

Harsdorff, Marek; Peters, Jörg

**Research Report**

## On-grid rural electrification in Benin: A socio-economic baseline study on a GTZ Project

RWI Materialien, No. 57

**Provided in Cooperation with:**

RWI – Leibniz-Institut für Wirtschaftsforschung, Essen

*Suggested Citation:* Harsdorff, Marek; Peters, Jörg (2010) : On-grid rural electrification in Benin: A socio-economic baseline study on a GTZ Project, RWI Materialien, No. 57, ISBN 978-3-86788-201-9, Rheinisch-Westfälisches Institut für Wirtschaftsforschung (RWI), Essen, <https://nbn-resolving.de/urn:nbn:de:101:1-20100430315>

This Version is available at:

<https://hdl.handle.net/10419/61152>

**Standard-Nutzungsbedingungen:**

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

**Terms of use:**

*Documents in EconStor may be saved and copied for your personal and scholarly purposes.*

*You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.*

*If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.*



Materialien

Marek Harsdorff  
Jörg Peters

# On-Grid Rural Electrification in Benin

A Socio-economic Baseline Study  
on a GTZ Project

Heft 57

# Imprint

## Board of Directors

Prof. Dr. Christoph M. Schmidt (President)

Prof. Dr. Thomas K. Bauer (Vicepresident)

Prof. Dr. Wim Kösters

## Governing Board

Dr. Eberhard Heinke (Chairman);

Dr. Henning Osthues-Albrecht; Dr. Rolf Pohlig; Reinhold Schulte (Vice Chairmen);

Manfred Breuer; Oliver Burkhard; Dr. Hans Georg Fabritius;

Hans Jürgen Kerkhoff; Dr. Thomas Köster; Dr. Wilhelm Koll;

Prof. Dr. Walter Krämer; Dr. Thomas A. Lange; Tillmann Neinhaus;

Hermann Rappen; Dr.-Ing. Sandra Scheermesser

## Scientific Advisory Board

Prof. Michael C. Burda, Ph.D.; Prof. David Card, Ph.D.; Prof. Dr. Clemens Fuest;

Prof. Dr. Justus Haucap; Prof. Dr. Walter Krämer; Prof. Dr. Michael Lechner;

Prof. Dr. Till Requate; Prof. Nina Smith, Ph.D.

## Honorary Members of RWI

Heinrich Frommknecht; Prof. Dr. Paul Klemmer †; Dr. Dietmar Kuhnt

## RWI Materialien Heft 57

Published by:

Rheinisch-Westfälisches Institut für Wirtschaftsforschung

Hohenzollernstraße 1-3, 45128 Essen, Tel. 0201 - 8149-0

All rights reserved. Essen 2010

Editor:

Prof. Dr. Christoph M. Schmidt

Editorial Office:

Joachim Schmidt

Concept and Design:

Julica Marie Bracht, Daniela Schwindt, Benedict Zinke

ISSN 1612-3573

ISBN 978-3-86788-201-9

Materialien

Marek Harsdorff and Jörg Peters

# On-Grid Rural Electrification in Benin

A Socio-economic Baseline Study on a GTZ Project

Heft 57



# On-Grid Rural Electrification in Benin

# Contents

## Summary 7

<b>1.</b>	<b>Study Background and Goals</b>	<b>11</b>
<b>2.</b>	<b>Methodology</b>	<b>12</b>
<b>3.</b>	<b>Baseline Results from Project Villages</b>	<b>15</b>
3.1	Power Supply in Households	15
3.1.1	Modern Household Energy	15
3.1.2	Energy Source	15
3.1.3	Problems concerning Energy Sources in the Households	18
3.1.4	Use of Electronic Devices	19
3.1.5	Planned Use of Electricity	19
3.1.6	Gender Relations	20
3.1.7	Households' Willingness to Pay for Electricity	20
3.1.8	Pre-paid Meters and Battery Systems	22
3.2	The Households' Social and Economic Situation	23
3.2.1	Occupation	23
3.2.2	Income	24
3.2.3	Savings and Credits	25
3.2.4	Expenses	26
3.2.5	Agriculture	26
3.2.6	Nutrition	28
3.2.7	Water Supply	28
3.2.8	Housing	28
3.2.9	Education	30
3.2.10	Health	30
3.2.11	Telecommunications	32
3.2.12	Migration	32
3.3	Social Infrastructure Institutions	32
3.3.1	Health Centres	32
3.3.2	Schools	33
3.3.3	Public Administrative Facilities	35
3.4	Small Enterprises	36
3.4.1	Existing Small Enterprises	36
3.4.2	Working Hours	39
3.4.3	Financial Situation	39
3.4.4	Energy Demand	40
3.4.5	Advantages of the Electrification According to Small Enterprises	42
3.4.6	Small Enterprises' Willingness to Pay for Electricity	42

# On-Grid Rural Electrification in Benin

<b>4.</b>	<b>Ex-ante Impact Assessment of the Electrification Intervention</b>	<b>43</b>
4.1	Impact of the Electrification on the Energy Supply of Households	43
4.1.1	Household Connection	43
4.1.2	Secondary Connections	46
4.1.3	Forms of Use of Electricity	47
4.1.4	Development of Electricity Consumption	48
4.1.5	Non-commercial Use of Electricity	49
4.1.6	Productive Use of Electricity in the Household	50
4.1.7	Productive Use of Electricity in Agriculture	51
4.1.8	Household's Expenses for Electricity	51
4.1.9	Reliability of Electricity	52
4.2	Electrification Impact on the Socio-economic Living Conditions	52
4.2.1	Impacts on the Gender Relations	52
4.2.2	Impacts on Children's Learning Habits	53
4.2.3	Impacts on Health	54
4.2.4	Impacts on Telecommunications	55
4.2.5	Impacts on the Perception of the Standard of Living	55
4.3	Impact of the Electrification on the Social Infrastructure	55
4.3.1	Health Centres	55
4.3.2	Schools	56
4.4	Impact of the Electrification on Small Enterprises	56
4.4.1	Grid Connection of Small Enterprises	56
4.4.2	Productive Use of Energy in Small Enterprises	58
4.4.3	Start-ups of Small Enterprises	58
<b>5.</b>	<b>Recommendations for Project Implementation</b>	<b>61</b>
	<b>Bibliography</b>	<b>62</b>

## Figures

- Chart 1** “Who uses lighting, TV, radio and telephone the most and who is responsible for kerosene in your household?” 21
- Chart 2** Main occupation of the male heads of household 23
- Chart 3** Average monthly incomes per household from different sources of income 24
- Chart 4** The contribution of different sources of income to the national income in the project region 25
- Chart 5** Pattern of expenditure in rural households (HH) 26
- Chart 6** “What is your household's drinking water source?” 29

# Contents

Chart 7	“Have you attended school, graduated or received vocational training?” 31
Chart 8	“Who suffers from which diseases in your household?” 31
Chart 9	Most important purposes and advantages of electricity from the point of view of connected households compared to non-electrified households 48
<b>Tables</b>	
Table 1	Population and number of surveyed entities 13
Table 2	Facilities of the social infrastructure and catchment areas 14
Table 3	Energy sources in the households (Average expenses, consumption, costs, time expenditure) 17
Table 4	Problems the households have when using different energy sources 19
Table 5	The use of electricity to generate income 20
Table 6	Willingness to pay, energy expenses and the planned costs of electricity 22
Table 7	Agricultural products and market orientation 27
Table 8	Schools in the non-electrified villages 34
Table 9	The schools’ problems from the headmasters’ points of view 35
Table 10	Number and kind of small enterprises in the individual villages 37
Table 11	Structure and income of private small enterprises 38
Table 12	Average energy consumption of particular types of enterprises per month, categorised according to energy demand 41
Table 13	Small enterprises’ willingness to pay for electricity 43
Table 14	Main occupation and average income 44
Table 15	Connection rates of the households concerning secondary and official connections 47
Table 16	Electricity consumption in connected households over the course of time 49
Table 17	Connected households (HH) that own electronic devices and machines 49
Table 18	Statements about the use of electricity for generating income 50
Table 19	The use of electricity for work in connected and non-electrified households 51

## On-Grid Rural Electrification in Benin

- Table 20** Energy expenses in connected and non-electrified households (HH) 52
- Table 21** Television viewing behaviour of men and women in connected and non-electrified households (HH) 53
- Table 22** Children's time for homework and school attendance rates in connected and non-electrified households (HH) 54
- Table 23** Respiratory diseases in connected and non-electrified households 54
- Table 24** Energy expenses of connected and non-electrified health centres 55
- Table 25** Grid connection of small enterprises that have already existed before the electrification 57
- Table 26** Start-ups of small enterprises that have resulted from the electrification in Copargo 60

### Photos

- Photo 1** A typical non electric source of light 16
- Photo 2** Revising the questionnaires under traditional lighting 16
- Photo 3** Women collecting firewood 18
- Photo 4** Modern housing 29
- Photo 5** Traditional housing 30
- Photo 6** Electric mill in an electrified village 38
- Photo 7** Diesel mill 39
- Photo 8** Sawmill 59
- Photo 9** Multimedia shop 59

## Summary

A baseline study has been conducted for the EnDev measure in Benin between November 2006 and February 2007. Throughout the course of the study, 290 households, 60 small enterprises and 60 social institutions were interviewed in the project region of the development measure. Being part of the project monitoring, this comprehensive socio-economic survey aims to assess the status quo before the implementation of the electrification component. It is complemented by a survey of 120 households, small enterprises and social institutions in villages close to the project region that already have access to electricity. This way, first impressions of the impact of electrification measures could be recorded. The central findings of the two surveys will be summarized below.

Based on the experiences gained in the electrified villages, it seems feasible that in the 12 project villages 25 percent of the population living within the range of the electricity network (distance < 40 meters) can be officially connected. Furthermore, the project monitoring will include those households which connect themselves unofficially, but with proper equipment to the electricity network. This group comprises another 25 percent of the population. The villages have 61,300 inhabitants; 43,000 of these live within the range of the planned network. Based on the current state of knowledge, one can, hence, anticipate that approximately 21,500 people will gain access to electricity through the project.

- ❑ Approximately 10 percent of the 43,000 households in the project region already have generators that they use around three hours every day. Another 5 percent of the households are served by a village mini-grid in the evening hours. This grid runs on a generator. In total, approximately 6,450 inhabitants can be regarded as pre-electrified.
- ❑ The following social infrastructure is located in the project region: 11 primary schools (catchment area: 52,000 people), 7 secondary schools (catchment area: 116,000 people), 10 health care centres (catchment area: 118,000 people) and 10 administrative facilities (catchment area: 114,000 people).
- ❑ Based on the data collected in the electrified villages, one can assume that 220 of the 500 small enterprises in the project region will connect. Yet 35 of these already dispose of a generator, so that approximately 185 enterprises will gain access to electricity through the project.

## On-Grid Rural Electrification in Benin

- ❏ Households face three access barriers concerning electricity. Especially the poorer part of the population has trouble gaining access because of these impediments:
  - ❏ Education (poor households lack knowledge about the advantages of electricity),
  - ❏ Affordability (poor households cannot afford a connection) and
  - ❏ Accessibility (the network covers only the centre of the village; remote, mostly agricultural and poor households are excluded).

Unequal opportunities of gaining access to the electricity network increase, at least temporarily, the level of inequality: This can be measured directly by the costs for electricity. Because of a higher efficiency, these costs are lower than the costs for kerosene and batteries for lighting and radios. But also the actual energy expenditures in non-electrified households are nearly twice as high, even when the consumption is lower (see table 20). Indirect impacts are related to: health (reduction of indoor air pollution), improved opportunities for studying at home and the productive use of energy. The findings in the electrified region show, however, only little evidence for these indirect impacts.

The primary use of electricity is lighting, which is used by all interviewed electrified households, followed by television (more than 70 percent). Productive use of electricity hardly occurs in the household. Only 2 percent use electricity directly to generate income.

- ❏ Households do not automatically climb the “energy ladder”, even if modern energy sources, such as electricity, exist. Cultural and traditional habits seem to prolong the use of kerosene lamps, for instance. Typically, wood and charcoal are hardly ever substituted by electricity.
- ❏ Men who helped within the household in the evenings before the electrification engage less after electrification. This could be due to the use of television.
- ❏ Primary schools do not connect to the grid. They either lack ideas how electricity could be used in the classroom or the necessary financial resources.
- ❏ Secondary schools finance the connection, installations and electricity consumption by increasing tuition fees. The use of computers and photocopiers clearly improves teaching. Yet, the increase of tuition fees could have negative effects on the number of school enrolments.

## Summary

- ❑ Small enterprises which do not necessarily need electricity in order to carry out their work have a tendency to not connect themselves, since a more capital-intensive mode of production would require investments. Using electricity for appliances and machines would make part of workforce redundant. However, this is either very inexpensive or from the perspective of the enterprises not necessary, which is eventually caused by missing market access. Purchasing power on local markets is low, while supra-regional markets are inaccessible. Therefore many enterprises refrain from connecting themselves to the grid.
- ❑ Start-ups and expansions of economic activity in the existing small enterprises will rarely take place in the short- and medium-term; in small villages they probably do not take place at all. Electrified enterprises use electricity mainly for lighting. They lack knowledge of other ways to use electricity productively, the finances to make necessary investments and market access.
- ❑ Electricity is used neither in agriculture, nor for the processing of agricultural products.
- ❑ The vast majority of the interviewed households state that for them, 12 V-batteries or photovoltaic systems do not present an alternative to grid electricity. This is not surprising, since they consider the interviewer a representative of the project that they hope will assure the accessibility and financial viability of a grid connection. In fact, doubts are raised about the probability of success of such systems, since diesel generators are affordable in the region and generate more power. Furthermore, households are willing to bridge up to one kilometre with their own wires in order to connect themselves to the grid.

The following recommendations concerning the implementation of the project can be deduced from these results:

- ❑ Raising awareness in poor households and holding general information meetings for all households.
- ❑ “Legalizing” unofficial connections while giving technical advice.
- ❑ Providing trainings on the productive use of electricity.
- ❑ Guaranteeing low or symbolic connection fees for schools and providing seminars targeted at teachers.

## On-Grid Rural Electrification in Benin

- ❏ The planned charging systems for batteries should not be implemented for the time being. A demand analysis may be carried out again, once the grid expansion is finished and once it becomes apparent that more remote households will not be able to connect to the grid.

# 1. Study Background and Goals

## 1. Study Background and Goals

In December 2004, the Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH was put in charge of implementing the programme *Energising Development (EnDev)*. EnDev is a partnership between the Federal Ministry for Economic Cooperation and Development (BMZ) and the Dutch Directorate-General for International Cooperation (DGIS). It is supposed to provide up to 5 Million people with sustainable access to modern energy. Overall target group is the population in rural and peri-urban areas of Dutch partner countries. In this context, an electrification measure is being implemented in Benin since 2005. Its goal is to connect a total of 12 villages in the North and Southeast of the country to the national grid.

Within the scope of the monitoring process of the EnDev measure, this study will document the social and economic situation of the target group before the connection of their villages to the grid (Chapter 3). Therefore a comprehensive survey was conducted among households, small enterprises, schools and health and administrative institutions in 12 villages. After that, the short- and medium-term effects of electrification on the social and economic living conditions of the rural population are analysed. This is done by comparing the survey results of the yet non-electrified villages to those in comparable but already electrified villages (Chapter 4). Among other things, this impact analysis is supposed to facilitate the development of accompanying measures that seem essential for the achievement of higher-order development goals (Barnes, Gregory 2003).

The Millennium Development Goals (MDGs) developed by the United Nations are the basis of the impact analysis. These development goals are a well-established framework of reference and fundamental for international cooperation. Thus they will also serve as an orientation for the development goals of the electrification project (Brand 2006).

These goals concretely involve reducing poverty (MDG 1), improving education (MDG 2), promoting gender equality (MDG 3), improving health (MDG 4, 5, 6) and ensuring environmental sustainability (MDG 7).

In 2002, when 30 amendments were made to the Johannesburg Plan of Implementation, the improvement of power supply was included in set of priority development targets (Nuscheler 2006). This decision is essentially based on the following consideration: electrification increases productivity and generates economic growth in the long run; thereby improvements in income are achieved; through “trickle down” effects, these inure to the benefit of the poor. Thus electrification contributes directly, as well as indirectly to the achievement

## On-Grid Rural Electrification in Benin

of the MDGs (Brook, Smith 2006:102). In the following we will show its direct contribution through the improvement of educational opportunities, health and income possibilities and its indirect contribution through economic growth.

### 2. Methodology

The baseline surveys were conducted in those 12 villages that are supposed to be electrified through the grid expansion in the course of the EnDev measure. For the impact analysis additional surveys were conducted in two villages that are already connected to the grid. They are similar to the project villages in population, political and economic characteristics. Except for questions on power supply, the same questionnaires were used in the electrified villages and the project region, so that the collected data can be analysed comparatively. However, because of the small scope of this study, only those survey results of the electrified villages are examined that allow for relevant conclusions with regard to the contribution of electrification to the achievement of the MDGs and economic development.

Households, small enterprises, schools, health centres and administrative facilities were interviewed respectively. A **household** was defined here as an “extended family that lives in grouped houses on a confined piece of land” (on average 11.5 persons). Over one third of the heads of households lives in polygamy with more than one wife. In almost every household, there are children, on average six to seven per household. Besides, distant relatives of the nuclear family often live in the households as well. A **small enterprise** in this study is represented by every non-agricultural occupation that generates income and is carried out in especially designated places.

In order to gather as much information as possible about life with electricity, only those households in electrified villages were interviewed that are connected to the grid. Yet the survey showed that the households connected to the grid are predominantly better-off and educated above average. Therefore the comparison between these connected and the non-electrified households that is necessary for arriving at conclusions about the impact of electricity is methodically problematic. To reassess to what extent the heterogeneity of the samples influences the results of the impact analysis, the electrified households were also compared with the richest 30 percent of the interviewed non-electrified households. The average income of these 30 percent corresponds roughly to that of the connected households, but it is twice as high as the average of all the non-electrified households.

## 2. Methodology

Table 1 gives an overview of the conducted surveys. A total of 409 households, 67 small enterprises, 12 health centres, 49 schools and 12 administrations were interviewed.

**Table 1**  
**Population and number of surveyed entities**

	Non-electrified villages		Electrified villages	
	Population living under the planned grid	Number of surveyed entities	Population living under the grid	Number of surveyed entities
Households	3,749	289	514	120
Household Members	43,114	3,324	4,626	1,080
Small enterprises	519	58	119	9
Health centres	10	10	2	2
Schools	38	38	11	11
Administrative offices	10	10	2	2

In order to ensure the representativeness of the household data for total village population, the number of households in all individual villages and village districts was at first recorded. Then the households to be interviewed in every district were selected at random, so that every district was represented proportionally to its part of the population in the sample. The small enterprises were selected so that in every village at least one enterprise of all local occupational groups was interviewed. These groups comprise mechanics, carpenters, tailors, hair dressers, bar owners, shop owners, and millers. In addition, interviews in all existing social infrastructure institutions were conducted. The population covered by the planned grid, as well as the catchment area of the covered social infrastructure are illustrated in table 2 according to the respective villages.

The questionnaires were developed in September 2006. They have been adapted to regional cultural conditions in cooperation with local assistants after pre-tests with 10 households in two villages. In a two-day training course, local assistants were then instructed for the household surveys. The interviews with the small enterprises, schools, health centres and administrative facilities were conducted by the author of this study. Most interviews were held in French, otherwise village inhabitants were asked to translate the questions and answers. All interviews

## On-Grid Rural Electrification in Benin

**Table 2**  
Facilities of the social infrastructure and catchment areas

Village	Population	Primary school	Catchment area	Secondary school	Catchment area	Health centres	Catchment area	Administrations	Catchment area	Enterprises
Oroukayo	3,200	2	4,400			1	18,295	1	18,295	23
Pouya	1,894	2	1,894							30
Kotopunga	2,158	1	2,158	1	12,856	1	7,790	1	7,790	25
Toucou'na	4,195	3	4,195	1	30,000	1	12,000	1	12,000	120
Birni	4,000	2	6,396	1	14,506	1	14,506	1	14,506	45
Chabi C.	3,770	2	3,553			1	6,870	1	6,870	42
Sèmèrè	7,500	6	7,500	1	25,492	1	21,926	2	21,926	83
Béléfoung.	3,175	2	3,175	1	5,125	1	5,125	1	5,125	26
Kolokondé	6,938	5	6,938	1	19,912	1	19,912	1	19,912	78
Honjin	2,430	3	5,500	1	7,889	1	7,889	1	7,889	17
Kansoukpa	3,000	2	4,000			1	4,000			16
Kpodji	850	1	2,750							14
Total	43,110	31	52,459	7	115,780	10	118,313	10	114,313	519

Source: data record of the survey on social infrastructure, Benin 2007

## 3. Baseline Results from Project Villages

took place in the period between 4 December, 2006 and 10 February, 2007. During the household surveys, the questions were first addressed to the heads of the households, traditionally the oldest in the family. Yet also his firstborn sons or women in the households were included in the interview, since they were usually informed best and more responsive. Interviewing a household took approximately 1 ½ hours on average; interviewing a small enterprise, a school, a health centre or an administrative facility around half an hour.

### 3. Baseline Results from Project Villages

#### 3.1 Power Supply in Households

##### 3.1.1 Modern Household Energy

In order to assess the potential benefits of the electrification measure for individual households, one has to distinguish two different groups among the households in non-electrified villages: households that have not used electricity so far and those that are already provided with modern household energy before the extension of the grid. Through an alternative reliable power supply, these pre-electrified households are enabled to use electronic devices and electric light. Approximately 10 percent of the households in the non-electrified villages have their own generator. Common generators generate 600 to 900 watt and cost between 35,000 and 70,000 FCFA (657 FCFA = 1 €). The price of one kilowatt-hour of electricity generated by such a generator is approximately 200 FCFA; this is double the price that is intended for grid electricity, yet much less expensive than the use of dry cell batteries with estimated prices of more than 3,000 FCFA/kwh for flashlights.

##### 3.1.2 Energy Source

Table 3 provides information on how many of the non-electrified households use certain energy sources and for what purposes. All households cook with wood or coal. For lighting, all interviewed households use so-called hurricane lanterns, closed kerosene lanterns with glass windows. Every household owns an average of four lanterns that are lit for 10 hours on average every night.

A household consumes 9 litres of kerosene on average every month. Often the lanterns are turned up at nightfall at 7 p.m. The lantern casts a dim light cone with a radius of about one to two metres. Reading is only possible in direct proximity to the lantern. A room of 10 square metres is not fully illuminated. Around 11 p.m., the lanterns are turned down, so that they cast only minimal light or none at all. They are placed next to the bed in “standby”, so to speak. Especially for women with small children it is important to have a source of light in their reach that is immediately ready for use. In the morning, around 6:30 a.m., the lanterns

## On-Grid Rural Electrification in Benin

Photo 1

A typical non electric source of light

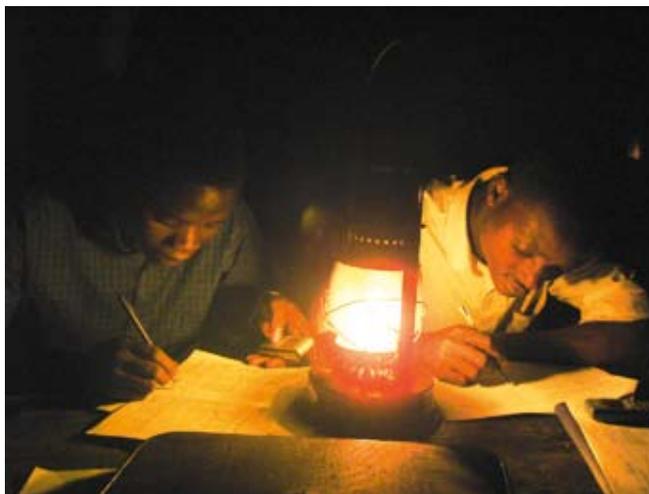
---



Photo 2

Revising the questionnaires under traditional lighting

---



### 3. Baseline Results from Project Villages

**Table 3**  
**Energy sources in the households (Average expenses, consumption, costs, time expenditure)**

	Household energy					Energy for transportation		Productive Energy		
	Candles	Kerosene for Lamps	Kerosene for fire	Batteries for radios	Batteries for flashlights	Kerosene for generators	Charcoal for cooking		Wood for cooking	Petrol for transportation
Monthly Expenses in FCFA	395	4,083	223	730	1,106	619	516	1,583	7,070	2,114
Households using this source in percent	12%	100%	15%	96%	97%	10%	22%	88%	48%	5%
Average monthly consumption costs in FCFA	12	9.1 l	0.4 l	10	12	1 l	36 kg	12 bunches	14.5 l	5.8 l
Time expenditure per month	26/ candle	12 min	3 h	88/ battery	2 h	20 min	45min	9 h	500/ litre	480/ litre

Source: data record of the survey of non-electrified households, Benin 2007

# On-Grid Rural Electrification in Benin

Photo 3

Women collecting firewood



are turned off completely. Besides, 95 percent of the households use flashlights, especially for activities outside the house after 7 p.m. A household uses up to 12 batteries every month. Half of all the money spent on household energy (lighting, entertainment, cooking), an average of approximately 4,500 FCFA every month, is spent on batteries and kerosene; the other half is spent on charcoal and wood for cooking as well as on radio batteries (see table 3). Only the richer households have expenses for transportation, yet these are comparatively high. Obtaining household energy takes a household on average approximately 15  $\frac{1}{4}$  hours per month – half of that time is devoted to gathering wood.

Electricity can substitute kerosene and batteries for lamps and radios. In the long run, using it for cooking would be possible. However, this is inhibited by the high costs of an electric stove and the possibility of procuring wood at no charge.

### 3.1.3 Problems concerning Energy Sources in the Households

Half of the interviewed households state that naked flames inside the house in the form of candlelight and cooking with wood and charcoal causes them health problems. Although the kerosene lamps used in the house deteriorate the quality of air, only 5 percent of the interviewees consider them a serious problem. The worries about availability seem to be more important than health risks in the case of kerosene: Almost half the households state that kerosene is difficult to obtain and that this presents a problem for them (cf. table 4).

### 3. Baseline Results from Project Villages

**Table 4**

**Problems the households have when using different energy sources**

Households that mention the following problem in percent

	Candles	Kerosene	Charcoal/ Wood	Batteries	Petrol	Diesel
Smoke („indoor air pollution“)	59	5	46	-	-	-
Lack of availability	9	48	3	-	19	43
Costs too high	9	24	-	51	23	14
Unsatisfactory efficiency	23	13	-	46	-	-
Obtaining involves high time expenditure	-	6	50	3	3	43

*Source: data record of the survey of non-electrified households, Benin 2007*

#### 3.1.4 Use of Electronic Devices

The electronic device that is used most frequently, in fact by 69 percent of the households, is the battery-powered radio. Only 12 percent of the households own a television set, yet 38 percent of the interviewees state that they watch TV occasionally, for instance at their neighbours' or at a bar. Aside from radios and television, hardly any electronic devices exist (cf. table 17).

#### 3.1.5 Planned Use of Electricity

When asked for what they would like to use electricity the most, 98 percent of the households say that first of all, they would like to use electricity for electric light. 63 percent of the households state that their second goal would be the use of electronic devices. Concerning the planned purchase of electronic devices, television sets (79 percent would like to buy one) and refrigerators (40 percent would like to purchase them) dominate. Only a few, however, intend to acquire devices that open up new income possibilities: 3 percent would like a photocopier and 1 percent would like to purchase a computer.

The question whether they could imagine using electricity also for activities that generate income is answered affirmatively by almost three fourths of the interviewees. So far, approximately 5 percent of the households interviewed use machines for their work that are not electricity driven (mainly foot-operated sewing machines and diesel-driven flour mills). More than half of the interviewees would like to use electricity at their current job (cf. table 5). These results have to

## On-Grid Rural Electrification in Benin

be interpreted carefully, though, since the people interviewed could be responding strategically in view of the electrification project. This problem can also be found in comparable studies (Barnes 1988).

**Table 5**

### **The use of electricity to generate income**

Household share in percent that...

	Men	Women
wish to use electricity at their current job	56	53
would like to start a new trade activity	64	76
would like to start selling cold drinks and ice	17	22
would like to learn in a seminar how electricity can be used productively	81	69

*Source: data record of the survey of non-electrified households, Benin 2007*

#### **3.1.6 Gender Relations**

Men usually start working at 7 a.m. and finish at 6 p.m. Women start about half an hour earlier (6.30 a.m.), and work considerably longer at night, approximately until 9 p.m. Men work an average six days a week with eight hours each, while women generally work seven days with 12 hours a day. The use of radio, television and mobile phones is part of the men's domain. Lighting, on the other hand, is mainly used by women, in fact for doing household chores (cf. figure 1). When asked about the "main activities" that individuals go about while the yard or the rooms are illuminated, almost 100 percent of the men answer that they rest and 100 percent of the women state that they mostly work and rest later. Only 3 percent of the men also work at night; these are usually teachers who prepare lessons, whereas 37 percent of the men also help in the household in the evening.

#### **3.1.7 Households' Willingness to Pay for Electricity**

The interviewed households state without exception that they would like to be grid connected. 96 percent of them think that they can raise the 50,000 FCFA necessary for the one-time connection fee.<sup>1</sup> Almost half of them want to finance the connection with money that they have saved; the other half wants to finance the connection by paying into an account that has been opened by the project.

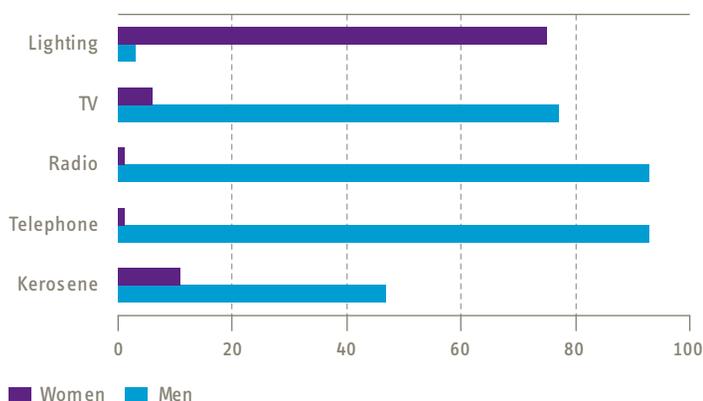
<sup>1</sup> *The connection fees have not been determined yet, but according to newer developments they will probably be below 50,000 FCFA.*

### 3. Baseline Results from Project Villages

Figure 1

“Who uses lighting, TV, radio and telephone the most and who is responsible for kerosene in your household?”

Shares in percent



Source: data record of the survey of non-electrified households, Benin 2007

In order to estimate the future demand for electricity, the households were asked about their willingness to pay for it (cf. table 6). On average, every household is willing to pay around 6,500 FCFA per month for electricity. When asked precisely how many 25 kwh-pre-paid-cards (2,700 FCFA each) they suppose they could buy every month, the households state that they could buy two cards. In non-electrified households, the willingness to pay for lighting and radio is below their current kerosene and battery costs, yet well above the costs that would be caused if they maintained their current consumption pattern after electrification. Hence, the common observation is confirmed that the poorer parts of population, too, are willing to pay a relatively large amount for an improved energy supply (Townsend 2000).

The willingness to pay for the operation of a machine in order to generate income (for example a mill), on the contrary, is clearly below the planned price for electricity. There is evidence that the households will demand electricity first of all for private consumption during their leisure time and to a lesser extent for generating income. The tendency to invest into electronic devices and comfort in the course of electrification, instead of investing into productive uses of electricity can also be observed in other electrification projects (Townsend 2000).

# On-Grid Rural Electrification in Benin

**Table 6**

**Willingness to pay, energy expenses and the planned costs of electricity**

In FCFA per month and household

	small lamp used 12 hrs a day	radio used 6 hrs a day	small tv set used 6 hrs a day	small electric machine used 6 hrs a day	total energy expenses
Willingness to pay for an electric counterpart	716	318	974	1,360	6,573
Current costs	1,000	471	-	-	6,151
Expenses arising after being grid-connected at a planned electricity tariff of 104 FCFA/ kwh	375	188	563	1875	variable

*Source: data record of the survey of non-electrified households, Benin 2007*

### 3.1.8 Pre-paid Meters and Battery Systems

91 percent of the households interviewed would prefer a pre-paid meter to the traditional one. Among electrified households that are already equipped with traditional (rotary current electromechanic) meters, 33 percent would exchange them for pre-paid meters and 23 percent would even exchange them if consumption with the pre-paid meter was more expensive (as planned in the project). That means that almost a fourth of the electrified households are obviously dissatisfied with the traditional counter.<sup>2</sup>

Besides, 98 percent of the households state that they would not be interested in alternatives to grid electricity, such as a charging system for batteries or a photovoltaic system, if their house was located too remotely to be connected to the grid. Examples from other countries show that battery and photovoltaic systems have a high demand in rural areas, though, especially if there is a broad rural middle class (Hankins 2000). But in the case of the 12 villages of the EnDev-project, the conditions for a battery system are not ideal. Although the majority of the population in the villages lives scattered, they still live so close to the centre of the village that they would try to gain secondary access at electrified neighbours' after the electrification. A cable drum with a cable that is 100 m long and 2.5 mm thick costs around 12,500 FCFA. In other villages, distances up to one kilometre are bridged with these kinds of cables.

<sup>2</sup> *In comparison: in Germany, there are approximately 44 million households – 99 percent of them use the traditional meter. cf. Baranski 2006.*

### 3. Baseline Results from Project Villages

For households that are too remote for such a secondary connection, electricity from generators would be a more attractive solution, also because it would have a higher performance than the planned battery system. On top of that, the use of battery power would probably imply an additional burden on the women, since obtaining batteries would be their responsibility and they would have to carry the batteries on their heads to the houses.

#### 3.2 The Households' Social and Economic Situation

##### 3.2.1 Occupation

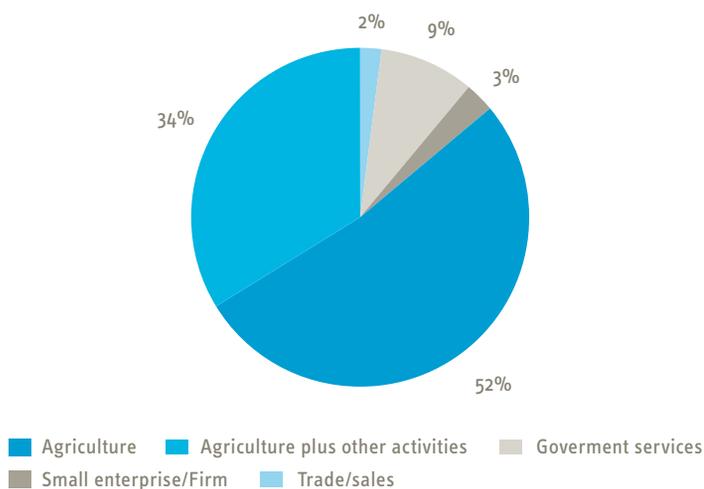
Among the interviewed households in the non-electrified villages, 86 percent of the men are employed primarily in the agricultural sector, whereas 52 percent are exclusively farmers. 9 percent work for the government and the remaining 5 percent do commerce or lead a small enterprise (cf. figure 2).

Household chores, which comprise fetching water and wood, cooking, washing, and taking care of children, are carried out exclusively by women. Additionally, 63 percent of the women work in the agricultural sector and 39 percent in trade. Only 2 percent work also as tailors, hairdressers or government officials.

Figure 2

#### Main occupation of the male heads of household

Shares in percent



Source: data record of the survey of non-electrified households, Benin 2007

# On-Grid Rural Electrification in Benin

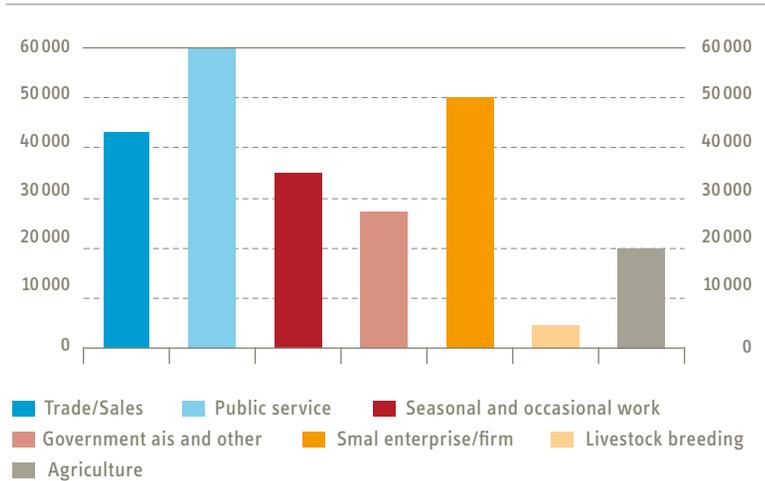
The project region is therefore basically characterized by two economic sectors, agriculture and services. An industrial sector does not exist. This structure is typical of developing countries in which little productive agriculture absorbs a vast part of the available labour force.

### 3.2.2 Income

Figure 3 illustrates the average monthly household income according to the income source. Households that derive their income exclusively from the agricultural sector earn an average of approximately 20,000 FCFA every month; the households that have additional earnings through trade earn around 43,000 FCFA per month. The average monthly income of a public servant is considerably higher with approximately 60,000 FCFA.

The agricultural sector only accounts for 29 percent of the entire monetary rural income (cf. figure 4), although the majority of the workers (86 percent of the men and 63 percent of women) are employed there. Yet one has to bear in mind that the agricultural households engage in subsistence agriculture, so that a large portion of their production is not part of the monetary income. Additionally the prices for agricultural products are very low during harvest.

**Figure 3**  
**Average monthly incomes per household from different sources of income in FCFA**



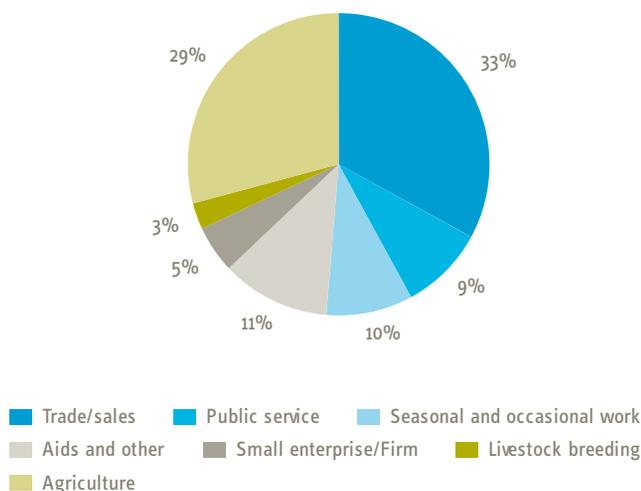
Source: data record of the survey of non-electrified households, Benin 2007

### 3. Baseline Results from Project Villages

Figure 4

The contribution of different sources of income to the national income in the project region

Shares in percent



Source: data record of the survey of non-electrified households, Benin 2007

On average, a household has a total income of 67,800 FCFA at its disposal. Converted to purchasing power parities that is 467 US Dollar (USD) per month and 1.4 USD per person and day.<sup>3</sup> The richest 30 percent of households have more than 3 USD, while the rest has less than 1 USD per person and day. As a consequence, almost two thirds find that their income does not suffice to fulfil the families' needs.

#### 3.2.3 Savings and Credits

At the time the survey was conducted, 11 percent of the households have credit debts between 10,000 and 10 million FCFA. 77 percent of these credits were used to make investments, 13 percent to supplement the household income in order to cover necessities. 61 percent of the open credits were provided by banks, 26 percent by relatives and the remaining by other creditors. 64 percent of the households have savings ranging between 5,000 and 1 million FCFA. 91 percent of these households state that the savings serve as reserves for contingencies, - for instance for illnesses, bad harvests or other unforeseeable events. The remaining 9 percent represent savings for future investments. 77 percent of the households that are saving money keep their savings at home or at their relatives'. Only 23 percent of all households have an account at a bank.

3 The World Bank estimates the purchasing power parity of 111,496 FCFA at 1 US Dollar.

## On-Grid Rural Electrification in Benin

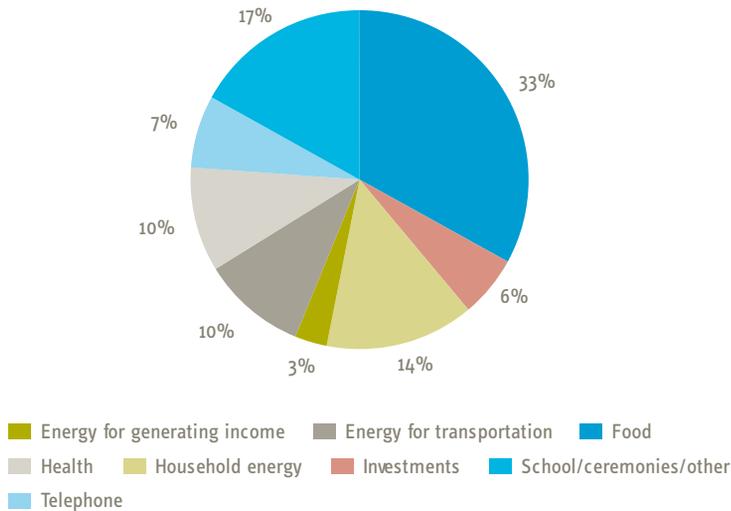
### 3.2.4 Expenses

Figure 5 depicts the monthly expenses of the interviewed households. One third of all expenses is spent on food and about one fourth on energy. Studies in developing countries document that the percentage of money spent on energy decreases with increasing income: the poorest households spend up to 20 percent on energy, while rich households spend only 2 percent (Waddams Price 2000).

Half of all expenses for energy, all in all almost a sixth of all expenses, is spent on household energy. These are expenses for kerosene and batteries for lighting and radios, as well as expenses for wood and charcoal. Productive expenses for diesel to operate mills represent the smallest part of the expenses for energy and are only half as high as for petrol, which is needed for transportation.

**Figure 5**  
**Pattern of expenditure in rural households (HH)**

Shares in percent; total: 67.800 FCFA/month



Source: data record of the survey of non-electrified households, Benin 2007

### 3.2.5 Agriculture

The agricultural structure in the project region is characterised by small-scale farming. The areas farmed have an average size of 3.4 ha per household and in almost all cases they are owned by the farmers themselves. Tilling the fields is manual work. Roots are harvested with a hoe and crops with a machete.

### 3. Baseline Results from Project Villages

In general the agricultural producers can be classified according to their market-orientation, depending on whether their production serves their own needs (subsistence production), local markets, domestic markets or export markets. The poorest regions of developing countries are typically characterised by subsistence production and low revenues. Although the production for domestic and export markets makes planning difficult because of the unsteady world market prices, these sectors usually offer considerably higher revenues and opportunities for expansion (Hein 1998). The survey in the non-electrified villages has shown that almost all households engage in subsistence agriculture and are more or less involved in the production for local markets. In addition, roughly one third of the households produces goods for domestic and export markets. Table 7 shows that various products are sold in different shares on different markets, or respectively cultivated for the farmers' own needs. Up to 75 percent of the staples (crops, roots, vegetables and fruits) are cultivated for their own needs; the rest is sold on local markets.

**Table 7**  
**Agricultural products and market orientation**  
Shares in percent

	Crops	Fruits	Roots	Vege- tables	Nuts	Tobacco	Vege- table oil	Cotton
producing households	91	19	84	41	61	15	19	17
production meant for sale		25 <sup>1</sup>		50			99 <sup>2</sup>	100 <sup>3</sup>
production meant for household consumption		75		50			1	0

<sup>1</sup>Sold exclusively on local markets. – <sup>2</sup>Sold on local and domestic markets. – <sup>3</sup>Production for the export market. – Source: data record of the survey of non-electrified households, Benin 2007

Products sold on the domestic market are tobacco, peanuts, cashews and vegetable oil. Cotton is grown exclusively for the export market. Yet only a minority of the households, 17 percent, grows cotton and thus has a share in export revenues. These farmers are united in cooperatives in contrast to households where women carry the goods to the local market.

## On-Grid Rural Electrification in Benin

Electrification may directly influence agriculture. Farming and harvesting might not be modernised through electricity, yet processing, such as threshing and hulling, will become possible with electric machines. On the other hand, electricity will also allow for irrigation with pumps which might contribute to a remarkable increase in productivity (Barnes 1988).

### 3.2.6 Nutrition

Almost half (47 percent) of the households state that there are times in which they lack their cultivated products and food in general is scarce, on average three months. This shortfall in supply occurs towards the end of the rainy season (around June to September) before the harvest, when agricultural households are running out of supplies. The households then depend on buying staple foods, such as corn or yams, in addition. Those are offered at the markets at higher prices by traders who have sufficient capital to buy the products during harvest time at low prices. These periods lead to unbalanced nutrition or malnutrition in almost 50 percent of the households.

### 3.2.7 Water Supply

Figure 6 illustrates the households' sources of drinking water. In order to bring the water home, women and children carry it in bowls on their heads. The water sources are usually almost 500 metres away. A household consumes an average of 322 litres every day, so that every household has to cover a distance of approximately 6.4 km a day for their water supply. None of the interviewed households boils the water before drinking it.

Only a controlled piping system guarantees potable water, although one may assume that also modern wells, drillings and cisterns surely provide with drinkable water. Consequently, almost half of the interviewed households are exposed to health risks due to an inadequate water supply.

### 3.2.8 Housing

Virtually all (97 percent) of the interviewed households in the non-electrified villages own the houses and estates that they occupy. 58 percent of the interviewed households live in traditional houses with clay floors, raw walls made of clay bricks and thatched roofs; 42 percent live in modern houses with cement floors, plastered walls and corrugated iron roofs.

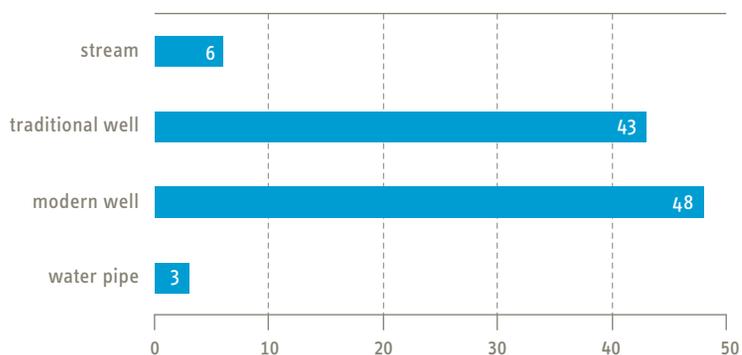
Although a cement house with a corrugated iron roof presents a status symbol and is less prone to fire, dwellers state that the quality of living is higher in traditional houses, since thermal insulation of corrugated iron roofs is worse compared to tiles and straw.

### 3. Baseline Results from Project Villages

Figure 6

“What is your household’s drinking water source?”

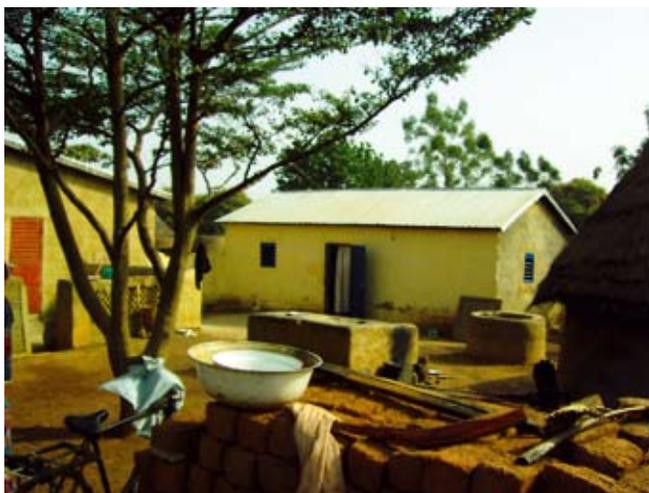
Shares in percent



Source: data record of the survey of non-electrified households, Benin 2007

Photo 4

Modern housing



# On-Grid Rural Electrification in Benin

Photo 5

Traditional housing



### 3.2.9 Education

19 percent of the male and 6 percent of the female adults that were interviewed have attended school. As a consequence, the illiteracy rate among men is more than 80 percent, among women more than 90 percent. Men attend school for an average of 8.5 years, women for 6.6 years. Almost 7 percent of men, but only 1 percent of women have completed their A-levels or graduated after ten years of schooling. 8 percent of men and 2 percent of women have received vocational training (cf. figure 7). Only 1 percent of male adults, but none of the females have gone to university. 50 percent of the interviewed households state that they cannot raise the money to pay the tuition fees for their 13- to 18-year-old children or cannot afford the schooling material of them (writing utensils, books, school uniforms). This is mentioned as the main reason for why children do not attend school.

### 3.2.10 Health

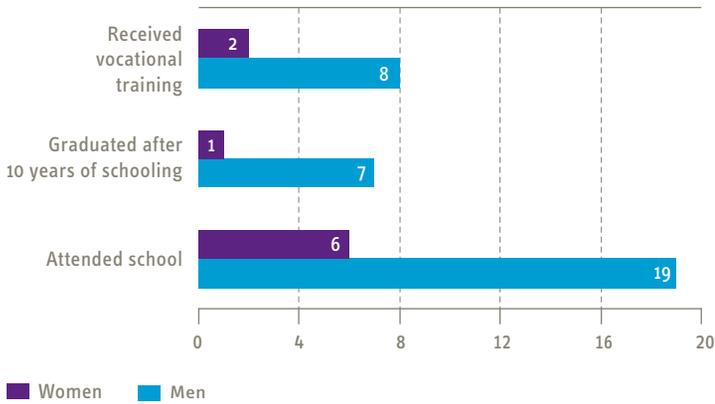
The most common diseases in the rural region are malaria, intestinal infections and respiratory diseases. 92 percent of the adults and 97 percent of the children suffer from malaria. When considering the other diseases, it becomes even more apparent that children are disproportionately affected: More than half of the children, but also a fourth of the adults, suffer from intestinal infections; 43 percent of the children and 35 percent of the adults are affected by respiratory diseases (cf. figure 8). Reasons for the spread and the frequent fatality of these infectious diseases are inadequate hygiene and health care.

### 3. Baseline Results from Project Villages

Figure 7

“Have you attended school, graduated or received vocational training?”

Shares in percent

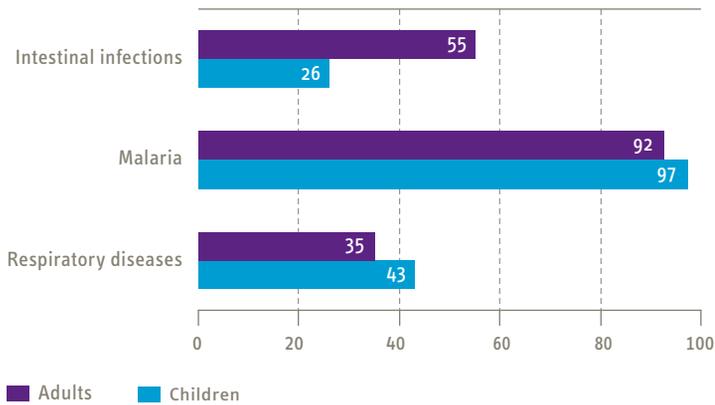


Source: data record of the survey of non-electrified households, Benin 2007

Figure 8

“Who suffers from which diseases in your household?”

Shares in percent



Source: data record of the survey of non-electrified households, Benin 2007

# On-Grid Rural Electrification in Benin

## 3.2.11 Telecommunications

Only 1 percent of the households is connected to the landline network. Almost half of the households state that they never use the telephone, whereas the other half either uses landline booths offered by the state network operator or private phone booths; these are small cabins at the side of the road that are equipped with a telephone connected to the mobile communications network via an antenna.

Although none of the 12 villages is actually covered by a mobile communications network, 20 percent of the households own a mobile phone. It can only be used “on good days” in seven villages where reception is possible to some extent. 60 percent of the households would like to buy a new or a mobile phone in general. On average, these households are willing to spend approximately 12,500 FCFA per month on telephony, considerably more than the 7,000 FCFA that they are willing to spend on electricity.

## 3.2.12 Migration

More than one third of the households state that a close family member has left the village. 16 percent of them have moved to the capital Cotonou, 44 percent to another city in Benin and 40 percent have immigrated to a foreign country. The average age of the persons who emigrate from these villages is 27 years. 50 percent migrated because they hoped for better employment, 25 percent because they married outside their village, 19 percent because of their studies in a university town and 6 percent because of poverty.

## 3.3 Social Infrastructure Institutions

### 3.3.1 Health Centres

In Benin, relatively extensive basic health care is warranted. Every arrondissement has usually one health centre. In each of the ten health centres in the 12 non-electrified villages, a senior physician was interviewed. The physicians state that almost all the sick persons can be treated successfully in these centres. According to them and in correspondence to the survey results of the households, the three most common diseases are malaria, intestinal infections and respiratory diseases. Almost all of the centres have the most important vaccines at hand. In all of the centres the most important pharmaceuticals are available. The centres are quite well staffed with roughly eight employees – usually one physician and an average of seven nurses. Yet since all the services have to be paid privately, the average number of 230 patients per month and centre is very low compared to a total population of almost 12,000 people per arrondissement.

By far the biggest problem that the health centres have to face is the lack of electricity (cf. box 1). This is especially due to the fact that the centres are open 24 hours and childbirths occur approximately every other night. Nevertheless, the

### 3. Baseline Results from Project Villages

mortality rate among newborns is reported by the interviewees at 0 percent. For sterilisation, charcoal is burnt in the health centres; on top of that, kerosene is used for lighting and the operation of refrigerators. Every centre has a 120-watt refrigerator that consumes 31 litres of kerosene every month and four kerosene lamps that consume 24 litres. Together, these cost approximately 25,000 FCFA per month. Two centres are temporarily provided with electricity from a generator. In almost all of the centres, the entire electrical installation already exists, so that important opportunities for usage would arise directly after the electrification and without further costs.

#### Box 1

##### Situation of the health centres

<i>Population to be served per health centre:</i>	<i>12,000 people</i>
<i>Average number of patients per month per health centre:</i>	<i>231 patients</i>
<i>Staff per health centre:</i>	<i>1 physician, 7 nurses</i>
<i>Number of health centres:</i>	<i>10</i>
<i>Interviewees that consider the following shortcomings as problems for the health centres:</i>	
<i>lack of electricity:</i>	<i>7</i>
<i>staff shortage:</i>	<i>2</i>
<i>lack of transportation:</i>	<i>3</i>
<i>low attendance:</i>	<i>2</i>
<i>inadequate water supply:</i>	<i>3</i>

#### 3.3.2 Schools

In each of the villages there is at least one primary school. On average three primary schools per village teach pupils from the age of 6 to 12. An area-wide coverage in terms of primary education is thus ensured. The villages that are seats of the arrondissements each have a secondary school (for pupils between the age of 13 and 18). Headmasters of all 38 schools in the 12 villages were interviewed about schooling structures and conditions. The average class in primary schools has approximately 50 pupils. Although primary education has been free since 2006,

## On-Grid Rural Electrification in Benin

the headmasters estimate the school enrolment and attendance rate in primary schools at only little more than 60 percent; that of secondary schools, for which parents have to pay, is estimated to be just over 40 percent (cf. table 8).

**Table 8**  
**Schools in the non-electrified villages**

	Primary schools	Comprehensive schools
Number of schools in the 12 villages	31	7
Average contribution of the tuition fees to the annual budget (in FCFA)	0	5,257,142
Average contribution of state funds to the annual budget (in FCFA)	680,129	8,047,000
Average number of teachers per school	6	19
Average number of pupils per school	303	646
Total estimated school attendance rate	62.9%	41.5%

*Source: data record of the survey of institutions of the social infrastructure, Benin 2007*

The headmasters consider the main problem in primary and secondary schools to be the lack of rooms. Besides, the secondary schools lack equipment and electricity, whereas the primary schools mention a shortage of teachers, inadequate water supplies and a lack of electricity in almost equal numbers as the schools' second problem (cf. table 9). The headmasters assume that once the general quality of life has increased through electrification, fewer teachers will migrate to other regions, whereby the problem of the shortage of teachers could be attenuated. These conclusions may well be applied to the general problem of a lack of human resources in the region.

The demand for electricity in schools is not as significant as in health centres, since classes can take place during the day and without electric devices. Headmasters were as well asked for which purposes other than lighting they would like to use the electricity connection for. Almost all of the headmasters in secondary schools stated that they would like to purchase computers and use them in classrooms. Since only very few headmasters were given notice about the electrification project in advance, none of their annual budgets included an item for electricity costs. Yet the headmasters in comprehensive schools reckon that the costs can easily be procured from the tuition fees that the parents paid. The headmasters in primary schools see little possibilities in their state-financed budget to pay for the arising expenses for connection, installation and consumption.

### 3. Baseline Results from Project Villages

Table 9

**The schools' problems from the headmasters' points of view**

Headmasters that mention the following problems in percent

	Primary school (Age 6-12 years)	Comprehensive school (Age 13-18 years)
lack of electricity	41	43
lack of water	35	0
no fencing	23	0
lack of furniture	26	57
lack of sanitation	13	0
shortage of teachers	38	29
lack of rooms	48	86
too few pupils	0	29

Source: data record of the survey of institutions of the social infrastructure, Benin 2007

#### 3.3.3 Public Administrative Facilities

Each village that is seat of an arrondissement has an administrative office. 9 of the 12 non-electrified villages are seats of their arrondissement, one of them is even seat of two arrondissements. The publicly elected chief administrators in these 10 administrative facilities were interviewed. Since the arrondissements do not have financial autonomy, they have little possibilities of intervening in the social and economic development of the villages that they administer – the municipality is responsible for the electrification as well. Theoretically, the municipality would also have to bear the costs for the electricity consumption in administrative offices and street lighting in the villages; according to the chief administrators, though, the budget so far does not allow for these items.

The elected representatives state that the most urgent problems in the villages are first of all the lack of electricity, second the lack of water supply and third missing roads, the shortage of health centres and the missing telephone network.

# On-Grid Rural Electrification in Benin

## Box 2

### Structure of the administrative offices in the arrondissements

<i>Average of the population covered by each administrative office:</i>	<i>11,431 people</i>
<i>Staff per administrative office:</i>	<i>2</i>
<i>Opening hours:</i>	<i>08:00 am – 12:30 pm, 03:00 pm – 06:30 pm</i>
<i>Number of visitors per month and per administrative office:</i>	<i>170</i>
<i>Offices that have access to electricity:</i>	<i>none</i>

## 3.4 Small Enterprises

### 3.4.1 Existing Small Enterprises

Table 10 offers an overview of the number and kind of the individual small enterprises in the villages. The owners of 58 small enterprises were interviewed. The most common enterprise form is milling, a service that is demanded regularly by all farmers. In the non-electrified villages, mills are operated by diesel engines that are usually located in a mud hut.

Tailoring businesses are the second most common form of small enterprises; the only tools used by tailors are foot-operated sewing-machines.

Shops, which can be found in almost all of the villages, offer, among other things, tinned food, coffee, soap, kitchen utensils, pharmaceuticals and batteries. Vital consumer goods are primarily sold on the market, yet these markets usually only take place six times a month. Typically there are several carpenters in every village. Not only do they manufacture tables and chairs, but they also build roofs and shuttering for houses. Work is done exclusively by hand; tools used are saws, planes and hammers. Due to the increasing number of motorcycles in the villages, mechanics have also taken up business along all of the main roads. They often only own a few tools, such as screw drivers and wrenches. There are relatively few hair-dressers in the villages; only in larger villages one can earn money this way, since the women usually have their hair styled by friends. Welders can only exist in larger villages as well. The costs for operating a generator to generate electricity and for purchasing a welding apparatus are high, whereas the demand for iron

### 3. Baseline Results from Project Villages

works is low. Typically the welder produces windows and doors and repairs bicycles, motorcycles and cars. There are only very few blacksmiths. They mainly manufacture the hatchets that are needed in agriculture. This occupation seems to die out, though, as a result of the cheaper and more modern mass products that are increasingly available.

**Table 10**  
**Number and kind of small enterprises in the individual villages**

Village	Bar	Shop	Welder	Tailor	Hair- dresser	Mechanic	Miller	Car- penter	Black- smith	Total
Oroukayo	1	3	-	3	-	1	14	1	-	23
Pouya	3	4	-	7	-	-	10	5	1	30
Kotopunga	4	3	-	-	-	2	11	3	2	25
Toucou'na	3	6	-	30	10	10	30	30	1	120
Birni	3	4	-	10	4	5	13	6	-	45
Chabi C.	3	7	1	11	2	3	10	3	2	42
Sèmèrè	1	11	2	15	5	10	25	10	4	83
Béléfoung.	2	5	-	2	-	3	8	2	4	26
Kolokondé	4	4	4	20	1	10	20	15	-	78
Honjin		3	-	2	1	1	6	3	1	17
Kansoukpa	3	2	-	3	3	-	5	-	-	16
Kpodji	-	-	-	4	-	-	2	8	-	14
Total	27	52	7	107	26	45	154	86	15	519

*Source: survey of private small enterprises, Benin 2007*

Bars serve soft drinks and beer. Yet for most families visiting a bar is a luxury because one drink is as expensive as five meals on the road. Therefore there are relatively few bars in the villages. They are mostly visited after the market. Most bars have a kerosene refrigerator and a stereo that either runs on batteries or a generator.

In a typical small enterprise, a foreman, who is the owner of the enterprise, works with two apprentices, who are not paid for their work. After deducting all the running costs, a small-scale entrepreneur has an average monthly income of almost 70,000 FCFA; however, this sum varies greatly depending on the occupation.

## On-Grid Rural Electrification in Benin

Mechanics, carpenters, shops and millers have customers every day and thus they have steadier and much higher turnovers than tailors and hair-dressers, whose work is only demanded highly before festivities and ceremonies.

**Photo 6**

**Electric mill in an electrified village**



**Table 11**

**Structure and income of private small enterprises**

Average number of employees per enterprise	3
Average age of owner of the enterprise	32
Percentage of owners with vocational training	53 %
Average monthly enterprise income (in FCFA)	69,148

*Source: survey of private small enterprises, Benin 2007*

## 3. Baseline Results from Project Villages

Photo 7

Diesel mill



### 3.4.2 Working Hours

In most of the enterprises, people work six days a week for 10 hours. On average, during two hours every day they work with artificial light, especially in bars and shops that are open after 7 pm. Yet also tailors – especially in the season in which a lot of festivities take place – and mechanics on much frequented roads work after sunset using flash lights and kerosene lamps.

### 3.4.3 Financial Situation

In 2006, about one third of the small-scale entrepreneurs invested in their enterprises. On average, 40,000 FCFA were invested, mainly in tools or the construction of workshops or shops. Approximately half of the owners of enterprises possess savings; the average sum of their savings is about 100,000 FCFA. 40 percent of the owners that have savings want to use these for making investments, while the remaining 60 percent rather consider them reserve funds.

Approximately 60 percent of the owners with savings keep these at home, 7 percent have a savings club manage them and one third pays the saved money into a bank account. Only a total of 16 percent of all the enterprises keep a bank account. About 20 percent of the enterprises took out loans, cf. box 3.

## On-Grid Rural Electrification in Benin

### Box 3

#### Loans, microcredits and investments in 2006

<i>Percentage of enterprises that have taken out a loan:</i>	19%
<i>Average sum of the loan:</i>	99,832 FCFA
<i>Loan was taken out for an emergency:</i>	6.5%
<i>Loan was taken out to make investments:</i>	93.5%
<i>Credit was granted by a bank – friend – relative:</i>	49% – 38% – 13%
<i>Enterprises that have problems in paying back their loans:</i>	10%
<i>Enterprises that know about microcredits:</i>	41%
<i>Enterprises that would take out a microcredit:</i>	3%
<i>Preferred monthly redemption rate of the microcredit:</i>	3,500 FCFA
<i>Entrepreneurs that invested in their enterprises in 2006:</i>	32%
<i>Average amount invested by the enterprises in 2006:</i>	40,979 FCFA

*Source: Survey of private small enterprises, Benin 2007*

#### 3.4.4 Energy Demand

Small enterprises can be divided into three categories with respect to their “energy demand for their work” (Barnes 1988: 12). The first category requires energy in order to do their job. Without access to energy sources, these lines of business cannot generate income. Welders, millers and blacksmiths can be assigned to this category. Diesel-engines and charcoal are necessary requirements for their activities. The majority of members of the second category make use of energy for their work: Although energy is not necessary to generate income, the lack of energy would heavily interfere with their activities. Shops and bars belong to this group. 14 percent of the shops and two thirds of the bars have a refrigerator and 56 percent of the bars have a stereo. The third category does not need energy for their work and to generate income. Yet their activity is limited in time due to the lack of light, so that some of these enterprises use energy for lighting.

### 3. Baseline Results from Project Villages

Mechanics, carpenter, tailors and hair-dressers are to be assigned to this group. They use kerosene and batteries exclusively for lamps in order to extend their working hours. Table 12 illustrates the energy consumption of the respective small enterprises.

**Table 12**

**Average energy consumption of particular types of enterprises per month, categorised according to energy demand**

	Diesel for mills/ generators (litre)	Charcoal for forging/ cooking/ ironing (kg)	Kerosene for refrige- rators (litre)	Petrol for generators (litre)	Kerosene for lamps (litre)	Batteries for flash lights/ radios
<b>1st category: energy is required</b>						
welder	37					4
miller	99.5				2.5	2
blacksmith		120			1.3	8
<b>2nd category: great interference without energy</b>						
bar		30	15.7	10.9	6.1	14
shop			2.5	11	5.9	22
<b>3rd category: energy is not necessary (but partly used for lighting)</b>						
carpenter					0.8	26
tailor		40		2.9	4.6	18
mechanic					4	40
hair-dresser					6	12

Source: Survey of private small enterprises, Benin 2007

Based on the results of the survey in the electrified villages it shall be assumed that about 220 of the 500 enterprises are going to connect to the grid. 35 of them are already supplied with energy from generators. For the EnDev counting, this results in a population covered of 37 percent. Taking the total population of 61,300 in the project region in consideration, 22,700 inhabitants benefit from the productive use of energy in small enterprises.

## On-Grid Rural Electrification in Benin

### 3.4.5 Advantages of the Electrification According to Small Enterprises

Enterprises being asked to assess the current energy situation, 71 percent judge it as bad; 93 percent of the enterprises wish for an electricity connection. When asked about the main benefits of electricity, 53 percent of the enterprises mention electric light.

Of all the interviewed small-scale entrepreneurs, 83 percent want to purchase electric devices once they have access to electricity. Yet not all the enterprises plan to switch to machines. A vast part of the millers does not want to switch to electric motors due to the high investment costs. Meanwhile, 88 percent of the entrepreneurs assume that they can finance the connection.

### 3.4.6 Small Enterprises' Willingness to Pay for Electricity

Future electricity demand can be roughly estimated on the basis of the willingness to pay, which is depicted in table 13. The subjective urgency for individual enterprises to have electricity can be recognized. Electric light is needed especially by bars, since they are open at night. But also tailors who have to work until late at night during busy weeks are more willing to pay for electric light than, for example, carpenters. Under kerosene light, sewing is difficult and it hurts, according to older tailors, the eyes.

The willingness to pay for the use of radios is likewise the highest with bar owners, since the radio may increase the turnover in bars. Millers, on the other hand, who only work during the day, are not very willing to spend money on light and radios. Shop and bar owners have the highest willingness to pay for the operation of a refrigerator. On average, the enterprises are willing to spend 8,000 FCFA per month for the consumption of electricity.

9 percent of the enterprises would be interested in a battery-system in case a connection to the grid was not possible due to their remote location. 1-2 percent of the households share this interest. Almost 60 percent of the enterprises would share a metre with their neighbours, and 85 percent wish for the pre-paid-metre instead of the traditional metre.

## 4. Ex-ante Impact Assessment of the Electrification Intervention

Table 13

Small enterprises' willingness to pay for electricity per month in FCFA

	Electric lamp (10 watt), 12 hours	Radio (10 watt), 12 hours	Small machine (30 watt), 6 hours	refrigerator (100 watt), 24 hours	Willingness to pay for electricity
carpenter	614	571	3,600	1,443	15,507
tailor	891	554	1,458	3,833	6,700
bar	900	821	743	5,714	8,893
mechanic	679	679	1,000	1,900	5,857
hair-dresser	716	667	1,083	2,917	5,957
welder	600	150	2,500	0	14,000
miller	475	300	658	125	6,175
blacksmith	567	667	2,000	500	3,667
shop	600	638	1,163	4,250	7,125
Average of the 519 enterprises interviewed	652	518	1,480	2,115	8,062

Source: Survey of private small enterprises, Benin 2007

### 4. Ex-ante Impact Assessment of the Electrification Intervention

#### 4.1 Impact of the Electrification on the Energy Supply of Households

##### 4.1.1 Household Connection

One of the two electrified villages has been connected to the grid for one year, but has only been supplied with electricity all day long for three months (Perma). 89 of the 304 households, i.e. 28 percent, are connected to the grid in this village. In the following, we will refer to these households as connected households among electrified households, whereas households in the villages without access to the grid will be called "non-electrified households".

The other village was already electrified two years ago and is supplied with electricity all day long since then (Copargo). In this village 61 percent, i.e. 425 of a total of 692 households, have an electricity connection. Yet only a fourth of all

## On-Grid Rural Electrification in Benin

the electrified households in the two villages has an official metered connection, whereas the remaining 36 percent of connected households are unofficially connected to these households. Based on these records, expecting an official connection rate of 25 percent in the 12 yet non-electrified project villages seems plausible. Another 25 percent will obtain a secondary connection, which will, however, be secure.

Among the interviewed connected households, the employment structure for men differs greatly compared to the structure among non-electrified households: only 45 percent of the men are employed in the agricultural sector (compared to 86 percent of the households in the non-electrified villages). At the same time, civil service with 38 percent has a much higher share (compared to 9 percent). Besides, the average monthly income of almost 150,000 FCFA of the connected households is more than twice as high as that of the non-electrified households in the project villages (cf. table 14).

However, one cannot draw the conclusion that the different employment structure and the higher income are caused by the electrification. The data presented in table 14 suggests that only the well-educated and the generally well-off households have connected themselves to the grid – assuming that all other expenses except for the investment are fixed (cf. Chapter 3.2.4), the households have to save money for 13 months in order to be able to pay the connection fee.

**Table 14**  
**Main occupation and average income**

	Commerce/ Sales	Civil Service	Small enterprise/ Firm	Agri- culture only	Agriculture and additional activity	Average income per household per month (in FCFA)
Non-electrified households	2%	9%	3%	52%	34%	67,800
Connected households	14%	38%	3%	26%	19%	149,418
The richest 30 percent of the non-electrified households	13%	14%	3%	37%	33%	146,992

*Source: data record of the survey of connected and non-electrified households, Benin 2007*

Whereas the sample in the electrified villages is random and quite representative, well-off households are overrepresented in comparison to the non-electrified villages. In order to still be able to draw comparative conclusions about the

## 4. Ex-ante Impact Assessment of the Electrification Intervention

interviewed non-electrified and connected households, adjustments have to be made. In the impact analysis, at first both overall samples are considered. Then the comparison is complemented like in table 14 by data of those among the non-electrified households that rank among the most affluent 30 percent. It can be as well taken from table 14 that the average income of these 30 percent corresponds to that of the connected households (approximately 150,000 FCFA). Thus the impact analysis is based on the assumption that in the non-electrified villages, too, the richer households will connect themselves to the grid (Barns 2006:31). If, however, other criteria play a role as well, such as the level of education, the analysis may be biased. At any rate the results of the impact analysis are to be interpreted carefully, since the trend of the correlation between socio-economic features and grid electricity connection in a household is undetermined.

The representative survey in the project villages has shown that 52 percent of the men in rural non-electrified households exclusively work in agriculture. In the electrified villages, only half as many, i.e. 26 percent, have connected themselves to the grid. Civil servants, traders and those who exclusively run a business, on the contrary, seem to have connected themselves by up to 100 percent assuming that the employment structure is comparable in the electrified and non-electrified villages. Possible explanations for the low connection rate among the farmers are the following:

1. The electricity connection costs 50,000 FCFA. The 52 percent who solely engage in agriculture constitute the lowest income group. Their income from agriculture amounts to about 20,000 FCFA per month; at best, their wives also generate income through commercial activities. For this group, the connection costs more than their monthly income. Due to the high connection fees, low income groups naturally do not connect themselves (Brook, Besant-Jones 2000). Probably more households in non-electrified villages state that they could afford the meter than are eventually able to afford the connection.
2. The farmers have a low level of education. Among the poorly educated only a few are aware of the actual costs of their current energy sources compared to the use of electricity (cf. willingness to pay). Likewise, 46 percent of the non-electrified households do not consider a lack of electricity their main problem. An analysis from Bangladesh also shows that the effect of electricity on increasing income is lower for farmers than for “non-farmers” (Barns 2006). This may suggest that farmers cannot use electricity as productively as other households. Therefore farmers connect themselves below average as a result of insufficient information and education.

## On-Grid Rural Electrification in Benin

3. Because of the high costs of infrastructure, the power lines often cover only the main road and the centre of the village. It is mainly civil servants, traders and businesspeople who live there. The farmers live aloof from the grid, close to their fields. The coverage and accessibility of the grid in the 12 villages of the EnDev-project is limited to 2,035 households of a total of 4,354 households located within a radius of 500 metres. The remaining 2,319 households (53 percent) are mostly farmers. They are already disadvantaged, since they have to face higher connection fees because of the greater distance.

Hence, there are three access barriers which affect first of all that part of the population that engages in agriculture, i.e. the poorest part of the population: connection fees (affordability), education (cognitive competence/knowledge) and the grid that is limited to the centre of the village (coverage/accessibility). As the possibilities of accessing and using electricity are unequal in the first place, they may as well lead to an unequal distribution of the benefits (Barnes 2006). Critics of rural electrification projects state that predominantly the richer households are able to pay for a connection; thus intensifying economic inequality in rural areas (Barnes 1988).

### 4.1.2 Secondary Connections

95 percent of the interviewed non-electrified households are willing to share the connection with a neighbour. In the village that has been electrified for two years, each connection is actually shared by 2.5 households. These secondary connections are established because households cannot pay the necessary connection fees and instead connect themselves to their neighbour using wires that they bought themselves. Furthermore, remote households are often forced to run their own extension cords to the closest neighbour, since they are not located within the 40 m radius of the grid in which the provider connects households.

The secondary connections have two disadvantages. First, they lead to transmission losses when they cover greater distances. This disadvantage is to be accepted, since electricity is a more affordable alternative to kerosene and batteries, even when the price is higher due to these losses.

Second, the unofficial connections are often wired without any technical knowledge, which increases the accident risk. Two scenarios are possible. First, overheating and resulting fire hazard may be caused by wires that are too thin and fuses that are not properly installed. Secondly, electric shocks and short-circuits with fire hazard may result from inappropriate material and careless wiring and wire links. Both scenarios occur rather seldom and could also happen in houses with official

## 4. Ex-ante Impact Assessment of the Electrification Intervention

connections, where the installation frequently does not meet safety standards as well. Therefore all households that obtain electricity should be considered as connected for the EnDev counting here.

These secondary connections in particular present possibilities for the poorer households to circumvent the mentioned access barriers. Thus the access barriers are also an explanation for the high rate of secondary connections.

**Table 15**  
**Connection rates of the households concerning secondary and official connections**  
 Shares in percent

	Connected households under the grid	Households with an official meter	Households unofficially connected to their neighbour
In Copargo, which is electrified for two years	61 (425 of 696)	25 (171 of 696)	36 (254 of 696)
In Perma, which is electrified for one year	29 (89 of 304)	23 (71 of 304)	6 (18 of 304)

*Source: survey of electrified households, Benin 2007*

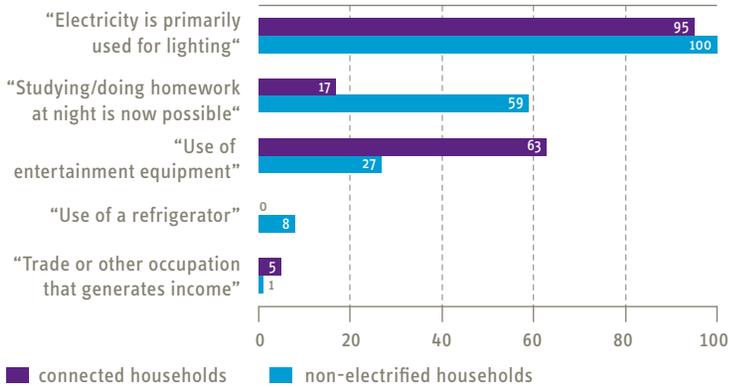
### 4.1.3 Forms of Use of Electricity

Electric light is also for connected households the most important purpose of electricity. Right after that they mention the use of entertainment equipment, especially television sets that were purchased by 36 percent of the connected households (cf. figure 9). They greatly prefer using electricity consumptively (television sets and music) to using it productively.

Connected households substitute batteries with grid electricity: All of the interviewed non-electrified households use batteries; in case of the interviewed connected households, however, only just about half of them use batteries. Battery-powered radios are used by 96 percent of the non-electrified households, yet only by 25 percent of the connected households.

# On-Grid Rural Electrification in Benin

**Figure 9**  
**Most important purposes and advantages of electricity from the point of view of connected households compared to non-electrified households**  
 Shares in percent



Source: data record of the survey of connected and non-electrified households, Benin 2007

## 4.1.4 Development of Electricity Consumption

Table 16 depicts the record of electricity consumption in the village that has been electrified for two years. Here one can recognize that the average consumption per officially installed meter has more than doubled over 1 ½ years, from 26 kilowatt hours every month to 63 kilowatt. Although part of this increase may be due to an increased share of secondary connections, the hypothesis that electricity consumption will increase over time can be validated.

Assuming for simplicity that the ratio of households connected per official meter is constantly 2.5 since the beginning of the electrification and that the social and economic infrastructure consumes as much as the households, the electricity consumption per household (9 persons) has increased from 10.7 to 25.7 kilowatt hours per month within two years.<sup>4</sup>

A study on 45 cities in developing countries has come to the conclusion that households of low income groups hardly react to price changes for electricity compared to households with higher income. This is due to the fact that relatively poor households use electricity primarily for lighting. Here electricity as an energy source is much cheaper than traditional sources. This allows the conclusion that

<sup>4</sup> Compared to that the per capita consumption in Germany in 2004 was at an average of 106 kwh per month (i.e. 9 persons 954 kwh; International Energy Agency 2006).

## 4. Ex-ante Impact Assessment of the Electrification Intervention

even higher prices for electricity would hardly lead to a decline in demands, although, of course, especially poorer households would be affected (Barnes et al. 2005).

**Table 16**

**Electricity consumption in connected households over the course of time**

	November 2004	March 2005	November 2005	December 2006
Officially installed metres in the village including households, social and economic infrastructure	0	78	202	235
Total of consumed kilowatt hours	0	2,064	6,994	15,027
Kilowatt hours per official connection	0	26.5	34.6	63.9
Paid invoice total in FCFA	0	254,494	766,449	1,605,567
Invoice per official connection in FCFA	0	3,263	3,794	6,832

*Source: Payments in Copargo 2004-2006, SBEE Regional office, Djougou*

### 4.1.5 Non-commercial Use of Electricity

On average, connected households have about five electric lamps compared to an average of four kerosene lanterns in non-electrified households. The quality of electric light – measured in lumen – is hundredfold better than that of kerosene lanterns (Barnes 2006) and can be considered an enormous increase in the standard of living. Yet, almost half of the electrified households continue to use kerosene lamps.

**Table 17**

**Connected households (HH) that own electronic devices and machines**

Shares in percent

	Radio	Television Set	Video unit	Refrigerator	Welding machine/mill	Ventilator	Regulator
Connected households	92	76	34	13	2	6	2
Non-electrified HH	96	12	1	0	0	0	0
The richest 30 % of the non-electrified HH	99	18	5	3	0	0	0

*Source: data record of the survey of connected and non-electrified households, Benin 2007*

## On-Grid Rural Electrification in Benin

### 4.1.6 Productive Use of Electricity in the Household

About 70 percent of the interviewed men and women in non-electrified households state that they would like to take up new income generating activities after the electrification. Just as many believe that their current work will become more efficient with electricity. The survey of connected households shows, however, that these expectations about strong effects on the economic activities of the households in such a short period of time should not be overestimated. Indeed electric light facilitates working at night but the electrified households hardly purchased any machines that would make their work more productive. Only 9 persons (approximately 6 percent) have taken up new activities since the electrification (cf. table 18). The reasons for this low uptake rate are a lack of funds available for purchasing new devices, too high expectations about automatically occurring improvements and missing training opportunities.

**Table 18**

**Statements about the use of electricity for generating income**

		Non-electrified households	Connected households
“Electricity might make my work more efficient”, respectively “...has made my work more efficient”	Men	72	12
	Women	72	48
“After the electrification I would like to take up a new commercial activity”, respectively “... I have taken up...”	Men	76	1
	Women	68	5
“I would like to do further training on how electricity can be used productively”, respectively “I have done further training...”	Men	81	0
	Women	69	0

*Source: survey of connected and non-electrified households, Benin 2007*

In the connected households, the percentage of men and women who use electric lighting for their work is 7 percent higher for men and 40 percent higher for women than in non-electrified households. Men that work at night are mainly teachers preparing their lessons, women use lighting for doing household chores (table 19).

## 4. Ex-ante Impact Assessment of the Electrification Intervention

**Table 19**

**The use of electricity for work in connected and non-electrified households**

Shares in Percent

	Men...	Women...	Households that use electricity for appliances and machines to generate income
	...who use electric light for their work		
Non-electrified households	2	1	0
The richest 30 percent of the non-electrified households	3	2	0
Connected households	9	41	6

*Source: data record of the survey of connected and non-electrified households, Benin 2007*

There is no indication of a substitution of manual or diesel-driven machines. In the electrified villages, 15 percent of the connected households continue to use manual sewing machines and 8 percent diesel mills. Yet some of the electrified households use their refrigerators and television sets also to generate additional income: 5 percent of the connected households use a refrigerator in order to produce ice for sale and 1 percent of the households earns money by hosting video nights.

Obviously the use of electricity for work in the households increases in consequence of the electrification; however, a diversification of incomes is identifiable only to a minor degree. This result was also observed in other developing countries: Households and household income benefit from the electrification rather because of electric light than due to the use of electric machines (Barnes 1988).

### 4.1.7 Productive Use of Electricity in Agriculture

In electrified villages, the agricultural structure and the level of productivity in the agricultural sector are not higher than for non-electrified farmers. Here the fields are also tilled manually. Just as the farmers in not electrified villages those in electrified villages produce agricultural goods almost exclusively for local markets and for themselves. Electricity is neither used in agriculture nor in the processing of agricultural products.

### 4.1.8 Household's Expenses for Electricity

Compared to the expenses of the richest 30 percent of the non-electrified households, the expenses of electrified households for light batteries are considerably lower, since grid electricity is much more affordable than kerosene and batteries (cf. table 20). A 20 watt radio costs 4 FCFA per hour with batteries,

## On-Grid Rural Electrification in Benin

2.1 FCFA with grid electricity. Likewise, a common neon lamp costs 2.1 FCFA per hour, while a kerosene lamp costs up to 6.4 FCFA. An electrified household spends approximately 4,500 FCFA less on household energy (lighting, radio and television set without wood and charcoal) and even enjoys a better light quality. With less than 10 percent, the percentage of the energy expenses from the total expenses is a lot lower in the electrified and the wealthier non-electrified households than the average of the non-electrified households. They spend more than 20 percent of their income on energy supply.

**Table 20**

**Energy expenses in connected and non-electrified households (HH) in FCFA**

	Kerosene and candles	Batteries for		Firewood and charcoal	Electricity (Electricity bill or petrol for generators)	Household energy	
		radios	flash lights			Total	without firewood and charcoal
Connected HH	760	109	369	3,834	3,778	8,850	5,016
Non-electrified HH	4,701	730	1,106	2,099	619	9,255	7,156
The richest 30 percent of the non-electrified HH	6,172	1,000	1,623	3,957	1,098	13,850	9,894

*Source: data record of the survey of connected and non-electrified households, Benin 2007*

### 4.1.9 Reliability of Electricity

Obviously, the reliability of the energy supply has improved through the electrification. The low availability of kerosene constitutes a central problem for the non-electrified households. The connected households, on the other hand, do not have any problems with the availability of electricity. Although power outages occur from time to time, they never last for a long time.

## 4.2 Electrification Impact on the Socio-economic Living Conditions

### 4.2.1 Impacts on the Gender Relations

Men in connected households work from 7 a.m. to 8:30 p.m., in non-electrified households on average from 7 a.m. to around 7 p.m. Both groups state that their average effective labour time amounts to 8 ½ hours every day. For women electrification as well seems to prolong the day: In the morning, women in electrified households begin their work half an hour earlier than in non-electrified

## 4. Ex-ante Impact Assessment of the Electrification Intervention

households, around 6 a.m. They also finish work half an hour later, at 9:30 p.m. Indeed, the women benefit most from the electric light that provides considerably better working conditions in the household.

Only 2 percent of the men in connected households help their wives with household chores, compared to 37 percent in non-electrified households. The same applies to the richest 30 percent of non-electrified households. This may be related to the fact that two thirds of the men in connected households watch television, compared to 18 percent in the richest 30 percent of the non-electrified households. Although predominantly males use the television set in both electrified and non-electrified villages, the discrepancy between the genders concerning television consumption is reduced through the electrification (cf. table 21). This may have positive effects in the medium term: Studies from Bangladesh have shown that by watching television, women in connected households gained more knowledge about gender equality than women in non-electrified households (Cabraal et al.2005).

**Table 21**

### Television viewing behaviour of men and women in connected and non-electrified households (HH)

Shares in percent

	Women...	Men...	HH, in which men watch considerably more television than women
	...who watch television at night		
Connected households	51	65	36
Non-electrified HH	1	16	77
The richest 30 percent of the non-electrified HH	2	18	76

*Source: data record of the survey of connected and non-electrified households, Benin 2007*

#### 4.2.2 Impacts on Children's Learning Habits

The hypothesis that children in electrified households study more at night as a result of the improved quality of lighting cannot be confirmed here: According to the survey data, primary school children in connected households even study slightly less at night than those in non-electrified households (cf. table 22). Concerning the longer study hours of older children in connected households, one may again assume that it is rather due to parents in these households valuing education more – which in turn is not necessarily to be seen as a consequence of the electrification.

Headmasters estimate that the school attendance quota is equal in the electrified and non-electrified villages. There not more schools in electrified villages, either.

## On-Grid Rural Electrification in Benin

**Table 22**

**Children's time for homework and school attendance rates in connected and non-electrified households (HH)**

	Hours pupils spend on homework in the evening		School attendance rate for children	
	Elementary schools (6-12 years)	Comprehensive schools (13-18 years)	Elementary school age	Comprehensive school age
Non-electrified HH	1.4	2.1	60-90 %	20-70 %
Connected HH	1.2	2.2	60-90 %	20-70 %

*Source: data record of the survey of connected and non-electrified households, Benin 2007*

### 4.2.3 Impacts on Health

Although all connected households continue to cook with biomass on a fireplace inside the houses, adults and children in these households are 50 percent less frequently affected by respiratory diseases than those in non-electrified households (cf. table 23). The results of a study from Bangladesh show that air pollution in houses depends also on the kind of biomass used for cooking, ventilation and the construction materials used. These conditions are usually better in richer and especially in well-educated households (Barns 2006). This may explain better than the substitution of kerosene lamps why respiratory diseases occur less frequently.

**Table 23**

**Respiratory diseases in connected and non-electrified households**

Shares in percent

	Adults	Children
Non-electrified households	35	43
connected households	16	17
The richest 30 percent of the non-electrified households	29	47

*Source: data record of the survey of connected and non-electrified HH, Benin 2007*

### 4.2.4 Impacts on Telecommunications

Connected households make considerably more use of telecommunications than non-electrified households: 92 percent state that they at least occasionally talk over the phone – compared to 52 percent of the non-electrified and 74 percent of the wealthier non-electrified households. The percentage of interviewed

## 4. Ex-ante Impact Assessment of the Electrification Intervention

households that own a mobile phone is with 59 percent in connected households 20 percent above that of the wealthier non-electrified households. In Copargo, the village that has been electrified for two years, antenna poles were set up by two private telephone companies when the electrification started. In this case it seems plausible that the electrification has entailed the availability of a mobile communications network. Yet in the electrified village Perma that is smaller and politically and economically less significant an extension of the mobile communications network is not planned.

### 4.2.5 Impacts on the Perception of the Standard of Living

The electrified households state without exception that electricity has improved their standard of living. The great majority supports the energy supply in the health centres, schools and local administrative offices. According to the local chief administrators, the street lanterns in electrified villages are one factor that has led to an improvement of the quality of life. People go for a walk more often in the evening while feeling safer.

## 4.3 Impact of the Electrification on the Social Infrastructure

### 4.3.1 Health Centres

The health centres in the two electrified villages analyzed in this study have connected themselves to the grid. According to the respective attending physicians, the overall quality of the treatments in the health centres has improved as a result of the electrification.

Table 24

### Energy expenses of connected and non-electrified health centres

In FCFA

	Average costs for the operation of a refrigerator per month	Average expenses for lighting per month
Non-electrified centres	14,400	10,800
Connected centres	9,000	19,000

Source: data record of the survey of connected and non-electrified health centres, Benin 2007

This is especially owed to electric lighting, which is used in the connected health centres for 12 hours during the whole night. The physicians report that this makes their work a lot easier, in particular during emergency surgeries and night births; before, these were lighted by flash lights and kerosene lanterns. Yet the financial situation of the centres has rather changed for the worse. While kerosene for the

## On-Grid Rural Electrification in Benin

operation of refrigerators has cost almost twice as much as electricity now, the expenses for lighting have doubled after electrification leading to an increase in overall energy expenditures (cf. table 24).

### 4.3.2 Schools

Only two of the nine primary schools in the electrified villages have connected themselves to the grid. Just one of them has electric installations, which is only sporadically used for electric light. Electric appliances do not exist. In primary schools, the syllabus thus does not seem to have improved through the electrification. Reasons for that may be the following:

1. Lacking funds for the acquisition of a meter, the installation and the purchase of appliances;
2. It is not imperative to use electricity for the current syllabus.

The situation is different for the two secondary schools in the electrified villages that have financed an electricity connection. They use electric light every day for their lessons in morning and evening hours, from 7 to 8 a.m. and from 6 to 7 p.m. An international organisation has provided 20 computers to one school which are in use six hours every day. In the other school a photocopier and a computer for the headmaster were acquired. The syllabus and the learning conditions in the comprehensive school have improved in consequence of the electrification, especially due to lighting.

## 4.4 Impact of the Electrification on Small Enterprises

### 4.4.1 Grid Connection of Small Enterprises

After one year, already 12 percent of the local businesses in Perma have connected themselves to the grid; in Copargo, 64 percent were connected after two years (cf. table 25). The propensity to connect has to be considered in relation to the energy demand of the respective enterprises outlined in Section 3.4.4. The enterprises that require energy or whose economic activity would be very limited without electric energy (first and second category) have connected themselves by 100 percent. Besides for lighting, these enterprises use electricity also for machines and appliances (welding machines, refrigerators and stereos). Exceptions are the millers who continue to use diesel-operated mills, since the purchase costs for an electric motor are very high.

## 4. Ex-ante Impact Assessment of the Electrification Intervention

Table 25

Grid connection of small enterprises that have already existed before the electrification

	Enterprises that already existed before electrification		Enterprises with an official electric connection		Enterprises that are connected unofficially to the grid	
	Copargo	Perma	Copargo	Perma	Copargo	Perma
Bar/Hotel	1	0	1	0	0	0
Bar	3	3	3	3	0	0
Supermarket	1	0	1	0	0	0
Shop (various)	8	5	5	3	3	1
Welder	3	0	1	0	2	0
Tailor	12	10	0	0	10	0
Hair-dresser	5	2	0	0	4	1
Mechanic	6	4	0	0	2	0
Carpenter	10	8	0	0	1	0
Mill	10	10	0	0	0	0
Shop	2	0	2	0	0	0

Source: data record of the survey of small enterprises in electrified villages, Benin 2007

The majority of the enterprises of the third category that do not necessarily need energy in order to carry out their activities – i.e. carpenters, mechanics, tailors and hair-dressers – mainly have not connected themselves. If they have, they only use electricity for lighting. These enterprises could also use electricity productively – the carpenter could for instance manufacture new furniture with a mortising machine, the mechanic could carry out other repair works, etc. The following reasons for the absence of this economic development were pointed out in the interviews: 1. Entrepreneurs lack the necessary financial resources or loans for the connection fees and machines. 2. In rural areas industrial machines are hardly commercially available. 3. The practice of manual work is deeply rooted. 4. Knowledge about the handling of machines does not exist. 5. The costs for electricity would increase the prices for services and products, which would lower

## On-Grid Rural Electrification in Benin

the demands in light of the existing purchasing power in the rural region. Finally, one third of the electrified enterprises state that their greatest problem is the missing customer base.

### 4.4.2 Productive Use of Energy in Small Enterprises

Nevertheless it can be declared that the productivity of the small enterprises has increased in the course of electrification. The connected enterprises state that lighting alone has made their work during the evening hours more efficient. In general, lighting seems to be the most important purpose of electricity for small enterprises. Other studies also come to the conclusion that because of its higher efficiency (not least concerning lighting) in contrast to other energy sources, electricity is a basic precondition for economic growth (Barns 2006:62–67).

Most notably bars, shops and welders use electricity not only for lighting, but also for the operation of appliances or machines. The operation of a common 120 watt refrigerator with electricity at the proposed electricity rate will cost half as much as its operation with kerosene. The estimated price for a kilowatt hour of electricity produced by a generator of approximately 200 FCFA is also twice as high as the costs for grid electricity at the planned rate. Grid electricity thus reduces the costs of services and products in the small enterprises that have already used electricity before the electrification. This way, the electrification may open up possibilities for investments, which may lead to economic growth and benefits for consumers as well.

### 4.4.3 Start-ups of Small Enterprises

In Copargo, the electrification has led to the start-up of many small enterprises. The number of small enterprises there has increased by 11 percent. A positive example is a new sawmill that has been founded with “direct investments from outside the village” and that now supplies the carpenters in the village with treated wood. Before, these pre-products had to be procured outside the village or produced manually. This way added value was introduced to the village and respectively, an important step into the direction of an improved division of labour has been taken.

Businesses that have been started after the electrification are depicted in photo 8 and 9.

## 4. Ex-ante Impact Assessment of the Electrification Intervention

Photo 8  
Sawmill

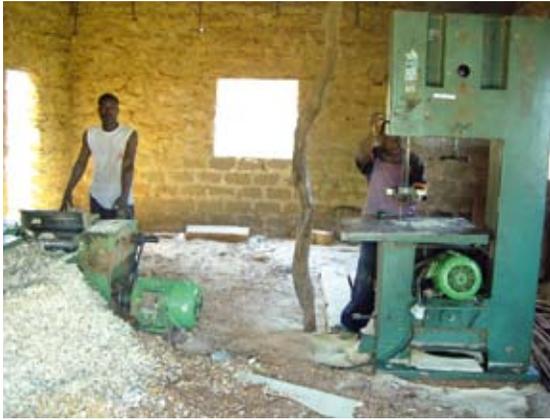


Photo 9  
Multimedia shop



Table 26 offers an overview of the start-up enterprises in Copargo according to sectors. It can be noted that the electrification has stimulated economic growth, technical advancement and economical modernisation here. An increase in activity can be recorded in the non-agricultural sector.

## On-Grid Rural Electrification in Benin

Table 26

Start-ups of small enterprises that have resulted from the electrification in Copargo

	Number of new small enterprises	Share of new small enterprises with an official electrical connection
Sawmill	1	100
Fishmonger's	1	100
Multimedia shop	1	100
Computer store	1	100
Electronics store	2	100
Welder	1	100
Households with refrigerators to produce ice for sale	6	100

Source: Survey of small enterprises in electrified villages, Benin 2007

In Perma, on the other hand, there are no new commercial activities. This may at least partly be due to the short duration of the electrification. Other factors for the current absence of economic development in Perma in contrast to Copargo may be the smaller population (Perma has around 3,500 inhabitants, Copargo around 8,000) or the less significant administrative standing: Perma is seat of the borough and Copargo is seat of the borough and the municipality. Politicians with financial resources and connections can be a relevant factor for the emergence of economic activities, since they facilitate the feasibility of larger capital investments. Furthermore, Copargo is the commercial centre of the region and has an important market. Missing market access presents a crucial barrier to investments in smaller villages.

Generally one has to warn against too high expectations about an automatic economic development. Likewise other studies of Asian developing countries show that the electrification of rural areas alone does not lead to boosting economic activity (Barnes 1988).

## 5. Recommendations for Project Implementation

### 5. Recommendations for Project Implementation

The results of the socio-economic baseline study and impact analysis allow for the conclusion that accompanying measures in rural electrification projects are indispensable for reaching development goals in due time. Other authors come to the same conclusion. Cabraal et al. (2005), for example, put it in the following way: “An emphasis on simply providing electricity coverage in rural areas without adequate forethought to opportunities for business development and poverty reduction is not only undesirable, but in the long run is unsustainable as valuable resources will be wasted. Also, energy in the context of failing schools, poor health facilities, and poor water supply will not lead to development”.

The following accompanying measures beneficial for the achievement of the development goals are proposed based on the results of this study:

1. To help households overcome the three access barriers and ensure equal opportunities of accessing the grid, the following measures should be taken:
  1. poorer agricultural households should be instructed specifically on the advantages of electricity,
  2. the connection fees for households should be reduced and
  3. secondary grid extensions (“Toile d’araignée”) should be technically advanced and their implementation should be supported.Low-cost electrification measures, in particular targeted at households with low electricity consumption, have led to an alignment of urban and rural connection costs in South Africa. An economic analysis identified rural electrification intervention there as a “model of social electrification.” It is argued in this analysis that “under-design will be preferred to over-design where the costs of under-performance are relatively low” (Gaunt 2005:1313–1314).
2. Training seminars on how electricity can be used productively in the households should be offered.
3. General information meetings about the advantages of electricity, especially about the cost advantages compared to kerosene and batteries should be offered, as well as technical assistance for the installation inside the house. This implies, for example, that light switches are installed next to the bed so that women can substitute kerosene lamps that were formerly lit during night.
4. Primary and secondary schools should obtain the electrical connection for a symbolic fee.

## On-Grid Rural Electrification in Benin

5. Seminars targeted at teachers showing how electricity can be used in the classroom should be offered. Teachers should serve as disseminators by specifically introducing subject matters (e.g. brochures on electricity) that teach about the advantages of electricity in everyday life and at work.
6. Seminars should be offered targeted at specific occupational groups on how electricity can be used in individual enterprises. For example, local small-scale entrepreneurs of already electrified enterprises could serve as instructors in the region and practical course could be offered in already electrified enterprises.
7. Micro credit organisations should be integrated into the training programmes for small-scale entrepreneurs. Additionally, opportunities for business start-ups should be presented in seminars. It seems reasonable to rely on successful models from electrified neighbouring regions.
8. Seminars targeted at farmers on how electricity can be used in the production and processing of agricultural goods should be offered.
9. Battery systems should not be advanced at first because the potential target group has a negative attitude towards them. It is advisable to repeat the demand analysis once the grid expansion is finished, since more remote households will then note that they are not able to gain access to the grid.

### Bibliography

Baranski, M. (2006), *Energie-Monitoring im privaten Haushalt*. Paderborn.

Barnes, D.F. (1988), *Electric Power for Rural Growth. How Electricity Affects Rural Life in Developing Countries*. Colorado.

Barnes, D.F. (2006), *Bangladesh Rural Energy Strategy*, World Bank, Washington, DC.

Barnes, D.F. and J. Gregory (2003), *Monitoring and Evaluation in Rural Electrification Projects: A Demand-Oriented Approach*. ESMAP/World Bank, Washington, DC.

Barnes, D.F., K. Krutilla, and W.F. Hyde (2005), *The Urban Household Energy Transition. Social and Environmental Impacts in the Developing World*. Washington, DC.

Brand, R. (2006), Mehr Worte als Taten? Der deutsche Beitrag zur Erfüllung der Millennium-Entwicklungsziele. In F. Nuscheler and M. Roth (eds.), *Die Millennium-Entwicklungsziele – Entwicklungspolitischer Königsweg oder ein Irrweg?* Bonn.

## Bibliography

Brook, P.J. and J. Besant-Jones (2000), Reaching the poor in the age of energy reform. In ESMAP, World Bank (eds.), *Energy Services for the World's Poor*. Energy and Development Report 2000. Washington, DC.

Brook, P.J. and W.P. Smith (2000), Better energy services for the poor. In ESMAP, The World Bank (eds.), *Energy Services for the World's Poor*. Energy and Development Report 2000. Washington, DC.

Cabraal, A.R., D.F. Barnes, and S.G. Agarwal (2005), Productive Uses Of Energy For Rural Development. *Annual Review of Environment and Resources* 30.

Gaunt, C.T. (2005), Meeting electrification's social objectives in South Africa, and implications for developing countries. *Energy Policy* 33 (10).

Hankins, M. (2000), A case study on private provision of photovoltaic systems in Kenya. In ESMAP, World Bank (eds.), *Energy Services for the World's Poor*. Energy and Development Report 2000. Washington, DC.

Hein, W. (1998), *Unterentwicklung – Krise der Peripherie*. Phänomene, Theorien, Strategien. Opladen.

International Energy Agency (2006), *Energy Report 2006*. Washington, DC.

Nuscheler, F. (2006), *Entwicklungspolitik*. Bonn.

Townsend, A. (2000), Energy access, energy demand and the information deficit. In ESMAP, World Bank (eds.), *Energy Services for the World's Poor*. Energy and Development Report 2000. Washington, DC.

Waddams Price, C. (2000), *Better energy services, better energy sectors—and links with the poor* In ESMAP, World Bank (eds.), *Energy Services for the World's Poor*. Energy and Development Report 2000. Washington, DC.

## On-Grid Rural Electrification in Benin