Satoguina, Honorat

Working Paper

Analysis of CDM Projects' Portfolio in West African Economic and Monetary Union - Regional Baseline Assessment in Energy Sector. Case Study: Benin, Burkina Faso, Niger and Togo

HWWA Discussion Paper, No. 356

Provided in Cooperation with:
Hamburgisches Welt-Wirtschafts-Archiv (HWWA)

Suggested Citation: Satoguina, Honorat (2006) : Analysis of CDM Projects' Portfolio in West African Economic and Monetary Union - Regional Baseline Assessment in Energy Sector. Case Study: Benin, Burkina Faso, Niger and Togo, HWWA Discussion Paper, No. 356, Hamburg Institute of International Economics (HWWA), Hamburg

This Version is available at:
https://hdl.handle.net/10419/19385

HWWA HAMBURG

DISCUSSION PAPER

Analysis of CDM Projects' Portfolio in West African Economic and Monetary Union - Regional Baseline Assessment in Energy Sector. Case Study: Benin, Burkina Faso, Niger and Togo

Honorat Satoguina

HWWA DISCUSSION PAPER

356

Hamburgisches Welt-Wirtschafts-Archiv (HWWA)
Hamburg Institute of International Economics
2006
ISSN 1616-4814

Hamburgisches Welt-Wirtschafts-Archiv (HWWA)
Hamburg Institute of International Economics
Neuer Jungfernstieg 21 - 20347 Hamburg, Germany
Telefon: 040/428 34 355
Telefax: 040/428 34 451
e-mail: hwwa@hwwa.de
Internet: http://www.hwwa.de

The HWWA is a member of:

- Wissenschaftsgemeinschaft Gottfried Wilhelm Leibniz (WGL)
- Arbeitsgemeinschaft deutscher wirtschaftswissenschaftlicher Forschungsinstitute (ARGE)
- Association d’Instituts Européens de Conjoncture Economique (AIECE)

HWWA Discussion Paper

Analysis of CDM Projects' Portfolio in West African Economic and Monetary Union - Regional Baseline Assessment in Energy Sector. Case Study: Benin, Burkina Faso, Niger and Togo

Honorat Satoguina

HWWA Discussion Paper 356
http://www.hwwa.de

Hamburg Institute of International Economics (HWWA)
Neuer Jungfernstieg 21 - 20347 Hamburg, Germany
e-mail: hwwa@hwwa.de

This paper has been prepared within the research Programme "International Climate Policy" of HWWA

This Version: December, 2006

Edited by the Department World Economy

HWWA DISCUSSION PAPER 356
December 2006

Analysis of CDM Projects' Portfolio in West African Economic and Monetary Union - Regional Baseline Assessment in Energy Sectors. Case Study: Benin, Burkina Faso, Niger and Togo

ABSTRACT

This study analyses current energy projects in Benin, Burkina Faso, Niger and Togo. Based on the size of these projects, the study shows that currently, only small scale CDM projects can be developed in these countries in energy sectors.

Moreover, baseline emissions factors are assessed for the different electricity grids. These baselines are very low in interconnected grids in cities, while they are relatively high for isolated and non-connected utilities in remote areas. Consequently, countries can maximise their revenues through CDM projects in remote areas.

Given that electricity exchange occurs between countries of the West African Economic and Monetary Union (WAEMU) and other West African countries, the assessment of regional baseline emissions factors shows very low emissions factors, due to the high hydro electricity import in Benin, Togo and Niger. However, the result is different in Burkina Faso, which imports less hydro electricity comparatively.

The study therefore suggests that small countries with suppressed demand are exempted from the use of the regional baseline emissions.

Keywords: Energy projects, CDM projects, regional baseline.

JEL classification: D00, G11, G20, Q20

Address for correspondence:

Honorat Satoguina
Programme International Climate Policy
Hamburg Institute of International Economics
Neuer Jungfernstieg 21, 20347 Hamburg
Germany
Phone: +4940 42834 349
Fax: +4940 42834 451
honorat.satoguina@hwwa.de, until 31.12.2006 and after: hsatoguina@hotmail.com

CONTENT AND OVERVIEW

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

CDM	Clean Development Mechanism
CEF	Carbon Emission Factor
CER	Certified Emission Reduction
CH4	Methane
CNEDD	Conseil National de l'Environnement pour un Développement Durable
CO_2	Carbon dioxide
CO_2eq	Carbon dioxide equivalent
DGE	Energy Administration
ECOWAS	Economic Community of West African States
EIA	Energy Information Administration
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GNI	Gross National Income
GTZ	Gesellschaft Technische Zusammenarbeit (Germany)
IEA	International Energy Agency
IEPF	Institut de l'Énergie et de l'Environnement de la Francophonie
IPCC	Intergovernmental Panel on Climate Change
LULUCF	Land-Use Land-Use-Change Forestry
N_2O	Nitrous oxide
SSN	SouthSouthNorth
UN	United Nations
UN-DESA	United Nations Department of Economics and Social Affairs
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNIDO	United Nations Industrial Development Organisation.

UNFCCC	United Nations Framework Convention on Climate Change
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
US	United States
WAEMU	West African Economic and Monetary Union
WB	World Bank
WEC	World Energy Council

1 INTRODUCTION

According to Articles 6 and 12 of the Kyoto Protocol, it is possible for Annex B countries to invest in CDM projects in order to create emission reductions that may help to reduce costs for achieving compliance with the emission targets (UNFCCC 1997). Emission reductions that occur as a result of a CDM project activity are called Certified Emissions Reductions (CERs). Issuance of CERs is based on emissions reductions calculated against a baseline which describe CO_2 emissions development scenarios in absence of the CDM project.

To be attractive in the international CDM market, host countries have to minimise transaction costs to CDM projects. As determination of the baseline can be one of the most complex and costly parts of a Project Design Document (PDD), provision of baseline data plays an important role in increasing attractiveness to project developers.

In the case study countries, baselines have not yet been assessed. The present study assesses baselines for energy sectors and shows the implications of applying the notion of a regional baseline.

In order to identify the size of possible CDM projects, ongoing and planned energy projects are analysed in section 2. Possible CDM projects are shown in section and analysed in section 3. Baselines are assessed in sections 4 and 6. The additionality issue is discussed in section 5. Possible CDM contribution to energy projects is analysed in section 7. Improvement of electricity supply under CDM projects is analysed in section 8. Concluding words are presented in section 9.

2 EXISTING ENERGY PROJECTS

2.1 Benin

Table 1 below presents the ongoing energy projects and those that are under preparation in Benin. From the table, the hydroelectricity and gas turbine projects are planned to provide electricity to the grid, while photovoltaic projects are intended for decentralised electricity services. Sustainable fuelwood promotion and biomass energy efficiency are planned to reduce pressure on the demand from forests and limit deforestation. Since Benin imports all oil consumed, the bio-ethanol project is designed to reduce oil importation. It is worth noting that none of the projects is designed under the CDM procedure. In addition, the interconnection project represents a least-cost solution to supply electricity to the north of the country (World Bank 2004). In effect, the electricity supply company's strategy is to use least cost electricity from Nigeria, Ghana and Ivory Coast to substitute diesel electricity generation from isolated diesel generators in the north.

Table 1: Existing projects in Benin

Projects	Specification	Implementation
Hydroelectricity	94 MW Adjaralla 26 MW Dyodyonga	2004-2008
Gas turbine generators	20MW	From 2005 onwards
Sustainable fuelwood promotion	Community-based fuelwood supply management system on 300,000 hectares of land with a production of permanent 675,000 tons/year	2003-2012
Biomass energy efficiency and inter-fuel substitution	Promotion of high efficiency kilns ("meule cassamance") for charcoal production Promotion of private sector-based improved fuelwood cook stove programs Dissemination of 30,000 improved fuelwood stoves	2003-2012
Photovoltaic (PV)	Installation of at least 125kWp for rural electrification	2000-2005
Promotion of bio ethanol production to substitute 15-20% of fossil fuel	Ethanol production from cashew fruits	Feasibility study has to be completed by 2006
Interconnection projects	South grid will be connected with the northern area North Benin interconnected with north Togo via 161 kV line. South-east Benin will be interconnected with West Nigeria via a 330kV line	2004 to 2006 2003 to 2005

Source: World Bank (2004), GEF (2000), WAEMU (2005).

2.2 Burkina Faso

In order to help improve the availability and reliability supply in the area covered by the national power utility, a 14 MW thermal plant as standby generation is projected

(World Bank, 2004). Moreover, an energy audit revealed that it is possible to reduce about 12GWh of electricity consumption in public buildings (about 12% of total public building consumption) (World Bank 2004, 1992). Hence, a five-year energy efficiency project in 30 public administration buildings is planned.

Table 2: Existing projects in Burkina Faso

Projects	Specification	Implementation
Additional thermal generation capacity (diesel plant)	14 MW	2005-2007
Energy efficiency project at 30 public administration buildings	5 buildings in the first year 10 buildings in the second year 15 buildings in third year 20 buildings in the fourth year 30 buildings in the fifth year	To be completed by 2009
Extension and reinforcement of transmission lines	Bobo - Dioulasso - Ouagadougou 225 kV line Burkina Faso-Ghana Burkina Faso-Ivory coast	Completion by 2009 NA NA

Source: World Bank, (2004), WAEMU (2005).

2.3 Niger

Three hydroelectricity projects are under consideration. Moreover, biomass projects are undertaken in order to reduce deforestation. Photovoltaic projects are used mainly for water pumping, telecommunication and lighting in rural areas. Interconnections are also adopted as a least-cost option. The photovoltaic projects as well as the biomass projects were designed in the frame of a programme called sustainable energy promotion for poverty alleviation. However, no conclusion has been drawn yet on the project's success or failure. All we know is that such projects were undertaken in the country.

Table 3: Existing projects in Niger

Projects	Specification	Implementation
Hydroelectricity	Hydropower plant: 75 MW Kandadji, 26 MW Dyodyonga 150 MW Gambou	Under consideration
Biogas	9 Biogas plants of a total capacity of 165 m^3	Underway
Biomass energy efficiency and inter-fuel substitution	Promotion of high efficiency kilns (“meule cassamance”) for charcoal production Promotion of private sector-based improved fuelwood cookstove programs Dissemination of 32,000 improved fuelwood stoves	Underway
Mineral coal briquette production for cooking purpose in households	650,000 tons of mineral coal used in 2000, will be increased with the dissemination of the stoves	From 2000 onwards
Photovoltaic (PV)	435,3 kWp Solar water pumping Telecommunication Lighting Television/Radio ...etc	Underway
Interconnection projects	Niger-Nigeria Niger-Burkina-Ghana Niger-Benin	Under consideration

Source: CNEDD (2003), World Bank (2004), WAEMU (2005), IEPF (2004a, b).

2.4 Togo

Togo and Benin have a long history in electricity co-operation. Hence, nearly the same types of projects are undertaken in both countries.

Table 4: Existing projects in Togo

Projects	Specification	Implementation
Hydroelectricity	Hydropower plant 94 MW installed capacity on the Mono river in co-operation with Benin	2004-2008
Gas turbine generators	20 MW	From 2005 onwards
Photovoltaic (PV)	Installation of at least 125 kWp for rural electrification	2000-2005
Interconnection projects	South grid will be connected with the northern area North Togo interconnected with north Benin via 161 kV line. Togo will be interconnected with West Nigeria via a 330 kV line through Benin	2004 - 2006 2003 to 2005

Source: World Bank (2004), GEF (2000) WAEMU (2005), IEPF (2004a, b).

3 POSSIBLE CLEAN DEVELOPMENT MECHANISM PROJECTS IN THE CASE STUDY COUNTRIES

The CDM projects in a country should match the country's economic situation as well as the capability of the country to absorb the potential projects. Hence, the possible CDM projects in the case study countries could be derived from the existing projects in the energy sector, namely hydroelectricity, thermal energy production and energy efficiency in biomass use. Biomass energy projects discussed here include only biomass from agricultural residues as required by the CDM Executive Board. We hope that rules will change and other biomass sources can be used.

3.1 CDM projects in Benin

3.1.1 Renewable energy

Based on table 1, CDM projects could be developed in hydroelectricity, biomass as well as in energy efficiency sectors. In effect, as for hydroelectricity, based on the hydroelectricity potential in the country (MW/GW) it is conceivable that at least two hydroelectricity projects of the size of the actual 94MW project could be developed. As fare as biomass energy projects are concerned, the actual natural gas turbine project (20 MW) would serve as a basis. Moreover, under the current rules dealing with biomass use for electricity generation, only biomass residues that do not lead to a depletion of the resource can be used under small scale CDM projects[1] (UNFCCC, 2005a). Hence, the installed capacity of each biomass power generation will not exceed 15 MW. In fact, this research suggests the installation of at least 2 biomass energy projects of 10 MW each, which would use agricultural residues and biomass from wood industry. Furthermore, in the discussion on biomass energy projects, it has been argued that the biomass supply sources should not be far away from the biomass power plant, normally within a radius of 100 km (Sutter, 2003). Otherwise, transportation costs would make projects financially unfeasible or unviable. With respect to biomass energy efficiency improvement and inter-fuel substitution, there is a possibility to develop some CDM projects. In fact, around 90% of energy consumption in the case study countries is based on traditional biomass use. In table 5, emissions from the end uses of different fuels are compared. The end-uses considered for the calculations here are limited to cooking and water heating, which are the most common and energy intensive household tasks.

3.1.2 Efficent charcoal production and efficient cookstoves

Emissions from charcoal and wood are higher than emissions from natural gas, kerosene and coal, which are the most commonly used fuels in industrialised countries. An inventory of greenhouse gas emissions in developing countries which does not take into account emissions from charcoal production and from wood would be biased. Unfortunately, in the national communications that are the basis for the CDM potential assessment, emissions from biomass used in households have not been properly taken into account, especially emissions from charcoal production cycle.[2]

Table 5: Comparison of CO_2 emissions from different fuels used for cooking in private households

	Stove efficiency	Daily use (kg)	Daily use (MJ)	Emissions g C/MJ	kg CO_2 emitted/ day
Natural gas	50%	1.3	63	15	3.4
Kerosene	35%	1.6	71	19	5.0
Coal	20%	5.2	125	22.1	10.1
Charcoal	25%	3.2	100	28.7	10.5
Wood	18%	8.7	139	29.7	15.1

Calculations based on 25 MJ effective energy consumption for a household of 7.
Source: (Kammen and Lew 2005, pp. 5-16).

The rationale behind is that the IPCC considers biomass as net neutral GHG emissions. Obviously this is true only for a small part of the biomass consumption in villages where biomass could be considered as sustainably harvested. But biomass used in the cities, especially charcoal, is not produced sustainably. Charcoal production is responsible for the large felling of wood, which may lead more directly to deforestation

1 For more information, see (http://cdm.unfccc.int/EB/meetings/020/eb20rep.pdf).
2 Charcoal production cycle generates gases and residuals such as CO, CH4, NMHC, NH3 and CO_2 (Kammen and Lew 2005). In most of the developing countries, information on charcoal production and emissions from production cycle is not available.

(Kammen and Lew 2005). Therefore, the issue of emissions from charcoal production in developing countries needs particular attention and must be addressed properly in the emission inventories. Based on the above discussion, one could develop some CDM projects in energy efficiency from charcoal and wood use in households through high efficiency charcoal production and improved cook stoves (Kammen and Lew 2005).

The promotion of high efficiency kilns ("meule cassamance") would allow to reduce emissions from charcoal production, which, taking into account the global warming potential of the products of incomplete combustion, are larger than emissions from charcoal combustion in cookstoves. Table 6 below shows the net CO_2-eq emissions from charcoal production and emissions reduction potential in Benin.

Table 6: Net carbon dioxide emissions from charcoal production and emission reduction potential.

Charcoal production (ton/year)	Charcoal emission factor (Kg CO_2-eq/Kg charcoal)	Emissions (ton CO_2-eq/year)	Emissions reduction** (ton CO_2-eq/year)
135,000*	3.2	432,000	239,760

* The actual sustainable wood production project will supply 675,000 tons of wood fuel per year, which corresponds to 135,000 tons of charcoal per year (World Bank 2004).

** The emission reductions calculation is based on 45-66% emission reduction due to efficient kilns (Kammen and Lew 2005). An average emission reduction of around 55% is selected.

Source: World Bank (1992), Energy series paper N° 51.

The emission reduction potential through improved cookstoves is based on a research in Niger, the results of which are summarised in table 7 below.

Since Niger and the other case study countries are in the same geographic region and have almost the same climatic conditions and economic development, the results in Niger can be used as a proxy for the whole region.

Table 7: Kg of biomass fuel per person per day and annual saving through improved cookstoves

	Traditional cookstoves	Improved cookstoves	Saving	Conversion to charcoal	Annual saving/household of 7
Niger (wood)	0.57	0.42	0.15	0.045	115

Efficiency: Traditional cookstoves: 5-10%.

Improved cookstoves: 30-50%.

Source: Kammen and Lew (2005). 0.3 kg charcoal is needed to replace 1kg wood.

Using the same emissions from a kilogram of charcoal production and the number of households in Benin, CER volumes of a charcoal cooking stove improvement project is carried out as shown in table 8 below. In the table, it has been assumed that 30,000 households receive the improved stoves.[3] Hence, it will be possible to reduce around 11,000 tons of CO_2-eq per year through an improved cookstoves project.

Table 8: GHG Emissions reduction through improved cookstoves in Benin

Population (Million)	Households (million)	Charcoal saving /household (kg /y)	Total charcoal saving (ton /y)	Households emissions reductions tCO_2/y	Emission reduction based on 30,000 households per country ($t\ CO_2/y$)
7	1	115	115,000	368,000	11,040

380kg charcoal = 1216 kg CO_2, World Bank (1992).

As far as photovoltaic (PV) projects are concerned, the existing installed capacity is so low that it hardly makes sense to consider these projects under the CDM projects.[4]

3.2 CDM projects in Burkina Faso

Based on the actual energy project portfolio, CDM projects could be developed in hydroelectricity, biomass and electricity efficiency sectors.

3.2.1 Renewable energy

Based on the biomass and hydroelectricity potential in the country, at least two 14 MW hydro and biomass electricity could be developed. The project size is based on the actual 14 MW diesel power plant project. Although the existing energy project portfolio does not contain any biomass energy efficiency projects, due to similar conditions as in Benin, the project types foreseen in Benin could also be developed in Burkina Faso. In

3 The existing improved cookstoves project planned to disseminate 30,000 improved cookstoves. The research uses this project size as its basis.

4 Based on the existing installed capacity, transaction costs will be high and the related emission reduction will be very low. However, under government climate change program, PV projects could be an option.

addition, the same reasoning is made for biomass electricity projects. Based on the analysis of emission reduction possibilities in biomass energy efficiency and using the same assumptions as in Benin, emission reductions through improved cookstoves and sustainable biomass production are around 254,000 t CO_2-eq/y (see discussion on Benin and tables 6 and 7).

3.2.2 Energy efficiency

As far as energy efficiency is concerned, the objective is to support the purchase of efficient air-conditioning, lighting systems and existing equipment to reduce electricity consumption. Small scale CDM projects of maximum 15 GWh energy saving per year could be developed. Table 9 below shows a hypothetical energy efficiency project. It is possible to develop separate projects for lighting, air conditioners or refrigerators. Due to the high costs of air conditioners, the research analyses a combination of air conditioners and lighting as a project and refrigerators alone as another project. With the lighting and air conditioner project, two options are distinguished based on the ratio of the lighting in the total energy saving. Option I is the case where lighting represents two-third of the total electricity saving, and option II the case where lighting amounts to one-third of the total saving. Due to a lack of information on the actual consumption by lights, air conditioners and refrigerators per administration building, the number of buildings needed per year will not be discussed further.

Table 9: Demand-side management in administrative buildings

Sector	Use	Hypothesis Business as usual	Project activi ty	Energy saving per year (kWh/device)	Number of devices needed to be changed (Unit of device) (d)	Electricit y saving per category (GWh)
Adminis-tration	Lighting Bureau(a)	40 W incandescent bulb	10 W CFL	77	3000	0.23
		60 W incandescent bulb	15 W CFL	115	3000	0.35
	Air conditioner(b)	1.1 kW	0.4 kW	2,044	1,800	4
	Refrigerators(c)	80 W	50 W	200	870	0.20
Total electricity saving (GWh/y)	5					

(a) Daily use 7 hours.

(b) Air conditioner's daily use 8 h.

(c) see http//www.afrepen.org. Annual consumption of inefficient refrigerators 700 kWh/y, efficient refrigerators: 500 kWh/y .
Remark: 64 kWh + 115 kWh = 179 kWh. 115 kWh = 1.8 x 64 kWh.

(d) The calculations are based on 21 Ministries at national level, 80 office rooms per Ministry, 4 lighting bulbs per office, 80 air conditioners per Ministry and 40 refrigerators per Ministry.
For the Presidency, the calculations are based on 100. Based on these assumptions, we derived around 6,000 lighting bulbs of 40 W and 60 W; 1,800 air conditioners and 870 refrigerators.

Source: DGE-Benin (2000).

Table 10: GHG emissions reduction potential from charcoal life cycle

	Charcoal production (ton/year)	Charcoal emission factor (kg CO_2-eq/kg charcoal)	Emissions (ton CO_2-eq/year)	Emissions deduction (ton CO_2-eq/year)
Burkina Faso	135,000	3.2	432,000	239,760

Source: Own table.

Table 11: CO_2 Emissions reduction through improved cookstoves in Burkina Faso

Population (Million)	Households (million)	Charcoal saving/house-hold (kg /y)	Total charcoal saving (ton /y)	Households emissions reductions tCO_2/y	Emission reduction based on 30,000 households per country t CO_2 /y
13	1.9	115	281,500	900,800	14,223

Source: Own table.

3.3 CDM projects Niger

Based on table 3, CDM projects could be developed in hydroelectricity and biomass energy sectors. With respect to hydroelectricity, based on the hydroelectricity potential in the country (250 MW) it is conceivable that at least two hydroelectricity projects of the size of the actual 75 MW and 36 MW projects could be developed. Since the 150 MW capacity at Gambou site is under consideration, fractionating in projects of smaller capacity could be an option. As far as biomass is concerned, due to water shortage in Niger, biogas is not a suitable option. Furthermore, agricultural residues are mostly used as an energy supply for households. Hence, biomass electricity project is not a suitable option in Niger. Biomass energy efficiency and inter-fuel substitution in contrast could be developed as discussed in Benin's case. Based on the same reasoning and assuming the same size of renewable wood energy production as in Benin, it is possible to reduce at least 240,000 tons CO_2-eq/year (see table 10). As far as improved cookstoves are concerned, the result of possible emission reductions is summarised in table 12 below. The calculations are based on the assumptions used in the discussion on Benin and the dissemination of 30,000 improved cookstoves (World Bank, 2004). In addition, the use of mineral coal for cooking in households could be replaced by the supply of efficient charcoal cook stoves. Due to a lack of information on the mineral coal stoves' efficiency, the possible GHG emission reduction will not be assessed in this research.

Table 12: CO_2 emissions reduction through improved cookstoves in Niger

Population (Million)	Households (million)	Charcoal saving /household (kg /y)	Total charcoal saving (ton /y)	Households emissions reductions t CO_2/y	Emission reduction based on 32,000 households per country t CO_2 /y
11	1.6	115	184,000	588,800	11,776

Source: Own table.

All together, it is possible to reduce at least 251,000 t CO_2-eq/y through biomass energy efficiency at the household level.

3.4 CDM projects in Togo

Based on the hydroelectricity capacity in Togo and the actual energy project portfolio in table 4, it is possible to develop at least two hydro power projects of the size of 94 MW.

In addition, based on the same reasoning as in Benin, at least two biomass electricity projects of 10 MW each could be developed since most of the biomass is not used for energy production. Although the actual energy project portfolio in Togo does not include biomass energy efficiency projects at the household level, based on the same climatic conditions and the same energy supply system as in Benin, the same energy efficiency projects at the household level could be developed. Hence, it will be possible to reduce around 250,000 tons of CO_2-eq/year through renewable wood energy production (see discussion on Benin and tables 6 and 7).

All possible CDM projects in the case study countries are summarised in table 13 below.

Table 13: Possible CDM projects in Benin

Country	**Project type**	**Emissions reduction (t CO_2-eq/y)**	**Crediting period**	**Total emissions reduction (Million t CO_2-eq)**
Benin	Hydroelectricity 2X94 MW*	20,000	21	0.42
	Wind energy** 25.5 MW	1,300	21	0.03
	Biomass electricity 2x10 MW	17,000***	21	0.36
	Energy efficiency in charcoal production	240,000	21	5.04
	Improved cook stove	11,000	10	0.11
	Energy efficiency in administration buildings	170****	10	0.0017
Total		289,470		5.96

* Based on the hydrology of the country, the plant operating capacity is around 35% (EIA 2003). The annual generation is around 576,408 MWh.

** The annual generation is 38250 MWh, based on 1500 FLH at the Atlantic coast of West Africa (Czisch, 2001).

*** The emission reduction is based on the emission reductions from projects of the same size in India (20MW installed capacity and 80% annual average plant load factor (Sutter 2003).

**** The emission reductions are based on 5 GWh energy saving projects and an emission factor of 34 g/kWh.

Source: Own table.

Table 14: Possible CDM projects in Burkina Faso

	Project type	Emissions reduction (t CO_2-eq/y)	Crediting period	Total emissions reduction (Million t CO_2-eq)
Burkina Faso	Hydroelectricity*	50,479	21	1.1
	Biomass electricity 2x10 MW	17,000	21	0.36
	Energy efficiency in charcoal production	240,000	21	5.04
	Improved cook stove	14,223	10	0.14
	Energy efficiency in administration buildings**	2,940	10	0.029
Total		324,639		6.67

* Based on the hydrology of the country, the plant operating capacity is around 35% (EIA 2003). The annual generation is around 85,848 MWh and an emission factor around 588 g/KWh.

** The emission reductions are based on 5 GWh energy saving projects and an emission factor of 588 g/kWh.

Source: Own table.

Table 15: Possible CDM projects in Niger

	Project type	Emissions reduction (t CO_2-eq/y)	Crediting period	Total emissions reduction (million t CO_2-eq)
Niger	Hydroelectricity	56,834	21	1.2
	Energy efficiency in charcoal production	240,000	21	5.04
	Improved cook stove	11,776	10	0.11
	Energy efficiency in administration buildings	840	10	0.01
Total		309,750		6.36

* Based on the hydrology of the country, the plant operating capacity is around 35% (EIA 2003). The annual generation is around 340,326 MWh and an emission factor around 167 g/kWh.

** The emission reductions are based on 5 GWh energy saving projects and an emission factor of 167 g/kWh.

Source: Own table.

Table 16: Possible CDM projects in Togo

	Project type	Emissions reduction (t CO_2-eq/y)	Crediting period	Total emissions reduction (Million t CO_2-eq)
Togo	Hydroelectricity	20,000	21	0.42
	Wind farm 25,5 MW	1,300	21	0.03
	Biomass electricity 2x10 MW	17,000	21	0.36
	Energy efficiency in charcoal production	240,000	21	5.04
	Improved cook stove	11,000	10	0.11
	Energy efficiency in administration buildings	315	10	0.003
Total		289,615		5.96

* The emission reductions are based on 5 GWh energy saving projects and an emission factor of 67 g/kWh.

Source: Own table.

Following from the above discussion on possible CDM projects, the issue of the applicable baseline scenario will be analysed next.

4 BASELINE SCENARIO

As discussed earlier, the CDM potential of the countries is low and the average project size small (Chapter 3). As there is a concern that transaction costs will be prohibitive for small projects (Michaelowa and Jotzo 2003), more clement rules have been decided for renewable energy projects below 15 MW installed capacity, energy efficiency projects that save less than 15 GWh per year and other projects that yearly directly emit less than 15,000 t CO_2. These simplified modalities were defined by the CDM Executive Board (UNFCCC 2004d).

The host country national electricity grid plays an important role and determines the baseline for all projects that can substitute, cut-off or reduce the electricity consumption supplied from the grid such as: grid connected renewable energy projects, power generation for self use to reduce electricity consumption from grid and electricity saving, efficiency or demand side management.

According to the baseline rules (§ 29), the baseline is the kWh produced by the renewable generation unit or saved (§ 36, 50, 59, 67) multiplied by the an emission coefficient (measured in kg CO_2 eq./kWh) calculated as the average of the "approximate operating margin" and the "build margin"[5] or the "weighted average emissions (in kg CO_2 eq./kWh) of the current generation mix."

The operating margin (OM) is derived in two steps:

(1) E (t CO_2/year) = $\Sigma_j E_J = \Sigma_j Q_j x\ F_j$.

Where: E_J is emissions per year in tons for fuel j,

5 The "approximate operating margin" is the weighted average emissions (in kg CO2 eq./kWh) of all generating sources serving the system, excluding, hydro, geothermal, wind, low-cost biomass, nuclear and solar generation. The "build margin" is the weighted average emissions (in kg CO_2 eq./kWh) of recent capacity additions to the system, which capacity additions are defined as the greater (in MWh) of most recent 20%5 of existing plants or the most recent plants.

Q_j is quantity of fuel j in year,

F_j is CO_2 emissions per unit of each fuel j,

(2) OM (t CO_2/MWh) = $\Sigma_j E_J \div \Sigma_j K_J$

Where K_j is electricity generation from fuel j.

The calculation of the build margin (BM) is given by the following formula:

$$BM(tCO_2/MWh) = \frac{\sum_{j}^{m} e_j.G_j}{\sum_{j}^{m} G_j} = \frac{e_1.G_1 + e_2G_2 + ... + e_m.G_m}{G_1 + G_2 + ... + G_m}$$

where:

G_j: the generation (MWh) from unit j,

E_j: the emission rate (in t CO_2/MWh) for unit j,

J: individual plants included among the selected representative set of plants,

For the assessment, we need the following data from the studied countries' grids:

- Weighted average emissions of all thermal power stations for the most recent year (OM),
- Generation of most recent 20% of existing plants,
- Generation of 5 most recent plants,
- Weighted average emissions of the higher of the two generation levels for the most recent year (BM), Weighted average emissions of all power stations (grid average, GA).

The aforementioned assessments require detailed information on all power stations serving national grids. As these information are not available for the studied countries, we will only assess the weighted average emissions of all power stations (GA), which requires less detailed information. However, such an assessment leads to a lower emissions factor compared to the combined margin[6] which uses detailed data (Michaelowa et al., 2004).

The results of the assessments in Benin are shown in table 17. The main fuel used for electricity generation is Oil as well as in the other case study countries.

In Benin, there are three interconnected electricity systems in the south, one system in the central area and two in the north (DGE-Benin, 2004). As detailed information on the electricity exchange between the southern grids are not available, for calculation simplification we consider them as one grid.

The baseline emissions are 201 g CO_2/kWh in the southern grid, and 749 g CO_2/kWh in Borgou and 874 in Atakora (the two northern grids). Due to hydroelectricity supply to the southern grid, the emission factor is lower than that of the northern grids.

6 The combined margin emission factor is the combination of the build margin and the operating margin (for more details see section on regional baseline 6.5).

Table 17: Baseline Benin - Weighted Grid Average 2003

Fuel Type		Southern Grid***	Northern Grid (Borgou)***	Northern Grid (Atakora)***
Hydropower generation	GWh	85	-	-
Electricity imports	GWh	-	-	-
Gas-oil and Oil 10310 kcal/kg IPCC* 20,1 TC/TJ IPCC Oil 9600 kcal/kg IPCC** 21,1 TC/TJ IPCC	GWh	35	29	9
	Kt C	7	6	2
	Kt CO_2	25	22	8
OM: Weighted thermal average, g CO_2/kWh		690	749	874
Total electricity supplied (GWh)		120	29	9
GA: Weighted grid average (g CO_2/kWh)		201	749	874

* Average net calorific value gas-oil and oil.
Fraction of carbon oxidised: oil and oil product: 0.99.
Energy content: Gas-oil: 43.33 TJ/103 t, Lubrifiant: 40.19 TJ/103.
** Average net calorific value oil.
*** Calculations based on average efficiency 38% (Southern Grid), 35% (Borgou); 30% Atakora and Oil used for electricity generation.
Source: Own table.

With respect to Burkina Faso, there are five electricity systems: Regional Load Center of Bobo Dioulasso (RLCB), Regional Load Centre of Ouagadougou (RLCO), Directorate-General of the Western Center (DRCO), Directorate-General of North (DRN), Directorate-General of the Eastern Center (DRCE) (World Bank, 2004). RLCB and RLCO are interconnected. However, detailed information on electricity exchange between them is not available. Hence, this research decided to consider both Bobo Dioulasso and Ougadougou as one system named “Bobo- Ouaga”. Therefore, emission factors for four systems are assessed as shown in table 18.

Due to hydroelectricity supply, the lowest baseline emissions factor is 592 g CO_2/kWh in Bobo-Ouaga’s grid, while that of the other grids are 764 g CO_2/kWh, 771 g CO_2/kWh, 936 g CO_2/kWh in DRCE, DRCO and DNR respectively.

Table 18: Baseline Burkina Faso - Weighted Grid Average 2003

Fuel Type		DRCE **	DRCO**	DRN**	Bobo-Ouaga**
		2003	2003	2003	2003
Hydropower generation	GWh	-	-	-	44
Electricity imports	GWh	-	-	-	-
Oil 9600 kcal/kg IPCC** 21,1 TC/TJ IPCC	GWh	99	15	12	265
	Kt C	21	2	3	48
	Kt CO_2	76	9	11	177
OM: Weighted thermal average, g CO_2/kWh		764	771	936	690
Total electricity supplied (GWh)		99	15	12	309
GA: Weighted grid average (g CO_2/kWh)		764	771	936	592

* Average net calorific value Gas-oil and oil; Fraction of carbon oxidised: oil and oil product: 0.99; Energy content: Gas-oil: 43.33 TJ/103 t; Lubrifiant, Fuel oil: 40.19 TJ/103
** Calculations are based on Fuel Oil; Efficiency: 36%; 34%;28%; 38%.
Source: World Bank (2004), IEPF (2004a, b).

As for Niger there are two systems, in the south and one in north. Results of the assessment are shown in table 19 below

Table 19: Baseline Niger - Weighted Grid Average 2003

Fuel Type		NIGELEC***	SONOCHAR***
		2003	2003
Hydropower generation	GWh	-	-
Electricity imports	GWh	-	-
Oil (Nigelec) 9600 kcal/kg IPCC* 20,1 TC/TJ IPCC Coal (Sonichar) 6667 kcal/kg IPCC** 28.8 TC/TJ - IPCC	GWh	45	153
	Kt C	9	42
	Kt CO_2	33	153
OM: Weighted thermal average, g CO_2/kWh		983	1252
Total electricity supplied (GWh)		45	153
GA: Weighted grid average (g CO_2/kWh)		983	1252

*Average net calorific value oil.
** Average net calorific value coal.
Energy content: Gas-oil: 43.33 TJ/103 t, Lubrifiant: 40.19 TJ/103
Energy content coal: 28.00 TJ//103 Fraction of carbon oxidised: oil and oil product: 0.99
*** Efficiency: 28% (NIGELEC); 30% (SONICHAR)
Source: Own table based on information from World Bank (2004), DGE-Niger (2004).

The baseline emission is 983 g CO_2/kWh in the southern system as there is no hydropower electricity generated locally. While in north's grid, due to coal use, emissions factor is around 1250 g CO_2/kWh.

As for Togo, there is one system in the south, one in the central area and one in the north. The southern and central systems are interconnected. However, details information on electricity exchange between both is not available. For simplification we consider both as one system and assess two baselines one in south and one in north. Results of the assessments are shown in table 20.

Table 20: Baseline Togo - Weighted Grid Average 2003

Fuel Type		**Southern Grid*** **	**Northern Grid*** **
		2003	2003
Hydropower Generation	GWh	155	-
Electricity imports	GWh	-	-
Gas-oil 10310 kcal/kg IPCC* 20,1 TC/TJ IPCC Oil 9600 kcal/kg IPCC** 21,1 TC/TJ IPCC	GWh	85	40
	Kt C	18	9
	Kt CO_2	67	33
OM: Weighted thermal average, g CO_2/kWh		786	823
Total electricity supplied (GWh)		240	40
GA: Weighted grid average (g CO_2/kWh)		278	823

*Average net calorific value gas-oil and oil.
** Average net calorific value Fuel Oil.
*** Calculation based on Fuel oil. Efficiency: 35% (Southern Grid); 32% (Northern Grid).
Fraction of carbon oxidised: oil and oil product: 0.99.
Energy content: Gas-oil: 43.33 TJ/103 t, Lubrifiant, Oil: 40.19 TJ/103.
Source: Own table based on information from World Bank (2004), DGE-Togo (2004)

Due to bcal hydroelectricity supply to the southern system, the baseline emissions factor is around 278 g CO_2/kWh compared to 823 g CO_2/kWh in the northern system.

As can be seen from the tables, emission factors are lower for grids which are supplied with hydropower electricity. However, the amount of CO_2 generated in each grid is not that high, as thermal electricity generations is very low. Consequently, countries will not have much CO_2 to reduce. Hence, transaction costs might be prohibitive for project development using new baseline methodologies.

An option to limit transaction costs for CDM project activities could be the use of the approved baseline methodologies by the CDM Executive Board.

Table 21 below shows the possible CDM projects and the applicable approved baseline methodologies.

The ACM0002 methodology is derived from eight different baseline methodologies for different renewable energy projects. It is applicable to grid-connected renewable power production project activities under conditions specified by the CDM Executive board (UNFCCC 2005a). An analysis of these conditions reveals that this methodology could be applied to hydroelectricity and wind projects. Moreover, the first condition to apply this methodology is the electricity capacity addition from renewable energy sources.[7]

Table 21: Applicable baseline methodologies

Project type	**Hydropower**	**Wind energy**	**Biomass energy**	**Energy efficiency in households**
Baseline methodology	ACM0002	ACM0002	ACM0006	Type II C

ACM = Approved Consolidated baseline Methodology.
Source: UNFCCC (2005a).

In the absence of the proposed renewable project activities, electricity is supplied from diesel power generators and electricity imports from Ghana, Ivory Coast and Nigeria.

As for biomass, the methodology ACM0006 could be used. The methodology is based on four methodologies for biomass-based electricity generation. In effect, this methodology covers different project types for power production using biomass residues such as the installation of a new biomass power generation plant at a site where currently no power generation occurs; or the installation of a new biomass power generation unit which is operated next to existing power generation capacity fired with

7 For more information, see http://cdm.unfccc.int/methodologies/Pamethodologies/approved.html

either fossil fuels or the same type of biomass residues as in the project plant (UNFCCC 2005a).[8]

In the absence of the proposed renewable project activities, electricity is supplied from diesel power generators and electricity import from Ghana, Ivory Coast and Nigeria. No electricity is generated from biomass.

As far as baseline methodology type II C is concerned, it deals with energy efficiency programmes for specific technologies. This category encompasses the adoption of energy efficient compact fluorescent (CFL) lamp, efficient refrigerators and air conditioners. The CFL will replace existing incandescent lamps of a similar lighting service. More efficient refrigerators and air conditioners will replace refrigerators and air conditioners of similar cooling service. Under these conditions, this methodology is applicable to the demand-side energy efficiency projects in administration buildings. In the absence of this project activity, incandescent bulbs as well as inefficient refrigerators and air conditioners will be used.

5 ADDITIONALITY

For each approved consolidated baseline methodology a tool to assess additionality is provided. Hence, for the demonstration and assessment of additionality, the project developers have to identify alternatives to the project activity, make an investment analysis to determine whether the proposed project activity is the most economically or financially attractive or a barrier analysis. Subsequently, a common practice analysis is required and the impact of registration of the proposed project activity as a CDM project activity has to be assessed (UNFCCC 2005b). As detailed information on the proposed projects is not available, only barrier analysis is discussed.

In fact, as far as the selected renewable CDM project activities are concerned, since the technologies involved are not locally available, they have to be imported. Moreover, the renewable technologies require high up-front investment which developing countries could not always provide. Hence, investment costs in energy projects are prohibitive to

8 For more information, see http://cdm.unfccc.int/methodologies/Pamethodologies/approved.html .

LDCs. Without CDM financing these projects might not take place. Therefore, the financial support of the CDM to these projects is additional.

As for energy efficiency projects, CFL and efficient refrigerators and air conditioners are more expensive and are currently not used in administration buildings. Their introduction would be different from the baseline scenario. In addition, the main issue is again higher investment needed for their introduction compared to the less efficient devices. These projects would be additional when the CDM makes their introduction possible, by financing part of the investment needed.

As far as prevailing practice is concerned, due to cost effective electricity supply in the neighbouring countries or in the sub-region, 80% to 95% of supplied electricity in the case study countries is imported (EIA 2003), preventing the introduction of technologies that would have improved the electricity supply from local energy sources.

With respect to investment barrier, there is no long term credit to finance high up-front cost of renewable energy projects. Most of the time, energy projects are financed through development programmes.

As far as institutional barrier is concerned, most of the energy generating utilities belong to the governments. There is no clear-cut regulatory framework. The willingness of the governments to implement CDM projects could lead to institutional changes to comply with the CDM requirements.

As for information barrier, potential private sector investors are not informed about CDM projects and the potential benefits from the renewable energy technologies. Moreover, there is limited public awareness on the benefits from using renewable energy. Hence, the selected projects could pass the additionality test.

In the practice of CDM projects, it has not been easy for project developers to prove the projects' additionality. This is due to the actual definition of additionality, which is the only guaranty that the CDM projects will bring about the expected positive effects (Michaelowa 2005). Based on the criticisms and suggestions on additionality, this issue is currently under discussion.

The baseline assessment presented in section 4 is only based on national electricity generation and supply. However, electricity exchange takes place between countries and influence grids' emissions factors. This leads to the assessment of the regional baseline. The next section assesses and analyses implications of the regional baseline to emissions factors in studied countries' grids.

6 REGIONAL BASELINE

6.1 Concept of regional baseline

In the discussion on baseline determination, one major issue was how to integrate into the CDM project electricity system, electricity import from another electricity system and electricity export to another system within the same country. In addition, the same issue was raised regarding electricity exchange between countries. The main issue here is, which emission factor should be used for the determination of the build margin and operating margin emission factor, necessary for the determination of the baseline emission factor. Should it be the emission factor of the exporting or importing electricity system?

To address these issues, the CDM Executive Board made a clear distinction between national system and international system. This leads to the notion of regional electricity system. The regional electricity system is the spatial extension of the power plants that can be dispatched without significant transmission constraints. The spatial extension of the power plant could include a connected electricity system at the national or international level. As for international system, the emission factor is zero for electricity import to the CDM project system if the exporting electricity system is located in another country (UNFCCC 2005a). As far as national system is concerned, the emission factor of the electricity imported to the CDM project system is the emission factor of the generating source if and only if this generating source is exactly known. If the generating source is not known, the emission factor of the exporting system is taken into account (UNFCCC 2005a). Of course, the consideration of the imported electricity with zero emission factor is penalising importing countries as the emission factor in turn is considerably reduced. This is the case in Benin, Niger and Togo, where the electricity import is more than 60% of own production (EIA 2003).

6.2 Assessment methodology

For the determination of the regional baseline, a combined margin (CM) is calculated consisting of the combination of operating margin (OM) and build margin (BM) emissions factors[9] (UNFCCC 2005a). The baseline methodology presented in section 4 differs from that presented here through the inclusion of imported electricity and the types of generation sources included into the generation mix.

Due to data unavailability, an assumption is made on a possible grid enlargement in Benin in order to assess the build margin emission factor. Benin is selected as example, as we know that the power authority has a power extension programme through gas power generation. Based on that, the combined margin is assessed to show the importance of detailed data on the generating systems.

For the calculation of the operating margin, four calculation methods[10] are proposed by the CDM Executive Board (UNFCCC, 2005a). Due to data unavailability in the case study countries, only method (d) is suitable. From these methods, OM emission factor is calculated as the average emission factor of all generating sources serving the system, including low-operating cost and must-run power plans.[11] The formula used for the calculation is presented below.

$EF_{OM} = \Sigma_{ij} F_{i,j,y} * COEF_{ij} ¸ \Sigma_j GEN_{jy}$

Where:

$F_{i,j,y}$ is the amount of fuel i (in mass or volume unit) consumed by relevant power sources j in year y.

---

9 For more details on regional baseline emission calculation method, see http://cdm.unfccc.int/methodologies/PAmethodologies/approved.html.

10 These methods are: (a) Simple OM, or (b) Simple adjusted OM, or (c) Dispatch Data Analysis OM, or (d) Average OM For more details see ACM0002 / version 04 (UNFCCC 2005a).

11 Low operating cost and must-run resources include hydro, geothermal, wind, low cost biomass, nuclear and solar generation. For more detailed, see:http://cdm.unfccc.int/methodologies/PAmethodologies/approved.html.

j refers to the power sources delivering electricity to the grid excluding low-operating cost and must-run power plants, and including import to the grid.

$COEF_{ij}$ is the CO_2 emission coefficient of fuel i (t CO_2/mass or volume unit of the fuel), taking into account the carbon content of the fuels used and the percent oxidation of the fuel in year (s) y, and

GEN_{jy} is the electricity (MWh) delivered to the grid by source j.

$COEF_i = NCV_i * EFco_{2i} * OXIDi$

Where NCV_i is the net calorific value (energy content) per mass or volume unit of a fuel i,

OXIDi is the oxidation factor of the fuel,

$EFco_{2i}$ is the CO_2 emission factor per unit of energy of the fuel i.

As for build margin emission factor $EF_{BM,y,}$ it is the generation-weighted average emission factor (t CO_2/MWh) of a sample of power plant m. The calculation is based on the following formula.

$EF_{BM,y} = \Sigma im\ F_{i,m,y} *COEF_{im} \div \Sigma m\ GEN_{my}$,

where:

$F_{i,m,y,}$ $COEF_{im}$ and GEN_{my} are analogous to the variables descried for the operating margin above the plants m.

Here again, the CDM Executive Board suggested two options on how to determine the BM (UNFCCC, 2005a). Option I calculates the BM emission factor ex-ante based on the most recent information available on the plant already built for the sample group m. Option II states that for the first crediting period, the BM emission factor must be updated annually ex-post for the year in which actual project generation and associated emissions reductions occur. Since emission factor update increases transaction costs to projects, and the countries' CDM potential is low, the research will adopt option I.

Moreover, the sample group m consists of either the five power plants that have been built most recently or the power plant capacity additions in the electricity system that comprise 20% of the system generation (in MWh) and have been built most recently. Since such detailed information on the generating utilities are not available in the case study countries, the research bases the determination of the BM emission factor on an hypothetical plant representing 20% of the generating capacity in Benin taken as example.

The combined margin CM is the weighted average of the Operating Margin emission factor ($EF_{OM,y}$) and the Build Margin emission factor ($EF_{BM,y}$) calculated as:

$$CM = EF_y \text{ (t } CO_2\text{/MWh)} = w_{OM} * EF_{OM,y} + w_{BM} * EF_{BM,y}$$

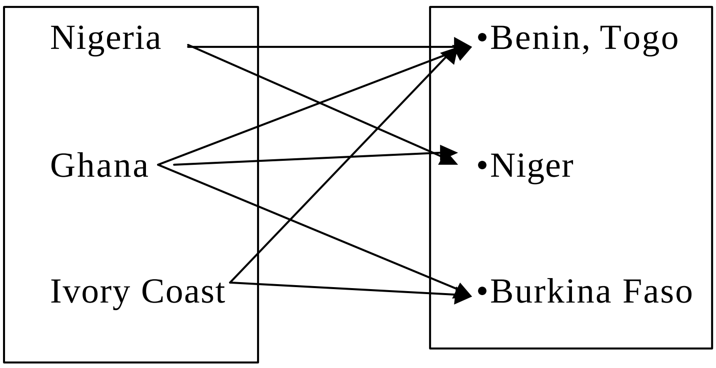
where the weights w_{OM} and $w_{BM,}$ by default, are 50% each.

The next section analyses the electricity exchange between the countries and thereafter, the regional baselines are assessed based on the aforementioned methodologies.

6.3 Analysis of electricity exchange between countries

In respect of the case study countries, the different electricity systems will be analysed and it will be shown to what extent the above presented regional notion could be applied. As discussed earlier, the strategy of the case study countries in facing the electricity supply challenge is to develop interconnections with neighbouring countries. Figure 1 below presents the electricity transfer between the countries.

Figure 1: electricity exchange between the case study countries



Source: Own figure.

Obviously, all the case study countries are net electricity import countries. Since they are experiencing electricity shortage and electricity demand is growing, it is not likely that these countries would export electricity in the short and medium terms. In addition, the interconnection projects between the case study countries intend to use the geographical position of some of them as transit countries, that is, there is no real electricity exchange between the countries.

An analysis of the electricity generation and distribution in the case study countries shows the following: In Benin, the three electricity systems in the south are interconnected. The electricity distribution is mainly based on hydroelectricity imports from Ghana, Ivory Coast and Nigeria. In case there is sufficient electricity imported, all thermal power plants would be closed down.[12] Taking into consideration electricity imports to the southern system, a regional baseline could be determined. The same reasoning is made in Burkina Faso, Niger and Togo where electricity imports supplied certain systems.

6.4 Regional baseline assessment

Based on the calculation method presented in section 4, the results of the assessments for the southern grid in Benin are summarised in tables 22 below. The data used for the calculations are presented in Appendix.

From table 22 it is obvious that the high imported electricity used for the calculation of the GA emission factor has considerably reduced the emission factor, decreasing from 690 g CO_2/kWh to 36 g CO_2/kWh. This in turn, will reduce the CDM project emissions reduction.

Note that hydropower generation is more than 15% of the electricity generation in the south system. Hence, it is included in the assessment of the regional baseline.

12 Actually, data on the real running time of the thermal power plants per year are not available

Table 22: Average operating margin in Benin (southern area) 2003

Fuel Type		
Hydropower Generation	GWh	85
Electricity imports	GWh	558
Gas-oil 10310 kcal/kg IPCC* 20.1 TC/TJ – IPCC Oil 9600 kcal/kg IPCC** 21,1 TC/TJ IPCC	GWh Kt C Kt CO_2	35 7 25
Weighted thermal average, g CO_2/kWh		690
Total electricity supplied (GWh)		678
Average Operating Margin (g CO_2/kWh)		36

* Average net calorific value gas-oil.
Fraction of carbon oxidised: oil and oil product: 0.99.
Energy content: Gas-oil: 43.33 GJ/t, Lubrifiant: 40.19 GJ/t.
** Average net calorific value Oil.
Source: Own table.

Due to the inclusion of electricity imports, average operating margin is around 82% lower than the weighted grid average calculated in section 4.

Let us now assume that the economic situation in exporting countries improves and electricity export towards Benin decreases[13]. It is likely that energy authorities in Benin will install new power plants. Benin is selected as example in order to show the importance of data quality. Let us assume that thermal electricity utilities are installed with a capacity of 20% of the current generation. As we do not have detailed information on extension programme of grids we assume that the plant will be fired by gas from the West African Pipeline project (the energy department in Benin is willing to install a 20 MW gas power plant). We assume gas power plants are more efficient, with efficiency around 46%. The expected annual generation will be about 142 GWh. Based on this information and calculation method explained earlier, the emission factor of the marginal power plant is about 488 g CO_2/kWh as shown in table 23 below. The commissioning of the new utilities will change totally the emission factor as shown in the determination of the combined margin.

Based on table 22 and table 23 the combined margin calculation gives:

13 This situation is likely to occur as we are already experiencing in Benin decreasing electricity import from Ghana due to development improvement and increasing drought (World Bank 2004b).

CM = 0.5*OM + 0.5*BM = 263g CO_2/kWh.

An analysis of the results leads us to conclude that the emission factor of the combined margin is around 20% higher than the emission factor of the weighted grid average (GA). In the absence of information on the build margin mix, the regional emission factor would be *36 g CO_2/kWh*. This result is important in the sense that it will change considerably the emissions reductions, carbon revenues and IRR to a given CDM project.

Table 23: Build margin in the southern area Benin 2005

Fuel Type		
Gas	GWh	142
8500 kcal/m3 IPCC*	Kt C	19
15.3 TC/TJ - IPCC	Kt CO_2	69
Total electricity generation in build margin (GWh)		142
Build margin, g CO_2/kWh		488

* Average net calorific value Gas.
Fraction of carbon oxidised: Gas = 0.99; Energy content: Gas : 48.15 GJ/t.
Lubrifiant: 40.19 GJ/t.

Source: Own table.

From this consideration, the research recommends that countries improve their data quality, so that their already low CDM potential is not reduced through incomplete calculation. The same reasoning could be made for all systems where, due to electricity import the emission factor is very low.

With respect to Burkina Faso, there are five electricity systems as discussed in section 4 In addition, electricity imports supply the Bobo-Ouaga system and hydroelectricity production is not dominating the system.[14] In this case, the methodology ACM0002 recommends abandoning the hydroelectricity production. Hence, taking the imports into consideration, a regional baseline emission factor is around 590 CO_2/kWh. Details on assessment are shown in table 24 below.

14 Hydroelectricity production is around 44 GWh compared to 265 GWh thermal production, i.e. 14% of local production.

Table 24: Regional baseline assessment in Burkina Faso (Bobo-Ouaga)

Fuel Type		2003
Hydropower production	GWh	44
Electricity imports	GWh	45
Gas-oil and Oil 10310 kcal/kg IPCC* 20.1 TC/TJ – IPCC Oil 9600 kcal/kg IPCC* 21,1 TC/TJ IPCC	GWh	265
	Kt C	48
	Kt CO_2	177
OM: Weighted thermal average, g CO_2/kWh		690
Total electricity supplied (GWh)		310**
Average Operating Margin (g CO_2/kwh)		590

*Average net calorific value Gas-oil and oil
Fraction of carbon oxidised: oil and oil product: 0.99
Energy content: Gas-oil: 43.33 TJ/103 t, Lubrifiant, Fuel Oil: 40.19 TJ/103
** 310 GWh represents total electricity without hydropower production
Source: Own table based on information from World Bank (2004), DGE-Burkina Faso (2004).

A far as Niger is concerned, there are two electricity systems: the Niger Company of coal (SONICHAR) in the north and Niger Electricity (NIGELEC) in the south

(HC/BK 2002). Assessment results are shown in table 25 below.

Table 25: Regional baseline assessment in Niger (NIGELEC)

Fuel Type		2003
Hydropower	GWh	-
Electricity imports	GWh	150
Gas-oil and Oil 10310 kcal/kg IPCC* 20.1 TC/TJ - IPCC	GWh	45
	Kt C	9
	Kt CO_2	33
OM: Weighted thermal average, g CO_2/kWh		983
Total electricity supplied (GWh)		195
Average Operating Margin (g CO_2/kwh)		227

*Average net calorific value gas-oil and oil
Fraction of carbon oxidised: oil and oil product: 0.99
Energy content: Gas-oil: 43.33 TJ/103 t, Lubrifiant: 40.19 TJ/103
Source: Own table based on information from World Bank (2004), DGE-Niger (2004).

As the two systems are not interconnected, electricity import from Nigeria supplements or supply only the southern system. Since there is no electricity exchange between the two systems, the baseline emission factor will be assessed separately for each system. Based on the electricity imports from Nigeria to the southern system, the regional concept could be applied. The assessment shows regional baseline emission factor around 227 g CO_2/kWh.

As for Togo, taking electricity imports to the south, a regional baseline could be calculated. The result of the assessment gives 115 CO_2/kWh. Details on assessment are shown in table 26.

Table 26: Regional baseline in Togo(southern area)

Fuel Type		2003
Hydropower	GWh	155
Electricity imports	GWh	341
Gas-oil 10310 kcal/kg IPCC* 20.1 TC/TJ - IPCC	GWh	85
	Kt C	18
	Kt CO_2	67
OM: Weighted thermal average, g CO_2/kWh		786
Total electricity supplied (GWh)		581
Average Operating Margin (g CO_2/kwh)		115

*Average net calorific value Gas-oil and oil
Fraction of carbon oxidised: oil and oil product: 0.99
Energy content: Gas-oil: 43.33 TJ/103 t, Lubrifiant: 40.19 TJ/103
Source: Own table based on information from World Bank (2004), DGE-Togo (2004)

7 POSSIBLE CDM CONTRIBUTION TO ENERGY PROJECTS

The CDM contribution to an energy project could be assessed from the economic, environmental and social aspects. In this section, only the financial contribution of the CDM projects under the economic aspect will be addressed. The other contributions will be addressed in the next section dealing with the contribution of the CDM to sustainable development.

In fact the financial contribution of the CDM to an energy project is measured in terms of the revenue from the CERs achieved during a crediting period. A crediting period could be either 10 years or 21 years.[15] As far as the crediting period for possible CDM projects in the case study countries is concerned, the study will use the crediting period of the already registered similar CDM projects.

15 A crediting period of 21 years is supplemented with a compulsory revision of the baseline and other related issues every 7 years (UNFCCC, paragraph 49 (a) and (b) of decision 17/CP7).

The actual CER price is fluctuating between 5 and 12 €/ton of CO_2 depending on project type (GTZ 2006, Newvalues 2006).[16] Due to the link of the CDM market to the EU Emission Trading System, CERs price is expected to climb (Point Carbon 2006). For the assessment of carbon revenues and economic calculation, the research will use a mean price of 9 €/CER.

In addition, the internal rate of return (IRR), which is an indication of whether a project is economically viable or not, will be used. Other financial parameters could have been used such as the net present value (NPV) or the pay back period (PBP). They are all accepted by the CDM Executive Board.

The discount rate used in the calculation of the IRR depends on different factors such as the risks in the project host country. Taking the different risks in to consideration, investors come up with a benchmark in each economic sector. In the absence of this benchmark in the case study countries, the research will only analyse the effect of the CERs revenues on the IRR. Hence, the IRR with and without CERs revenue will be compared. In fact, based on different inflows, different IRRs are calculated for the same project. An investor will decide in favour of a higher IRR. Hence, the financial impact of a CDM project will be assessed through its impact on the IRR.

Table 29 shows the variation of the IRR due to the CER revenues of two renewable energy projects. Only results for Benin are presented here.

The same reasoning can be made in other studied countries which results are similar. Changes in IRR are of the same order compared to Benin. The assessment of impacts of CER revenues on IRR is based on hypothetical hydro and biomass energy projects of 15 MW and 5 MW installed capacity respectively. Investment costs are based on cost of projects of similar size extracted from BMU (2005) and Czisch (2001). The investment plants are shown in tables 27 and 28 below.

16 CER prices depend on project category and the stage of the project in the CDM project cycle. - CER price: 4-6 Euro for medium-risk forwards, ~8 Euro for low-risk forwards, ~11-14 Euro for registered projects, around 15 Euro for Gold Standard registered projects, 15-17 Euro for issued CERs (GTZ 2006). For more information, see also: (http://www.community.newvalues.net) .

Table 27: Investment in a hydroelectricity project (15 MW)

Investment costs ('000 $):	16,450
Setting costs ('000 $	4,935
Subtotal ('000 $):	21,385
Operation Time (y):	21
Interest Rate:	12%
Capital Costs ('000 $/y):	2.828
Maintenance: 1.5% subtotal('000 $/y):	321
Total Costs ('000 $/y):	3,149

(Device type: Kaplan).

Source: own calculation based on information From: BMU (2005), El Bassam (2004).

Table 28: Investment in a modern biomass energy project (5 MW)

Investment costs ('000 $):	15,400
Setting costs ('000 $):	3,850
Subtotal ('000 $):	19,250
Operation Time (y):	21
Interest Rate:	12%
Capital Costs ('000 $ /y):	2,546
Maintenance: 4% subtotal ('000 $/y):	770
Total Costs ('000 $/y):	3,316

Source: own calculation based on information from: BMU (2005), El Bassam (2004).

In order to show the importance of emissions factors' size we used operating margin emissions factors (36 g CO_2/Kwh) and regional baseline (263 g CO_2/Kwh) for the southern grid, and the weighted average emissions factor around 749 g CO_2/Kwh in Borgou and 874 g CO_2/Kwh in Atakora, the northern grids.

Table 29 (see columns 2 and 5) presents the internal rate of return with and without carbon revenues. Column 3 shows carbon revenues. Due to carbon revenues, the IRR increases by 2.3% in northern system for the hydroelectricity project. As far as hydro electricity project in the south is concerned, the IRR changes by 0.1% when the weighted grid average is used. But when the combined margin emissions factor is used, the IRR increases by 0.6%. For the analysis of the biomass project in the southern grid, we only take into consideration the combined margin emissions factor, as the operating margin is very low.

Table 29: Impact of CERs revenues on the IRR based on $ 9/CERs

	IRR (without CER revenues)	CO_2 reduction (t/y)	Revenues from sales of CERs (US$ /y)	IRR (incl. CER revenues)	Electricity yield (MWh/y)
15 MW hydro electricity project Benin, Southern system (GA: 36 g CO_2/kWh)	40.3%	3,000	24,000	40.4%	74,625
15 MW hydro electricity Benin, Southern system (CM: 263 g CO_2/kWh)	40.3%	20,000	175,000	40.9%	74,625
15 MW hydro electricity Benin, Northern system (GA: 749 g CO_2/kWh) - Borgou's grid	40.3%	56,000	504,000	42.7%	74,625
15 MW hydro electricity Benin, Northern system (GA: 874 g CO_2/kWh) - Atakora's grid	40,3	63,000	564,000	43	74,625
Biomass energy project 5 MW installed capacity (CM: 263 g CO_2/kWh) - Southern grid	13.2%	9,000	82,000	13.8%	35,000
Biomass energy project 5 MW installed capacity (GA: 724 g CO_2/kWh) – Borgou's grid	13.2%	26,000	237,000	14.9%	35,000
Biomass energy project 5 MW installed capacity (GA: 724 g CO_2/kWh) – Atakora's grid	13.2	30,000	275,000	15.2	35,000

Estimates based on information from EIA (2003); Ministry of Energy Benin (2002), Ministry of Energy Burkina Faso (2003), Ministry of Energy Niger (2005), Ministry of Energy Togo (2003).
FLH: hydro = 5000h/y, Biomass = 7008h/y (Sutter 2003).
A crediting period of 21 years for hydro and 10 years for biomass is used.
Source: Own estimates.

The IRR in the biomass energy project increased of 0.6% in the southern case, while it increased by 1,7% and 2% in Borgou and Atakora respectively in northern cases (see table 30).

The analysis of changes in IRR revealed that, the higher the emission factor, the higher the change in IRR. This result shows the importance of baseline data quality which is a challenge in the studied countries. As northern grids have higher emission factors, projects in that region show higher increase in IRR compared to those of the south.

An investment decision is made if a high IRR can be achieved. Hence, the CERs revenues have increased the project's feasibility for hydroelectricity projects only for emission factors higher than the grid average emission factors in southern grids. As for biomass energy projects, the CERs revenues improved project feasibility, as we only use emission factors higher than grid average in southern grids. Whether the increase in IRR is sufficient is a different issue.

Table 30: Variations in IRR

	IRR (without CER revenues)	**IRR (incl. CER revenues)**	**% variation**
15 MW hydro electricity project Benin, Southern system (GA: 36 g CO_2/kWh)	40.3%	40.4%	0.1
15 MW hydro electricity Benin, Southern system (CM: 263 g CO_2/kWh)	40.3%	40.9%	0.6
15 MW hydro electricity Benin, Northern system (GA: 749 g CO_2/kWh) - Borgou's grid	40.3%	42.7%	2.4
15 MW hydro electricity Benin, Northern system (GA: 874 g CO_2/kWh) - Atakora's grid	40,3	43	2.7
Biomass energy project 5 MW installed capacity (CM: 263 g CO_2/kWh) - Southern grid	13.2%	13.8%	0.6
Biomass energy project 5 MW installed capacity (GA: 724 g CO_2/kWh) – Borgou's grid	13.2%	14.9%	1.7
Biomass energy project 5 MW installed capacity (GA: 724 g CO_2/kWh) – Atakora's grid	13.2	15.2	2

Source: Own estimates.

Furthermore, the financial contribution of a CDM project is not the only driving force to the CDM project investors. To attract CDM investment, equity capital has to be available. The decision to invest in a CDM project comes from the option to invest the equity capital in an environmental friendly technology, different from a business as usual. The CDM investment makes it feasible to invest in the non business as usual technology.

In the case study countries, the main issue is the unavailability of the equity capital. Let us illustrate this issue with the hydroelectricity project discussed previously. The same reasoning could be made for all renewable energy projects. In order to show the importance of emissions factors, we based calculations on combined margin emissions factor for the southern system (263g CO_2/Kwh) and the weighted grid average for the northern systems (874 g CO_2/kWh).

To install the hydroelectricity project, an equity capital of around US$ 21 million is required. In addition, an Operating and Maintenance (O&M) cost of US$ 321 thousand per year is needed. Investment costs amount to around US$ 3.15 million per year.

Let us assume that an alternative fossil fuel project which will generate the same amount of electricity as the hydro project per year requires a capital of around US$ 17 million.[17] Instead of investing in the fossil power plant, the country could decide to invest in the hydro power project, expecting the CERs revenues.

Based on the emission factor in the northern system, around 63,000 tCO_2 will be reduced per year, equivalent to 1.32 million t CO_2 over the 21 years crediting period. Using actual CERs price of US$ 9, the expected carbon revenue is around US$ 12 million[18] over the crediting period. The carbon revenue represents around 20% of the hydro investment cost per year. Obviously, investors will decide for the hydro energy project based on this high carbon revenue contribution. In addition, these US$ 12 million are the investment a CDM project investor will make.[19] If the southern combined margin emissions factor were used, 420,000 CERs over the 21 years of the crediting period would have been expected. Furthermore, the carbon revenue around 3.7 million over the crediting period would have made a contribution of around 5% of the investment costs per year. From what has been discussed so far, as the CDM is a market mechanism, one could imagine that CDM projects are specially developed in electricity systems or grids endowed with higher emission factors. Hence, applying the notion of regional baseline in the studied counties endowed with suppressed demand[20] is penalising and reduce their attractiveness in the international CDM market.

Actually, the CDM investors do not make any up front payment, but only pay for CERs issued. Hence, since equity capital is not available in the studied countries (World Bank 2004), it is unlikely that CDM projects of this type would take place. If the investment needed for the fossil power plant is not available, the CDM will not

---

17 This figure is extracted from the installation of a diesel power generator project of 14 MW in Burkina Faso (world Bank, 2004b).

18 This carbon revenue is not discounted. Less revenue should be expected when discount rate is taken into consideration.

19 Assuming a constant price of € 9 over the project crediting period.

provide it. In fact, the unavailability of the equity capital is linked to several risks such as market size, unclear legislation regarding the energy sector, currency issue, political instability, lack of skilled people, and revenue transfer issue. All these issues are known and have not been until now successfully addressed. It is not likely that the CDM will address them. Therefore, in such countries, it is questionable that the CDM, under its current definition, makes a contribution. However, as unilateral CDM projects are eligible, local investors who have another perception of risks may make equity capital available when information about CDM is well disseminated.

In the next section, the improvement of the regional electricity supply due to the CDM will be analysed.

8 IMPROVEMENT OF ELECTRICITY SUPPLY UNDER THE CDM PROJECTS

This section analyses the impact of the CDM projects on the electricity supply in the case study countries. In order to assess this impact, one needs to make it clear as to how the CDM would influence the electricity supply systems. A question to be answered here is whether the CDM has improved the electricity supply of the production systems, in other words, whether the CDM benefits have been a determinant in increasing the electricity supply in the countries. This impact could not be assessed directly but indirectly by analysing the impact of the CDM on the main barriers to electricity production in the case study countries. A positive contribution of the CDM will be concluded if the CDM helps to overcome the major hurdles to the electricity generation.

In fact, in the case study countries, the possible CDM projects selected were in the renewable energy and energy efficiency in households and public administration sectors. The main barriers to renewable energy and energy efficiency in the case study countries were presented in section 5. A removal of the aforementioned barriers would definitely lead to an improvement of the energy supply. 31 below summarises the impact of the CDM on the main barriers to the energy sector. In the table, (0) stands for "no effects" and (1) for "positive effects", (0.5) in case the effect is not obvious. An

20 Suppressed demand is used to characterise countries where electricity supply is lower than growing electricity demand. This is the case in most Least Developing Countries (SSN 2004).

overall positive contribution will be deduced when a positive mean value (1) is obtained. The CDM does not have any impact on three out of the five most important barriers to the energy sector. In addition, there is no clear positive impact for two barriers.

Regarding the financial barrier, the CDM would not be providing the investment equity, which is the most important issue in the case study countries. In the absence of this, no CDM project will take place. But a contribution of up to 20% in hydroelectricity projects is important. Since this contribution is not the same for all renewable projects, a clearly positive contribution could not be deduced.

Altogether, the barriers here are not CDM specific and the CDM does not have a positive impact on their removal. Hence, the energy supply will not change that much. Therefore the CDM has an overall limited contribution to the improvement of the energy supply in the sub-region.

Table 31: CDM impact on the barriers to the energy sector

Barriers	**CDM contribution**	**Comment**
Institutional barriers	0.5	Theoretically, CDM will not address the institutional barriers. Nonetheless, important CERs revenues expected could lead to an adaptation of the institutions so that the barriers are removed.
Information barriers	0	It is not the duty of the CDM to inform the public on the benefits of the renewable energy. Energy authorities at country level are supposed to do so.
Financial and technological cost barriers	0.5	Due to the limited CO_2 emission reductions in wind energy projects, CDM will not make any contribution. While for the hydro projects, CDM could make up to 52% of investment costs. In addition, CDM should lead to technology transfer and revenue from CERs sale will reduce technology costs.
Education and training barriers	0	CDM capacity building addresses only skills development regarding CDM project cycle.
Market and fiscal barriers	0	CDM will not have any impact on market and fiscal issues.
Total	0.2	No important contribution

Source: Own table.

9 CONCLUSION

From what has been discussed so far, there are currently some energy projects ongoing in case study countries countries. The size of these projects serves as a useful indicator in selecting possible CDM projects. Obviously it will be possible to implement small-scale projects in renewable energy and energy efficiency sectors. Hydroelectricity import in the countries has led to the assessment of regional baselines. The regional baseline has led to low emission factors for some electricity grids. In contrast to these grids, isolated grids have higher emission factors. With low emission factors, the CER revenues have a very low impact on the IRR. Similar result is obtained if the regional baseline were applied. For that reason, the study therefore suggests that small countries with suppressed demand are exempted from the use of the regional baseline emissions. Although the impact of CERs revenues on IRR is positive with higher emission factors, the CDM does not address major hurdles to energy sectors.

REFERENCES

BMU (2003):

Ecologically Optimized Extension of Renewable energy Utilization in Germany, German Federal Ministry for the Environment, Stuttgart

BMU (2005):

Leitfaden Bioenergie – Planung, Betrieb und Wirtschaftlichkeit von Bioenergieanlagen, Fachagentur Nachwachsende Rohstoff, Gülzow

CNEDD (2003):

Stratégie Nationale et Plan D'Actions sur les Energies Renouvelables – Document Final, Cabinet du Premier Ministre pour le Dévelopment – Conseil National de L'Environnement pour un Développement Durable and UNDP – FAO, Niamey

Czisch, Gregor (2001):

Global Renewable Energy Potential- Approaches to its Use, http://www.iset.uni-kassel.de/abt/w3-w/folien/magdeb030901/overview.htm (20.05.2006)

DGE-Benin (2000):

Energy Efficiency in Administration Buildings, Project Report, (Unpublisched)

DGE-Benin (2001):

Tableau de Bord de l'Energie, Direction Generale de L'Energie, Cotonou

DGE-Benin (2003; 2004):

Rapport D'activité 2001 et 2002 & 2003, Direction de l'Energie, Cotonou

DGE-Burkina Fasso (2003; 2004):

Rapport d'Activité 2001- 2002 – 2003, Direction de l'Energie, Ouagadougou

DGE-Niger (2004):

Rapport Rapport D'activité 2001 - 2002 & 2003 Direction de l'Energie, Niamey

DGE-Togo (2003; 2004):

Rapport D'activité 2001 – 2002 & 2004, Direction de l'Energie, Lomé

El Bassam, Nasir; Maegaard (2004):

Integrated Renewable Energy For Rural Communities – Planning Guidelines, Technologies and Applications, Elsevier B.V., Amsterdam

EIA (2003):

Country Analysis Briefs – Economic Community of West African States (ECOWAS), http://www.eia.doe.gov/emeu/cabs/ECOWAS/Electricity.html (10.06.2004)

FAO (2004):

FAO Database Collections FAOSTAT 2004, last updated February 2004

GTZ (2006):

CDM Highlights 37, http://www.gtz.de/de/dokumente/en-climate-cdm-highlights-06-06.pdf (08.07.2006)

IEPF (2004a):

Mécanisme pour un Developpement Propre (MDP) et Francophonies – Fiche MDP,

http://www.iepf.org/recherche/resultat.asp?p=../docs/publication/contenu/g.%20initiative%20francophone%20mdp/atelier6-initiative%20franco.ppt (25-03.2006)

IEPF (2004b):

Energie dans le Monde – Profils energétiques, Benin – Burkina Faso – Niger – Togo,
http://www.iepf.org/recherche/resultat.asp?p=../docs/hydro_quebec/franco_bdem.html, http://www.iepf.org/recherche/resultat.asp?p=../docs/profils2001exl/ben.pdf,
http://www.iepf.org/recherche/resultat.asp?p=../docs/profils2001exl/bfa.pdf,
http://www.iepf.org/recherche/resultat.asp?p=../docs/profils2001exl/ner.pd,
http://www.iepf.org/recherche/resultat.asp?p=../docs/profils2001exl/tgo.pdf
(25.03.2006)

Kammem, Daniel M.; Lew, Debra (2005):

Renewable and Appropriate Energy Laboratory Report – Review of Technologies for The Production and Use of Charcoal, Energy and Resouce Group & Goldman School of Public Policy, University of California, Berkeley

Michaelowa, Axel; Jotzo, Frank (2003):

Impacts of Transaction Costs and Institutional Rigidities on the Share of the Clean Development Mechanism in the Global Greenhouse Gas Market, Rostock

Michaelowa, Axel; Butzengeiger, Sonja; Krey, Matthias (2004):

Clean Development Mechanism and Joint Implementation. New Instrument for Financing Renewable Energy Technologies, Thematic Background Paper Renewables 2004, Secretariat for the International Conference for Renewable Energies, Bonn

Michaelowa, Axel (2005):

CDM Current Status and Possibilities for Reform, HWWI Research Paper 3, Hamburg.

Ministry of Mines, Energy and Water Benin (2002):

Tableau de Board de L'energy 2001, Direction de l'Energy, Cotonou

Ministry of Energy Burkina Faso (2003):

Rapport Dactivité 2001, 2002, 2003, Direction de L'energie, Ouagadoudou

Ministry of Energy Togo (2003):

Rapport d'Activité 2001, 2002, Direction de l'Energie, Lomé

New Values (2006):

ACX-Change & New Values Fourth CER auction shows significant Improvement in prices being bid for CERs, http://newvalues.blutarsky.nl/downloads/NV_20060221_Pressrelease_CERAuction_Feb_16_Final.pdf (15.05.2006)

Point Carbon (2002):

Is There a Business case for Small-scale CDM Project?, Carbon Market Analyst, December 2002

SouthSouthNorth (2004):

SouthSouthNorth CDM Toolkit. Module 1, SouthSouthNorth, Cape Town

Sutter, Christoph (2003):

Sustainability Check-up for CDM Projects, Wissenschaftlicher Verlag, Berlin

United Nations (2005):

The Energy Challenge for Achieving the Millenium Development Goals, United Nations, Addis Ababa, http://esa.un.org/un-energy/pdf/UN-ENRG%20paper.pdf (25:05:20069

United Nations (2002):

Millenium Declaration, United Nations, New York

United Nations (2005):

The Millenium Development Goals Report 2005, United Nations, New York, http://unstats.un.org/unsd/mi/mi_worldmillennium_new.asp (15.05.2006)

UNFCCC (1997):

Report of the Conference of the Parties on its Third Session, held at Kyoto From 1 to 11 December 1997. FCCC/CP/1997/7/Add.1. United Nations Framework Convention on Climate Change, Kyoto

UNFCCC (2005a):

Approved Consolidated Baseline Methodology ACM0002, 'Grid-Connected Electricity Generation From Renewable Sources', Version 2, cdm.unfccc.int/EB/015/eb15repan2.pdf

UNFCCC (2005b):

Tool for The Demonstration and Assessment of Additionality, http://cdm.unfccc.int/methodologies/Pamethodologies/AdditionalityTools/Additionality_tool.pdf

USAID (2003):

West African Power Pool (WAPP) Just a Matter of Time?, http://lasen.epfl.ch/webdav/site/lasen/shared/import/migration/Zakharov.pdf, (25.03.2005)

WAEMU (2005):

Politique régionale de la CEDEAO et de l'UEMOA pour atteindre les Objectifs du Millénaire pour le Développement, http://www.energie-omd.org/IMG/pdf/cedeao-monographie_benin.pdf

(25.03.2006)

http://www.energie-omd.org/IMG/pdf/cedeao-monographie_burkina.pdf (25.03.2006)

http://www.energie-omd.org/IMG/pdf/cedeao-monographie_togo.pdf (25.03.2006)

http://www.energie-omd.org/rubrique.php3?id_rubrique=18 (25.03.2006)

World Bank (1992):

CO_2 Emissions by Residential Sector: Environmental Implications of Inter-Fuel Substitution, World Bank Energy Series Paper 51, Washington D.C.

World Bank (2004):

Energy Services Delivery Project in Support of The First Phase of The Energy Services Delivery Program, Report No: 29092-BJ, World Bank, Washington DC

World Bank (2005):

World Development Report, World Bank, Washington D.C.

Wiesmann, Urs (1998):

Sustainable Regional Development in Rural Africa: Conceptual framework and case studies from Kenya, Geographica Bernensia – Africa Studies, Bern

APPENDIX:

Table 1: Electricity consumption in Benin 2003

Grid designation	Thermal generation (GWh)	Hydroelectri-city generation (GWh)	Electricity Import (GWh)
South system	35	85	513
Centre System	0,2	-	-
North-east system	29	-	-
North-west system	9	-	-

Source: World Bank (2004); DGE-Benin (2004); USAID (2003), EIA (2003).

Table 2: Gas-oil consumption in Benin 1994-2003, 103 Kg

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Atlanti-que 1	263	485	269	516	2,511	3,000	3,626	3,711	967	4580
Atlanti-que 2	13	-	-	-	-	-	-	-	-	-
Ouéme	68	20	32	44	56	250	184	284	22	-
Mono	1	-	-	-	-	-	-	-	-	-
Zou	2,376	501	588	427	380	20	2	2	2	42
Borgou	2,684	3,099	3,538	3,904	4,290	4,697	5,210	6,232	6,982	7,329
Atacora	1,014	1,126	1,282	1,078	1,063	1,106	1,362	1,669	1,926	2,046
Total	6,156	5,925	5,709	5,969	8,300	9073	10,384	11,898	9,899	13,997

Source: DGE-Benin, 2004

Table 3: Total fossil fuel consumption 103 Kg

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Total consumption	6,156	5,925	5,709	5,969	8,300	9073	10,384	11,898	9,899	13,997

Table 4: Electricity consumption in Burkina Faso 2003

Grid designation	Thermal generation (GWh)	Hydroelectri-city generation (GWh)	Electricity Import (GWh)	Average plant efficiency (%)
CRCO (Ouaga/Saaba)	265	44	45	35
CRCB (Bobo)	50	44	50,6	35
DRCO	14	7	15.4	38
DRN	12	2.6	-	40
DRCE	99	-	-	33

Source: World Bank (2004); DGE-Burkina Faso (2004); USAID (2003), EIA (2003).

Table 5: Electricity consumption in Niger 2003

Grid designation	Thermal generation (GWh)	Hydroelectricity generation (GWh)	Electricity Import (GWh)	Average plant efficiency (%)
SONICHAR	153	-	-	-
NIGELEC	45	-	150	-

Source: World Bank (2004); DGE-Niger (2004); USAID (2003), EIA (2003).

Table 6: Electricity consumption in Togo 2003

Grid designation	Thermal generation (GWh)	Hydroelectricity generation (GWh)	Electricity Import (GWh)	Average plant efficiency (%)
Southern Grid	85	140	341	-
Northern Grid	40	-	-	-

Source: World Bank (2004); DGE-Togo (2004); USAID (2003); EIA (2003).