organisations or the use of funds for improving energy infrastructure. This use of output is generating short-term development results, called **outcomes** (e.g. improved access to electricity for rural households) and **impacts**, which are medium- and long-term development results (e.g. increased household income, reduced workload for women).

Figure 1: GTZ results model – Example for qualification of electricity utility staff



Anderes Schaubild mit Pfeilen! Neue Begriffe: direct results und indirect results

Up to the level of “outcome”, attribution is relatively easy in most cases. However, beyond the levels of “outcomes” external factors that cannot be influenced by projects and programmes become increasingly important. The attribution gap widens up to an extent where the observed changes cannot be directly related to project outputs any more. Up to the level where a causal relationship between outputs and observed development changes can be shown, projects are entitled to claim the observed positive development changes as a “direct result” or “outcome”. The project or programme objective is set at this level of the results chain. Always, however, the actual reason for launching operations in a sector or country is to achieve results beyond that level, and these can usually be influenced only indirectly by the project/programme. In general, it is not possible to attribute “indirect results” to the activities of an intervention, as too many actors are involved in the intervention, but it is obligatory to prove the plausibility that their project have contributed to development goals.

Nonetheless, highly aggregated development results (for instance progress made towards achieving the Millennium Development Goals) need to be kept in view. Even though comprehensive *attribution* is not possible, EnDev projects should provide plausible hypotheses on the project's *contributions* to overarching development results.

The following tables show the typical results chains for projects regarding "Energy for cooking" and "Rural Electrification".

Table 2: Results Chain for the Project type: Energy for cooking

Impact Chain	Applied to EAP - Cooking Energy
Outputs	<ul style="list-style-type: none"> • Appropriate & viable stove technologies are further developed/available • Stove producers are qualified in technical and business skills • Marketing campaigns are initiated and carried out • Quality control system is developed/in place • Increased access to information & knowledge about cooking energy (technologies & techniques) for general public • Household energy in mainstreamed into public sector
Use of outputs	<ul style="list-style-type: none"> • Stove producers use new appropriate & viable stove technologies models • Stove producers apply their technical and marketing skills • Control institutions implement quality control system • Households, social institutions and SMEs change their decision due to increased awareness about cooking energy issues
Outcome (Direct results)	<ul style="list-style-type: none"> • Increased sustainable access to modern cooking energy services for households, SME and social institutions. = Increased effective and correct utilisation of energy-efficient Rocket stoves
Impacts (Indirect results)	<ul style="list-style-type: none"> • Biomass energy is saved leading to <ul style="list-style-type: none"> - Savings: less expenses for fuel wood - Saved time on fuel wood collection • Improved working and living conditions <ul style="list-style-type: none"> - Saved cooking and collecting time - Less workload for women and children • Less deforestation and land degradation and improved climate protection • Improved indoor air quality and less respiratory and eye diseases • Improved safety and hygiene in the kitchen • Increased income generation for stove producers and retailers, more jobs and SMEs created • Increased engagement & employment of women
Highly aggregated results	<ul style="list-style-type: none"> • Reduction of extreme poverty (MDG 1) • Improved economic conditions (MDG 1) • Improved environmental conditions (MDG 7) • Improved health situation (MDG 4-6) • Improved situation of women (MDG 3)

Table 3: Results Chain for the Project type: Rural Electrification

Impact Chain	Criteria
Output	<ul style="list-style-type: none"> • Institutions / organisations¹ are qualified • Partner organisations have sufficient financial resources to implement pro-poor electrification programmes • Back-up/accompanying measures² are implemented
Use of output	<ul style="list-style-type: none"> • Qualified institutions / organisations work more efficiently and offer innovative products and services • Partner organisations use financial resources to provide facilitated access to modern energy services for households, SME, social institutions • Long-term sustainability is ensured by the implemented back-up/accompanying measures
Outcome (Direct benefits)	<ul style="list-style-type: none"> • Improved sustainable access to electricity for households, SME and social institutions • The provided electricity is increasingly used for productive purposes and income generation
Impact (Indirect benefits)	<p><u>Electricity for Households:</u></p> <ul style="list-style-type: none"> • Increased income through household production facilitated by improved working conditions • Monetary savings through reduced energy costs • Improved indoor air quality in households • Improved conditions for reading / studying of school children • Reduced workload / improved working conditions for women • Improved information and communication facilities • Enhanced perception of safety • Enhanced social cohesion in the community <p><u>Electricity for Social Infrastructure:</u></p> <ul style="list-style-type: none"> • Improved health services (medical infrastructure) • Improved educational services (educational infrastructure) • Enhanced perception of safety • Enhanced social cohesion in the community <p><u>Electricity for SME & Agriculture:</u></p> <ul style="list-style-type: none"> • Increased number / higher productivity of SME • Development of new businesses / energy-based value chains • Increased agricultural productivity
Highly aggregated results	<ul style="list-style-type: none"> • Reduction of extreme poverty • Improved economic conditions • Improved health situation • Improved educational situation • Improved situation of women

A more detailed overview on potential impact chains of EnDev electrification projects can be found in the annexe and is also available in Excel-format upon request.

¹ E.g. Government agencies, power generators/network operators/utilities, financial institutions/banks, NGOs/private enterprises/associations/cooperatives, educational institutions

² E.g. Introduction of quality assurance system, tariff and billing system, recycling system, awareness campaigns, marketing campaigns, promotion of productive use, monitoring

3 Monitoring and impact assessment

Monitoring of output, use of output and direct results (outcomes) are part of the existing project monitoring; biannual each EnDev project provides a monitoring report with the no. of people provided with access to a modern form of energy (direct benefit / outcome).

Monitoring of impacts (indirect results and highly aggregated results (MDG level)) in the results chains should be done during an impact assessment. The plausibility of the relation between outcomes and impacts has to be demonstrated and proven. The quantification is not possible, but for this monitoring already available data should be used where ever possible (such as national statistics).

Therefore, the EnDev projects should select a set of applicable indicators to be monitored on a regular basis through case studies or surveys. If needed, the EnDev team in Eschborn will provide additional support. The following paragraphs and tables present some options for indicators. For reasons of comparison and potential further analysis of data (e.g. cost-benefit-analysis) it is highly recommendable to include certain essential indicators (marked in the tables) for every EnDev Impact-Assessment.

3.1 Indirect Benefits - Indicators and possible sources of information

Important indirect benefits are listed in the tables below and linked to indicators which could be assessed through surveys.

The following table presents indicators which can be used to assess the impact of interventions regarding energy for cooking. To collect information regarding respective indicators, different methods are applicable.

Table 4: Indirect benefits: Criteria and Indicators regarding Energy for Cooking

MDG-relevance	Criteria	Indicator	What to measure? before and after (Examples)	How to measure?
MDG 1	Secured EGV for cooking energy	Increase of HH cooking on a regular basis due to availability of cooking energy	- Number of meals cooked per day with the regard to availability of fuel wood - Availability of fuel wood versus demand (according to statistics)	
	Income generation for stove producers and retailers	Increased income for male and female stove producers and retailers	- Average monthly/yearly, seasonally income from stove production (producers) and trading (retailers) – disaggregated for men and women	
	Creation of jobs and SMEs	Increase in number of new jobs in the stove production business	- Number of individual producers expanding and number of jobs in SMEs	
MDG 3	Female employment	Increase in number of women earning in stove business	- Number and percentage of women in small, medium and big stove business	
MDG 7	Biomass energy savings	Decrease in fuel wood used in at household level, in social infrastructures and SMEs	- Quantity of fuel wood used - Saving rate; - Stove utilisation rate	
MDG 1	Savings in fuel wood expenses	Decrease of expenditures on cooking energy (in households Social institutions and SMEs)	- Firewood and charcoal prices - Expenditures for cooking energy	
MDG 1,3	Time savings	Decrease of time spend for firewood collection	- Relation of firewood collected versus firewood bought - Time spend daily/weekly on firewood collection	
		Decrease of time spend on cooking	- Cooking time	
MDG 1	Additional income through productive activities	Increase in household incomes through additional productive activities (crop production, handycraft, etc)	- Purposes for which saved money and time is used - Household investment (time and money) in productive activities - Income	
MDG 3	Better working conditions for women and children	Increase in quality of working conditions for women and children	- Women's and children's subjective perception of changes in workload and working conditions related to the use of improved cooking technologies	
	Healthy indoor air	Decrease of smoke in the kitchen	- Subjective perception of women and children	

MDG 3,4-6	quality		regarding indoor air quality and smoke - Concentration of CO and PM (PM2.5 and PM10) in the kitchen	
	Better health	Decrease in number of cases of respiratory and eye diseases related to smoke	- Women's subjective perception of changes in illness (respiratory and eye diseases)	
		Decrease in medical costs for respiratory and eye diseases	- Expenditure on treatment of respiratory and eye diseases	
	Safety and hygiene in the kitchen	Decrease in number of accidents and burns caused by cooking	- Changes in number of accidents and burns in the kitchen	
		Kitchen cleanness raised to "living room standard"	- Cleannes in kitchens compared to observations of cleanness in living rooms	
MDG 7	Protection of forests	Decrease in deforestation rate	- Amount of fuel wood taken from trees and shrubs and bushes (living plant matter) versus dead plant matter – for fuel wood and charcol production - Deforestation rate (from forestry department)	
	Climate protection	Reduction of GHG emission per type of stove	- GHG emission of traditional and improved stove - Number of improved stoves in use	

The following tables present indicators which can be used to assess the impact of interventions regarding electricity access for households, social institutions and SMEs. To collect information regarding respective indicators, different methods are applicable.

Table 6: Criteria and Indicators regarding Electricity for Households

Criteria	Indicator
Increased income through household production facilitated by improved working conditions (appliances, lighting)	Average monthly income from productive use of electricity
	Percentage of households using electricity for productive purposes
Increased agricultural productivity	Subjective perception of farmers regarding agricultural production and changes related to electricity
	Annual agricultural yields for most important crops
	Percentage of farmer households using electric irrigation pumps
Monetary savings through reduced energy costs	Overall household expenditures on energy (kerosene, firewood, electricity, etc.)
Improved indoor air quality in households	Average monthly/annual amount of kerosene and candles used per household
	Subjective perception regarding indoor air quality and changes related to electricity
	Results of indoor air analysis: Concentration of carbon monoxide/ Concentration of air pollutants
Improved conditions for reading / studying of school children	Parents'/children's subjective perception of reading conditions and changes related to electricity
	Average time per day used for reading / studying of school children
Reduced workload / improved working conditions for women	Women's subjective perception of workload/working conditions and changes related to electricity
	Women's daily working hours and general time use
Improved information and communication facilities	Subjective perception of information and communication options and changes related to electricity
	Percentage of households owning TV/radio/cell phone
	Percentage of households using TV/radio/cell phone regularly (e.g. more than once a week)
Enhanced perception of safety	Subjective perception of safety and changes related to household electrification
Enhanced social cohesion in the community	Subjective perception of social activity in households of the community and changes related to electricity

Legend

	→ Essential Indicator*
	→ Recommendable Indicator

* should be included in every EnDev impact assessment, where possible

Table 7: Criteria and Indicators regarding Electricity for social infrastructure

Criteria	Indicator
Improved health services (medical infrastructure)	Percentage of rural clinics using fridges or other electrical medical equipment
	Subjective perception of rural health staff regarding the quality of rural health facilities and changes related to electricity
	Subjective perception of rural households regarding the quality of health care facilities and changes related to electricity
Improved educational services (educational infrastructure)	Percentage of schools using electric teaching aids such as projectors, cassette recorders, TVs, video machines etc.
	Subjective perception of rural teachers regarding the quality of rural education and changes related to electricity
	Subjective perception of school children in rural households regarding the conditions for studying in their schools and changes related to electricity
Enhanced perception of safety	Subjective perception of safety and changes related to public lighting
Enhanced social cohesion in the community	Subjective perception of public social activity in the community and changes related to electricity

Legend

	→ Essential Indicator*
	→ Recommendable Indicator

* should be included in every EnDev impact assessment, where possible

Table 8: Criteria and Indicators regarding Electricity for SME and agriculture

Criteria	Indicator
Increased number / higher productivity of SME	Number of SME in the target area
	Production/income of SMEs in the target area
	Subjective perception of rural entrepreneurs regarding productivity/income and changes related to electricity
Development of new businesses / energy-based value chains	Composition of business types, percentage of new/energy-based businesses

Legend

	→ Essential Indicator*
	→ Recommendable Indicator

* should be included in every EnDev impact assessment, where possible

3.2 *Highly Aggregated Results - Indicators and possible sources of information*

Table 9: Criteria and indicators regarding highly aggregated results

Criteria	Indicator
Poverty reduction	Number of households / persons below the poverty line
Improved economic conditions	Average household income
Improved health situation	Occurrence of respiratory diseases
	Infant mortality
Improved educational situation	Illiteracy rate
	Percentage of population with basic schooling
	Average results in central examinations
Improved situation of women	Gender-specific assessment of the above indicators

4 References

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Annex A: Methodologies for data acquisition

To collect empirical data on impacts of energy projects a wide range of methods and approaches is available, all of which can significantly differ in terms of time, money and expertise needed for implementation. This paragraph will give an overview on methodologies applicable and recommendable for the measuring of energy-related project impacts.

Available methodologies can be distinguished into *quantitative* and *qualitative* approaches. Whereas quantitative approaches are concerned to quantify social phenomena by collecting and analysing numerical data, qualitative methods emphasise personal experience and interpretation.

Quantitative approaches make use of a relatively large number of cases for investigation. Household sample surveys with structured questionnaires are the most commonly used application of quantitative methods in social science. They can be a good way of gathering quantitative information on socio-economic patterns.

Qualitative methods are often more time-consuming and elaborate in implementation and analysis. Therefore they commonly focus in detail on only a few cases, but provide in depth explanatory information. Examples for useful qualitative methods for the case of impact assessments are focused qualitative interviews as well as focus group discussions.

In general, the combination of quantitative and qualitative approaches is suggested for a broad insight in existing socio-economic patterns as well as to reveal the respective explanatory background. However, as mentioned earlier, the application of respective methods will depend on the available time frame as well as financial and personnel capacity.

a) Quantitative Sample Survey

Structured sample surveys can be a good source of information regarding quantitative information on the conditions of sampling units such as households, SMEs and social institutions. **Scheduled-structured interviews** are the most common form in impact assessments. The questions, their wording and their sequence are fixed within a structured questionnaire and identical for every responder. Therewith variations between given responses can be attributed to actual differences between the responders and not to variations in the process of interviewing.

In this context, the most commonly used type of question is the **standardized question** in which quantitative information is requested, response categories are specified and/or fixed alternatives supplied.

Example:

- 1.) How many persons live in your household? ___ persons
- 2.) Have you heard of Solar Home Systems before?
() yes () no
- 3.) Which of the following energy sources are used for cooking purposes in your household?
() Firewood () Dung () LPG

Beside standardized information, to some extent additional qualitative information can be gathered by the use of **open questions**. Open questions allow the responder to answer more freely without limitations by given answers, and can provide interesting additional information. However, analysis of open questions for large samples can be a time-consuming task.

- Example:**
- 1.) What changes in daily life could be observed after the purchase of your improved stove?
-
- 2.) What are the main problems your household currently has to deal with?
-

It is advisable to translate the questionnaire into local language beforehand, so that variations in answering can not be accounted to variations in the interviewers' own translation.

For Energising Development impact assessments focus on changes occurring due to the advent of improved energy access. In most cases, it will take a certain amount of time for these changes to fully evolve. It is therefore important to periodically conduct surveys and gather information for different points in time. At best, data collection is already commenced before the start of project activities. Data gathered in **baseline surveys** can later be used to conduct before-after comparisons for the respective project interventions. In cases where baseline data is not available, the so-called **recall-method** can be used for the initial survey. Respondents are requested to provide all information for the current situation as well as for a fixed point in time before the advent of improved energy access. However, as the memory of respondents is limited, the observed time period should not be too long, as otherwise collected data may become unreliable. It is also advisable to identify a so-called **control group** which is not affected by the project's or other programmes' interventions. By simultaneously conducting surveys with both the target group and the control group, the development effect of interventions can be supplementary verified through with-without comparisons.

In contrast to qualitative interviews (see 4.2) the **sample size** is fundamental for quantitative surveys. To gather representative results, i.e. results that are representative for the total population and statistically significant, a relative large sample size should be chosen. However, the size of the sample will depend on factors such as the basis of the characteristics of the target population, the topics being studied, the resources available, and the degree of accuracy necessary. As a rule of thumb for household surveys it is advisable to draw a sample of at least 40 to 50 households for each stratum (see below: stratified sample)³. In case of very small numbers of sampling units, e.g. a very limited number of hospitals in the project area, it may be advisable to prefer qualitative approaches.

There are different **types of sampling** available. Depending on the survey context one of the following sampling methods will be chosen:

- *Full sample*
Drawing a full sample will provide highest significance of results. However, due to the large amount of time and effort needed in most cases, conducting interviews with all sampling units existent in the study area is only advisable for small, manageable numbers of sampling units. In most instances it will be more advisable to draw smaller samples, which will be described in the following.
- *Random sample / Systematic sample*
In a random sample, every individual unit in the population has an equal chance of being selected for the sample; selection occurs by chance. As totally random selection of households is difficult in practice, the systematic sample is a common technique to draw near-random samples. For a systematic sample every nth unit is selected (e.g. interviews are conducted in every third household on the interviewer's way). Random / systematic samples provide information about distributions within the whole population. For example,

³ GTZ – Measuring Successes and Setbacks. How to Monitor and Evaluate Household Energy Projects. 1996.

to gain information about the percentage of Solar Home Systems existing in a village, a random sample should be drawn.

- *Stratified sample*

Stratified samples are used to ensure that appropriate numbers of members of small subgroups are included in the sample. This could apply for surveys focusing on technologies that have not yet widely disseminated, such as Solar Home Systems. For this case ownership/non-ownership of a Solar Home System might be typical strata. Other strata might include socio-economic groups, districts, professional groups, etc. The percentage drawn from each stratum may be equal or varying, according to the needs of the survey. In case of different percentages drawn for each stratum, data has to be weighted for analysis to correctly represent the population. For example, in a sample stratified by two household income groups, with 10% of existing high-income households and 30% of existing low-income households being interviewed, the data for high-income households has to be weighted by the factor 3.

Example: For studying the impacts of Solar Home Systems (SHS) in two villages in Bangladesh a stratified sample was drawn. The percentage of SHS in the respective villages was well below 10%. But as detailed information of households owning a SHS was crucial for the study objective, a full sample (51 HH) of SHS households was drawn. Additionally, 10% (87 HH) of remaining non-electrified households in the two villages were drawn in a systematic sample. Furthermore as a control group 25% (40 HH) of households in a village without electricity were interviewed. To adjust the different percentages drawn from each stratum, the data for the respective household groups was weighted: by factor 4 for the control group, and factor 10 for the non-electrified households in the SHS villages.

For **data analysis**, the use of statistical software such as SPSS (Statistical Package for the Social Sciences) is advisable, although for smaller surveys some statistical analysis tools are also provided by Microsoft Excel. Basic descriptive statistics (e.g. distribution of certain variables) can already provide most information necessary to assess energy-related impacts. Statistical analysis should be performed for the whole sample as well as for respective subgroups, such as groups defined by energy source (e.g. HH with/without electricity, improved stoves etc.), income or other socio-economic conditions relevant for the project context.

b) Qualitative Interviews

Qualitative interviews are well suited to reveal background information and detailed opinions regarding specific thematic aspects. This type of interview is generally conducted within a small number of sampling units. In many cases, information gathered from qualitative interviews may be used as basis for the design of a detailed structured questionnaire for subsequent quantitative surveys. For example, qualitative interviews in a small number of households can reveal information on the energy sources most commonly in use. This data can afterwards be used as answer alternatives for a structured questionnaire. Furthermore, data gathered from quantitative surveys can often be better understood through the acquisition of background information (e.g. regarding underlying cultural patterns) through focused qualitative interviews.

Instead of using large random samples, sampling units for qualitative interviews are often selected by purpose. For example, it might be interesting for a project to gain information on the opinion of a woman from one low-income as well as one high-income household respectively. Other possibilities include interviews with selected businesses with/without electricity, with experts from partner organisations, school teachers or clinic staff.

It is advisable to make use of **semi-structured questionnaires** containing several open routing questions, as this will assure comparability between the data gathered from different

interview partners. Through the use of open questions, respondents are free to articulate their personal view. However, the interviewer has to pay attention to keep the respondent in line with the routing questions.

The requirements for interviewers are generally higher than in the case of quantitative surveys. Interviewers should be eloquent and familiar with the interview topic, so they can flexibly react on the different issues brought up by the interview partners. To record the information, the interviews should be taped and transliterated. Where this is not possible for technical or cultural reasons, interviewers should be urged to take detailed notes on the most important issues.

c) Focus Group Discussion

Focus Group Discussions are one type of qualitative method, allowing interviewers to study people in a more natural setting than in a one-to-one interview. Focus Group Discussions are low in cost, one can get results relatively quickly, and they provide several opinions by talking to several people at once. However, compared to a one-to-one interview the moderator has less control over the group. Discussions typically take about one to two hours with a group size of usually six to ten members. The discussion should be loosely structured, and the moderator should encourage the free flow of ideas and opinions. Moderators should be highly trained and experienced with the topic of discussion.

Potential members of focus group discussions include members of households, entrepreneurs, representatives of social institutions, etc. To focus on gender aspects, discussions within groups of women/men might also be thinkable.

Discussions can be recorded on video or audio tape. Otherwise, detailed written documentation of the discussion has to be provided.

d) Observations

Observation of the target groups, villages and project interventions through local field staff is a cheap and simple way of gaining a first impression of energy's impacts. Even though not as accurate and representative as structured surveys, observations can be especially useful for preparing further scientific research (e.g. questionnaires) by providing first 'site-specific' knowledge. As observations are particularly prone to interference by the subjective impression and attitude of the observer, their results, however, should be interpreted with reservations.

e) Document and Statistics Review

Besides information that needs to be gathered from interviews or observations, data on particular indicators might be readily available from local databases, statistics and registers. However this is highly dependent on the country context and local practices of data collection and recording. Potential sources of information are local statistic departments, school / hospital registers, statistics of NGOs, etc.

Annex B: Detailed results chains of EnDev rural electrification projects

Level	Element	Example	Indicator
Inputs	Supply of materials and equipment	Vehicles, computers, poles, turbines	
	Assignment of staff	Long-term and short-term experts	
	Funds		
Level	Element	Example	Indicator
Activities (Aktivität)	1. Setting-up of / Advisory services and training for / provision and improvement of physical infrastructure for:	Workshops with experts, consultancy through German/local experts, study tours, on the job trainings, training workshops:	
	a) Government agencies	Advisory services for elaboration and adoption of laws and regulations regarding the promotion of renewable energies/rural electrification	number of trainings, workshops, meetings etc. conducted, number of participants and institutions
	b) Power generators/network operators/utilities	Training of staff for construction and operation of power plants, identification (pilot projects) and implementation of adequate operation systems, adapted tariff and billing systems, advisory services for marketing issues, technical and operational advice	number of trainings, workshops, meetings etc. conducted, number of participants and institutions
	c) Financial institutions/banks	Information on opportunities for financing of electrification projects, Advice on financing schemes (e.g. subsidy schemes)	number of trainings, workshops, meetings etc. conducted, number of participants and institutions
	d) NGOs/private enterprises/associations/cooperatives	Advisory services on strategy, marketing issues, technical and operational aspects; advice on organisation of after sale services, support in making international contacts, support in setting up associations, investment subsidies	number of trainings, workshops, meetings etc. conducted, number of participants and institutions
	e) Educational institutions	Advisory services on design of training concepts, Support in training material and curricula design, support for certification of trainings	number of trainings, workshops, meetings etc. conducted, number of participants and institutions
	2. Funding of:	Develop and agree funding criteria with the partner, agree size of funding and funding disbursement, agree contractual arrangements	
	a) Extension/Densification of national grid	Transfer of funds to organisations in charge of grid extension, refinancing of revolving funds	
	b) Installation/Extension of mini grids (incl. small power plants)	Transfer of funds to organisations in charge of power generation plants and mini grid installation, refinancing of revolving funds	
	c) Subsidies for connection costs (grid) and stand alone systems	Transfer of funds to organisations in charge of grid extension/stand alone system dissemination, refinancing of revolving funds	
	d) Credit lines for micro financing	Transfer of funds to micro finance institutions	
	3. Back-up/accompanying measures		
	a) Introduction of a quality assurance system	Introduction of standards, certificates; inspections, setting up of organisations for quality assurance, development of warranty systems	
	b) Introduction of a tariff and billing system	Feasibility studies, concept development, implementation strategies	
	c) Introduction of a recycling and waste management system	Feasibility studies, concept development, implementation strategies	
	d) Creating awareness / knowledge base on RE technologies	Awareness and information campaigns regarding electricity access and RE technologies	
	e) Marketing	Marketing campaigns for energy products, organisation of fairs and exhibitions	
	f) Promotion of productive use of electricity	Trainings and information for entrepreneurs and households, financing for rural entrepreneurs	
	g) Monitoring	Introduction of a functioning monitoring system for implemented activities	

Level	Element	Example	Indicator
Use of Outputs (Nutzung)	1. Qualified institutions/organisations work more efficiently and offer innovative products and services		
	a) Government agencies	Effective implementation of rural electrification through improved structures, methods and tools; creation of favourable political conditions	<ul style="list-style-type: none"> • A target setting regarding energy supply with renewable energy sources is in place (number of households/villages).
	b) Power generators/network operators/utilities	Profitable, efficient operation of power plants, utilisation of efficient operation and tariff systems, offering of attractive and affordable energy services for the target groups	<ul style="list-style-type: none"> • Quality business plans and procedures of generators, operators and utilities are documented
	c) Financial institutions/banks	Efficient operation, provision of attractive financial products for energy providers/NGOs/private enterprises	<ul style="list-style-type: none"> • Credits for small scale energy investments increase by XX%
	d) NGOs/private enterprises/associations/cooperatives	Efficient operation, provision of attractive and affordable energy products and services for the target groups, associations support and promote the introduction and dissemination of modern energy services	<ul style="list-style-type: none"> • At least at X sites the expansion of renewable energy services through NGOs, private enterprises or cooperatives is taking place • The necessity of environmental sound disposal of incidental waste materials has been recognised
	e) Educational institutions	Execution of demand-orientated, certified training programmes for RE organisations and technical staff, implementation of training concepts	<ul style="list-style-type: none"> • A certification system für training is introduced • Training programmes für technicians are introduced
	2. Partner organisations use financial resources to provide facilitated access to modern energy services for households, SME, social institutions:		
	a) Access to a national grid	The organisation in charge of grid extension uses the provided funds to build new power lines, physical access to a national grid line is possible for rural households	<ul style="list-style-type: none"> • Length of grid extension (km) • Number of households that could technically be served with electricity from the national grid through the newly built power lines
	b) Access to a decentralised mini-grid	The organisation in charge of mini grid installation uses the provided funds to build a mini hydro plant, physical access to a mini grid is possible for rural households	<ul style="list-style-type: none"> • Number and capacity of additional power plants • Length of mini grid extension (km) • Number of households that could technically be served with electricity from the mini-grid grid through the newly built power lines
	c) Availability of affordable electricity connections and stand alone products	The organisation in charge of grid extension/system dissemination uses the provided funds to reduce the price of electricity connections/stand alone systems, therewith making them affordable to rural customers	<ul style="list-style-type: none"> • Amount of subsidy (total & per system) • Number of households that could afford a grid connection/stand alone system at the subsidised price
	d) Availability of micro financing options for covering of initial costs of energy products	Financing institutions offer attractive micro financing products and therefore increase affordability of energy products for rural households	
	3. Long-term sustainability is ensured by the implemented back-up/accompanying measures		
	a) Quality of promoted technologies is ensured		<ul style="list-style-type: none"> • Certificates and standards are used by suppliers, operators etc.
	b) Effective and user-friendly tariff and billing systems ensure the covering of running expenses		
	c) Waste products are recycled / safely disposed and do not pose any risk for the natural environment		
	d) Awareness and knowledge on use of energy products by the target groups		
	e) Rising demand for the newly provided energy products and services by the target groups		
	f) Entrepreneurs and households are aware of the possibilities for productive use of electricity and have the financial potential to start related activities		
	g) Quality and efficiency of processes is ensured		

Level	Element	Example	Indicator
Outcomes / direct benefits (Direkter Nutzen)	Improved <u>sustainable</u> access to energy for households, SME and social institutions (1+2+3)		<ul style="list-style-type: none"> • At least X persons gained access to electricity • Increase of the proportion of the rural population with access to electricity • X years after the installation of plants/services, at least X% of users is still connected • X years after the installation of plants/services, at least X% of users are satisfied with the quality of provided services • All social institutions (schools, clinics, community centres) are provided with electricity • At least X% of counselled energy providers cover the operational costs not later than after Y years • Annually the labour market is provided with X technicians for the respective RETs • Free rider effect is minimal
	The provided electricity is increasingly used for productive purposes and income generation (3f)		<ul style="list-style-type: none"> • At least X% of electricity customers use electricity for income generating activities • X new jobs have been created by the productive use of electricity

Level	Element	Example	Indicator
Impacts / indirect benefit (Indirekter Nutzen)	Increased income through household production facilitated by improved working conditions	Use of appliances (e.g. sewing machines), improved lighting	<ul style="list-style-type: none"> • Monthly income from productive use of electricity • Changes in percentage of households using electricity for productive purposes
	Increased number / Higher productivity of SME	Use of machinery for increased production	<ul style="list-style-type: none"> • Number of SME in the target area • Production/income of SMEs in the target area • Percentage of SMEs stating that electricity had significant positive influence on production/income
	Development of new businesses / energy based value chains	ICT, entertainment (cinemas), electricity supply business	<ul style="list-style-type: none"> • Composition of business types, percentage of new/energy-based businesses
	Savings through reduced energy costs	Expenditures for kerosene (lighting) are substantially reduced	<ul style="list-style-type: none"> • Changes in overall household expenditures on energy
	Increased agricultural productivity	Improved irrigation, processing and conservation	<ul style="list-style-type: none"> • Number of electric irrigation pumps in the target area • Annual agricultural yields for most important crops • Percentage of farmers stating that electricity had significant positive influence on agricultural production
	Improved health services (medical infrastructure)	Vaccine cold chain can be maintained in rural clinics (fridges), improved communication facilities	<ul style="list-style-type: none"> • Percentage of rural clinics using fridges or other electrical medical equipment • Percentage of rural health facilities stating that the quality of their work significantly improved due to electricity • Percentage of households stating that health care facilities have significantly improved due to electricity
	Improved indoor air quality in households	Avoidance of kerosene for lighting and related fumes	<ul style="list-style-type: none"> • Subjective perception of indoor air quality • Results of indoor air analysis • Average monthly/annual amount of kerosene and candles used per household
	Improved conditions for reading / studying of school children	Improved quality of light, studying at night is possible	<ul style="list-style-type: none"> • Subjective perception of reading conditions e.g. agreement on statements such as "In my house it is easy to read in the evening" • Average time per day used for reading / studying of school children • Percentage of school children stating that conditions for studying in their households have improved significantly due to electricity
	Improved educational services (educational infrastructure)	Lighting at schools, Use of teaching aids (overhead projectors, TV, tape recorders, video machines)	<ul style="list-style-type: none"> • Percentage of schools using electric teaching aids such as projectors, cassette recorders, TVs, video machines etc. • Percentage of rural schools stating that the quality of education significantly improved due to electricity • Percentage of households with school children stating that the conditions for studying in their schools have significantly improved due to electricity
	Reduced workload / improved working conditions for women	Use of household appliances and lighting	<ul style="list-style-type: none"> • Percentage of women stating that they have to work significantly less due to electricity (time savings) • Percentage of women stating that household work is significantly easier due to electricity (working conditions) • Average women's working time per day
Improved information and communication facilities	Use of TV, radio; cell phone charging	<ul style="list-style-type: none"> • Percentage of households owning TV/radio/cell phone • Percentage of households using TV/radio/cell phone regularly (e.g. more than once a week) • Subjective perception of communication e.g. agreement on statements such as "It is easy for my family to get news and information" 	

Level	Element	Example	Indicator
Impacts / indirect benefit (Indirekter Nutzen)	Enhanced social cohesion in the community	(Improved) street lighting, lighting of community centres, religious buildings (temples, mosques, churches, etc.)	<ul style="list-style-type: none"> • Subjective perception of social activity in households of the community e.g. agreement on statements such as "We often socialise with friends, relatives, or neighbours at our home in the evening" • Number of social events taking place in the evening during the last month
	Enhanced perception of safety	Improved lighting reduces risk of burglary	<ul style="list-style-type: none"> • Subjective perception of safety e.g. agreement on statements such as "We feel safe in our household in the evening" "We feel safe outside of our home in the evening" • Percentage of households stating that overall security has significantly improved due to household lighting • Percentage of households stating that overall security has significantly improved due to public lighting

Level	Element	Example	Indicator
Highly aggregated benefit (Hoch aggregierter Nutzen)	Poverty reduction		<ul style="list-style-type: none"> • Number of households / persons below the poverty line
	Improved economic conditions		<ul style="list-style-type: none"> • Average household income
	Improved health situation		<ul style="list-style-type: none"> • Occurrence of respiratory diseases • Infant mortality
	Improved educational situation		<ul style="list-style-type: none"> • Number / Percentage of illiterates • Number / Percentage of people with basic schooling
	Improved situation of women		<ul style="list-style-type: none"> • Gender specific assessment of the indicators above