



Feasibility Study for Development of a Regional Grid Emission Factor for the West African Power Pool (WAPP) as a Standardised Baseline

Final Version

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All data in the study have been updated to the best of the consortium's knowledge as of 9 December, 2014.

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Acronyms

ACAD	African Carbon Asset Development
CDM	Clean Development Mechanism
CDM EB	CDM Executive Board
CLSG	Côte d'Ivoire, Liberia, Sierra Leone and Guinea interconnection
CO ₂	Carbon Dioxide
DNA	Designated National Authority
ECOWAS	Economic Community of West African States
ECREEE	ECOWAS Regional Centre for Renewable Energy and Energy Efficiency
ERERA	ECOWAS Regional Electricity Regulatory Authority
EREI	ECOWAS Renewable Energy Investment Initiative
GEF	Grid Emission Factor
GHG	Greenhouse Gas
GWh	Gigawatt-hours
IRENA	International Renewable Energy Agency
LC:MR	Low-Cost / Must-Run
LDC	Least Developed Countries
MW	Mega-watts
NAMA	Nationally Appropriate Mitigation Action
OMVG	Gambia River Basin Development Organization
OMVS	Senegal River Basin Development Organization
PIN	Project Idea Note
RCC	Regional Collaboration Centre of the UNFCCC
SAPP	South African Power Pool
SBL	Standardised Baseline
SIDS	Small Island Developing States
UNFCCC	United Nations Framework Convention on Climate Change
WAPP	West African Power Pool
WAPP JIC	West African Power Pool Joint Implementation Committee



Executive Summary

The assignment offers recommendations for the development of a regional Grid Emission Factor (GEF) for the West African Power Pool (WAPP) as a Standardised Baseline (SBL). The Standardised Baseline provides the value of the CO₂ emission factor for the interconnected electricity system of the WAPP and it is applicable to the group of countries connected to the WAPP. The SBL in the context of renewable energy and energy efficiency carbon projects is a vital tool towards reduction of transaction costs and improving the project implementation pace.

This study suggests options for the calculation of a regional GEF for the WAPP region as a SBL. This is done by examining the extent of the electricity systems across the national boundaries in the WAPP as well as assessing the current structure and the technical features of the interconnected transmission lines.

The “Tool to calculate the emission factor for an electricity system” (version 4.0)¹ provides guidance on how to perform the GEF calculation. The tool is also applicable for the calculation of a regional GEF.² The application of this approved tool is recommended by the Executive Board of the UNFCCC and is the most common/widely used methodological tool for the calculation of the GEF under different carbon schemes.

Not all the countries in the WAPP region are equally prepared for the development of a regional GEF as standardised baseline. The level of GEF “standardised baseline readiness” is mainly defined by whether all these countries meet the technical and applicability criteria under the approved tool (e.g. their electricity networks shall be checked against any transmission constraints). Lack of reliable up-to-date grid data/information among WAPP member states remains one of the main challenges, also when it comes to analysis of prospective interconnections and dynamics of the WAPP as a whole.

The preliminary WAPP GEF value calculated at 0.60 tCO₂/MWh¹⁴ (0.588~0.620 tCO₂/MWh depending on project type and crediting period) lies moderate among WAPP members’ GEFs (Table 3).

The report also elaborates on why the inclusion of off-grid decentralised power units in the WAPP GEF calculation as a SBL is not a viable option under the current circumstances. This study offers two main options for the development of GEF in the WAPP region; which can be implemented in parallel:

1. Calculation of a regional WAPP GEF as a SBL: Nine countries were found to qualify for a grouped WAPP GEF standardised baseline development: Nigeria, Ghana, Cote d’Ivoire, Togo&Benin, Burkina Faso, Niger, Mali and Senegal. These countries were found to be interconnected within the WAPP without any transmission constraints. Despite some inconsistencies and incompleteness, sufficient grid data and detail information on WAPP connected power plants were available for the WAPP GEF calculation.³
2. Calculation of GEFs as national GEFs: for countries not yet integrated into the interconnected WAPP network including: Liberia, Sierra Leone, Guinea, Guinea Bissau and the Gambia. Since these countries

¹ “Tool to calculate the emission factor for an electricity system” (version 4.0)

² The example is the [South African Power Pool GEF as a Standardized Baseline](#) approved on 31 May 2013 by UNFCCC

³ To facilitate data collection the consortium introduced a data form template that lists specific data needs for the establishment of the WAPP GEF as standardised baseline as well as country specific GEFs.



do not meet the requirements to be included for a regional WAPP GEF calculation, they may be considered to have their national GEFs updated using the latest available grid data.

Chapters' quick guide

This report starts with an introduction to this assignment and background information on the WAPP network and power statistics in the WAPP region (Chapter 1). Chapter 2 is an introduction to the methodological choice for the calculation of the WAPP GEF as a SBL.

Chapter 3 introduces the WAPP member states' national grids and their most recent GEF. The chapter includes an approximate estimation of the future WAPP GEF and explanation of what this means for the WAPP member states. Chapter 4 includes an elaboration of the WAPP network extension and identification of the qualified countries to be included in the WAPP GEF determination as a SBL. The chapter also contains an analysis on the existence of any transmission constraints within the WAPP interconnection network.

Chapter 5 investigates the inclusion of off-grid systems in the GEF calculations and chapter 6 offers options for the GEF development in the WAPP region based on the previous chapters' discussions. Overall conclusions and recommendations are presented in Chapter 7. Finally Chapter 8 proposes an outline for further capacity building in the context of WAPP GEF as a SBL.



1 Background

The assignment is carried out under the methodology development support component of the African Carbon Asset Development (ACAD) Facility in collaboration with the UNEP DTU Partnership. The ACAD Facility aims to incentivise development of low carbon energy projects under the Clean Development Mechanism (CDM) in Africa by facilitating their access to finance. The main purpose of this assignment is to develop a regional GEF for the West African Power Pool (WAPP) that can be adopted by the United Nations Framework Convention on Climate Change (UNFCCC) as a Standardised Baseline (SBL) for the CDM or other carbon schemes. The Standardised Baseline (SBL) provides the value of the CO₂ emission factor for the interconnected electricity system of the WAPP and it is applicable to the group of countries connected to the WAPP. The SBL in the context of renewable energy and energy efficiency carbon projects is a vital tool towards reduction of transaction costs and improving the project implementation pace.

The ACAD Facility's overarching objective is to enhance the viability of low carbon development projects in sub-Saharan Africa by facilitating demonstration projects and providing key stakeholders with targeted technical support. The ACAD Facility was launched in 2009 and has entered into its second phase, which is aimed to be completed in 2014. ACAD successfully supported the development of a regional GEF for the Southern Africa Power Pool (SAPP) during its initial phase of implementation. This was subsequently adopted as one of the first SBLs by the CDM Executive Board (CDM EB) of the UNFCCC in May 2013.



Figure 1. Grid extension of the WAPP⁴

⁴ WAPP (2011) HV Transition networks and prospective interconnection projects. For a larger file version, please visit: http://www.ecowapp.org/?dl_id=452

WAPP Secretariat⁵

The WAPP Organisation is a specialized institution of the Economic Commission of West African States (ECOWAS) created in 1999 and its Secretariat established in 2006 to serve as a vehicle to develop the required transmission and generation infrastructure with a view to establishing a regional electricity market to provide competitive and reliable supply of electricity to member states.⁶

The organisational structure of WAPP is presented in Figure 2.

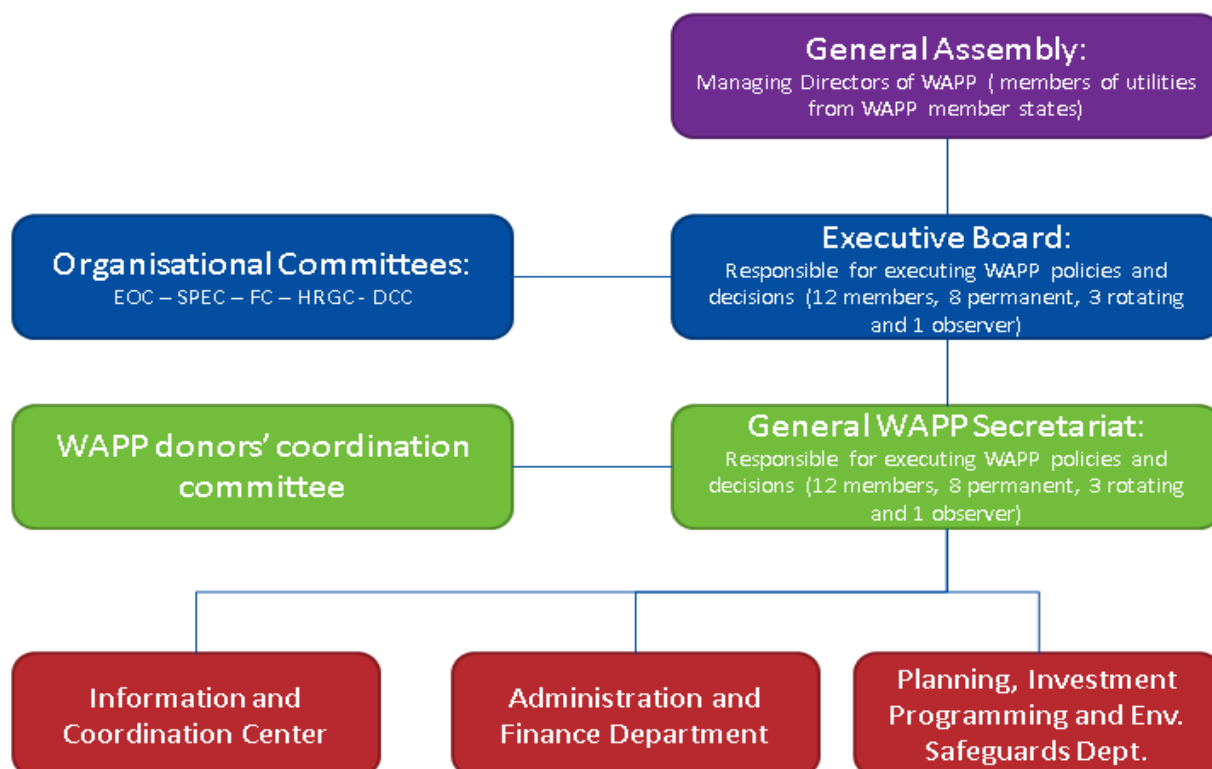


Figure 2. Organisational structure of the WAPP⁷

⁵ After the assignment was awarded to the consortium, the consultants paid a visit to the WAPP Secretariat in Cotonou, Benin, on 27-28 February 2014. Two meetings (eight hours in total) were held between the consultants (consisting of Bamshad Houshyani from Climate Focus and Alexandre Dunod from Ecosur Afrique) and Cisse Mustapha from the WAPP Secretariat, Mr. Houessou Chairman of Strategic Planning and Environment Committee (SPEC) of WAPP and Mr. Momodou A.K. Njie, the director of Planning, Investment, Programming and Environmental Safeguards of WAPP. During the meetings the consultants introduced the assignment and its objectives from the perspective of carbon development, specifically focusing on CDM and GEF Standardised Baselines. The consultants then elaborated the data/information needs on existing and planned interconnected transmission lines from the WAPP Secretariat as well as data/information on national grids from the WAPP member states. The WAPP Secretariat presented the existing and ongoing interconnected transmission lines and agreed to assist the consultants in providing necessary data/information both on WAPP Secretariat and national grid utility levels in order to facilitate the drafting of the feasibility study and further GEF calculations.

⁶ Update of the ECOWAS revised Master Plan for the Generation and Transmission of Electrical Energy, 2011, Final report Vol. 4

⁷ The WAPP Organizational Committees comprise the Engineering and Operating Committee (EOC), the Strategic Planning and Environmental Committee (SPEC), the Finance Committee (FC), the Human Resources and Governance Committee (HRGC) and the Distribution and Commercialization Committee (DCC).



WAPP power network

The WAPP covers fourteen countries: Benin, Burkina Faso, Côte d'Ivoire, Gambia, Ghana, Guinea, Guinea Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone and Togo. Its members include public and private power generation, transmission and distribution companies involved in the operations of the electric power network system in West Africa (see Figure 1). The existing power generation capacity and fuel split within the WAPP members is shown in Table 1.

Table 1. Generating (available) capacity (MW) within the WAPP members⁸

Country	Oil	Coal	Gas	Hydro	Total
Burkina Faso	146	0	0	23	169
Cote d'Ivoire	0	0	765	585	1,350
Gambia	49	0	0	0	49
Ghana	700	0	180	1,380	2,260
Guinea	19	0	0	95	114
Guinea-Bissau	4	0	0	0	4
Liberia	13	0	0	0	13
Mali	114	0	20	153	287
Niger	15	32	20	0	67
Nigeria	0	0	3,858	1,358	5,216
Senegal	395	0	49	68	512
Sierra Leone	44	0	0	56	100
Togo/Benin	57	0	0	65	122
Total	1,410	32	4,892	3,760	10,094

WAPP and renewables

ECOWAS Regional Centre for Renewable Energy and Energy Efficiency (ECREEE) has established the ECOWAS Renewable Energy Investment Initiative (EREI) to facilitate and provide support to medium- and large-scale renewable energy projects in the region. The initiative has already attracted a number of renewable energy projects that are currently in development across all of the ECOWAS countries, and covering a range of technologies. Figure 3 below demonstrates the capacities of identified renewable energy projects within the WAPP that are either under development or at feasibility study stage. Together, the projects have a total power capacity of 552 MW, with a combined greenhouse gas (GHG) mitigation potential of 19 MtCO₂.

⁸ [WAPP: Planning and Prospects for Renewable Energy, IRENA 2013](#), updated from WAPP members' comments when received

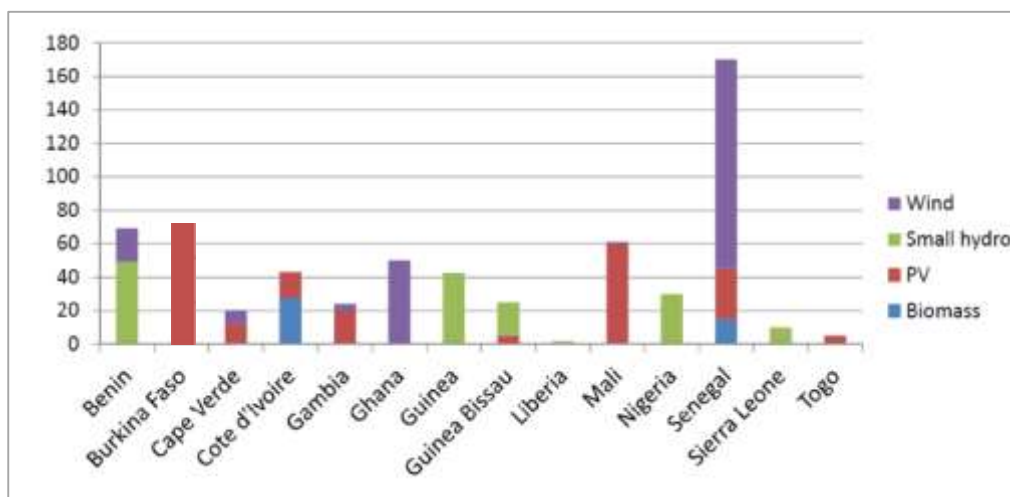


Figure 3. Identified renewable energy projects in the WAPP, vertical axis in MW (under development or in feasibility study stage)

Future transition

The ECOWAS Revised Master Plan for the Generation and Transmission of Electrical Energy⁹ concludes that power generation within the WAPP will evolve towards a generation mix that integrates more and more cleaner and renewable sources of energy. The share of renewables within the WAPP network is of an importance factor, considering the region's aim at interconnecting the isolated countries and zones that presently produce a significant share of their power through diesel generators.

It will become more feasible to integrate large renewable energy projects within the WAPP considering the planned interconnection projects, where without interconnected power transmission lines renewable energy projects may often be too large for one isolated country or zone due to financial and technical constraints. The reference scenario shows that by 2025 power share from hydropower and natural gas fuelled plants reach 30% and 60% respectively. The remaining 10% are produced from other sources such as coal or diesel, but also from renewables (Figure 4).

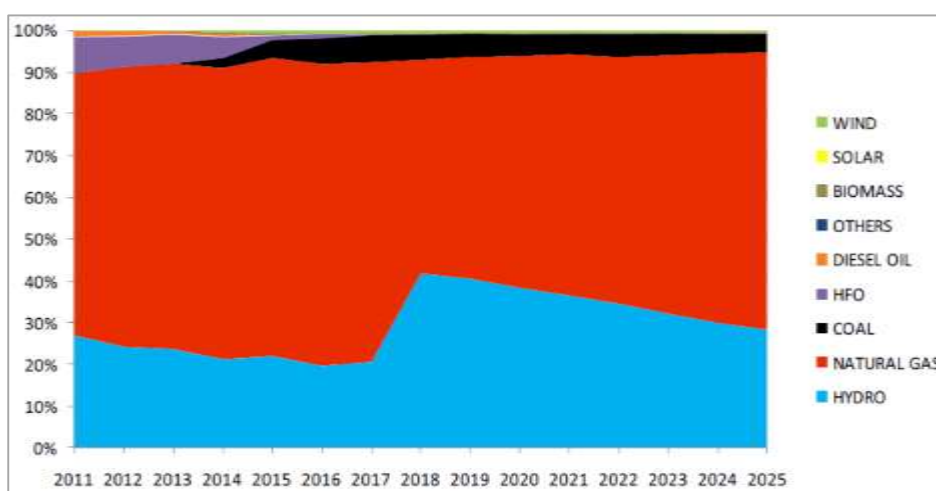


Figure 4. Energy mix in terms of produced energy in the ECOWAS region (reference scenario)

⁹ [ECOWAS Revised Master Plan documentation](#)



In the renewable policy scenario, that is a voluntary development of renewable energy, an objective of 10% renewable energy by 2020 is considered as an ambitious but realistic target (Figure 5). Based on this scenario, some renewable energy projects have been considered as regional priority projects. The Master Plan also strongly recommends developing other renewable projects at national level especially in countries with high solar, wind or biomass potential.

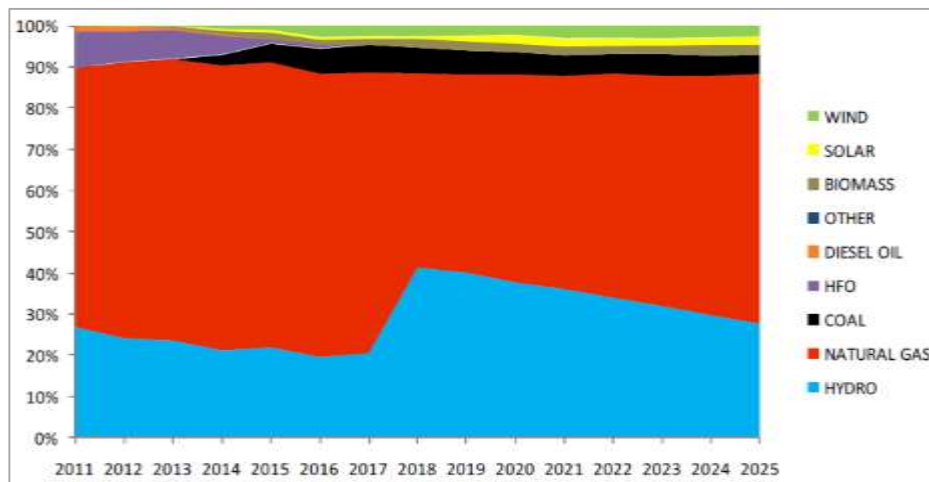


Figure 5. Energy mix in terms of produced energy in the ECOWAS region (renewable policy scenario)



2 GEF Methodology

The main purpose of this assignment is to develop a regional GEF for the West African Power Pool that can be adopted by the UNFCCC as a Standardised Baseline for the CDM, climate finance, NAMAs and other emerging schemes. A SBL can be developed on the basis of either an approved or a newly submitted methodology and an approved tool “*Tool to calculate the emission factor for an electricity system*” (version 4.0)¹, or on the basis of the *Guidelines for the Establishment of a sector specific standardized baselines*.¹⁰ The main difference between the above approaches is that the tool offers a methodology specifically designed for the power sector and widely used by non-Annex I countries for the calculation of the GEF, including the regional GEF for the South African Power Pool (SAPP) adopted as a SBL, while the *Guidelines* offers a generic methodology applicable to many sectors.

Substantial data and information both on the technical and commercial ground is needed to use the *Guidelines* approach for calculating the GEF. Besides, with the current approach and default benchmarks defined within the *Guidelines* it is likely that the baseline for the grid connected electricity is determined as gas fired power plant which results in a low GEF (+/- 0.35 tCO₂/MWh). In a meeting with UNEP, UNEP DTU Partnership, the UNFCCC CDM Secretariat and some West African states’ DNAs in Bonn¹¹, the CDM Secretariat informed the consultants that the *Guidelines* will be updated in the coming months and may offer an alternative approach for calculating the GEF as a SBL. The CDM Secretariat was of the opinion that for the time being the UNFCCC approved methodological procedures outlined in the “*Tool to calculate the emission factor for an electricity system*” is an appropriate way forward in this assignment. Under this tool the calculation of the GEF is carried out through a six step process as follows:

- Step 1: Identify the relevant electricity systems;
- Step 2: Choose whether to include off-grid power plants in the project electricity system;
- Step 3: Select a method to determine the operating margin (OM);
- Step 4: Calculate the operating margin emission factor according to the selected method;
- Step 5: Calculate the build margin (BM) emission factor;
- Step 6: Calculate the combined margin (CM) emission factor.

The present feasibility study contains data, information and analysis to cover Step 1 (in chapters: “National grids and GEF” and “WAPP grid and inter-connections”) and Step 2 (in chapter “Off-grid inclusion in GEF”) of the above process. This includes a technical assessment on whether the WAPP power network meets the required criteria under the approved tool (e.g. the transmission constraint check). For the accomplishment of Steps 3-6 the main activities are country specific grid data and information collection and the calculation of GEF; that has been accomplished in parallel to this study.

The application of the tool¹ including the above mentioned procedures will be fully elaborated once the WAPP GEF is developed as a SBL and will be documented in a separate report.

It is also noteworthy to mention that the application of a GEF as a SBL may become compulsory once approved by all the DNAs of the involved host countries. This means that the application of a WAPP GEF as a SBL may have priority on nationally approved GEFs. The same occurred when the South African Power Pool (SAPP) GEF was approved by the UNFCCC. At the moment there is no clear guidance on the topic thus it is advisable to follow the upcoming decisions on SBL closely.

¹⁰ [Guidelines for the establishment of sector specific Standardized Baseline, Version 02.0](#)

¹¹ In a meeting organised by the UNEP, UNEP DTU Partnership and the UNFCCC CDM Secretariat in Bonn on 6 June 2014 the result of the current feasibility study was presented to some West African states’ DNAs.



3 National grids and GEF

The WAPP consists of several national electricity grid networks that are either inter-connected, have ongoing inter-connection projects or have future plans for the development of connections. WAPP members' grid information, including the countries' power sector specifications, are presented in Appendix 3. The most recent operational statistics of the WAPP member states' grid systems are shown in Table 2.

Table 2. Overview of Power Systems Operations of WAPP members, sorted by Total Energy Generated (2013)¹²

COUNTRY	INSTALLED CAPACITY (MW)	AVAILABLE CAPACITY (MW)	ENERGY IMPORTED (GWh)	ENERGY EXPORTED (GWh)	PEAK LOAD (MW)	ENERGY GENERATED (RENEWABLES) GWh (SHARE TO TOTAL %)	ENERGY GENERATED (THERMAL) GWh	TOTAL ENERGY GENERATED (GWh)
Nigeria	10,915	5,061	0	1,789	4,458	6,101 (20%)	23,358	29,459
Ghana	2,814	2,185	120	653	1,943	8,232 (63%)*	4,635	12,867
Cote d'Ivoire	1,632	1,195	32	825	1,077	1,606 (21%)	5,965	7,570
Senegal	683	468	308	0	471	0 (0%)	2,592	2,592
Burkina Faso	219	135	482	0	200	106 (16%)	550	655
Guinea	203	109	0	0	162	482 (73%)*	171	654
Mali	220	86	597	213	228	225 (43%)	295	519
Niger	164	138	602	4	160	0 (0%)	397	397
Benin/ Togo	205	134	1,935	2	370	72 (22%)	252	326
Gambia	100	39	0	0	45	0 (0%)	228	228
Guinea Bissau	No Data	No Data	No Data	No Data	No Data	6 (8%)	68	74
Sierra Leone	No Data	No Data	No Data	No Data	No Data	104 (62%)*	No Data	167
Liberia	No Data	No Data	No Data	No Data	No Data	0 (0%)	55	55

* The red figure in the parenthesis is when the Low Cost Must Run power plants' share in total power generation is above 50%. This means that they cannot use the Simple OM method when calculating the Operating Margin Emission Factor according to the tool.

The above table clarifies the role of Nigeria as the largest power producer within the WAPP region. It is both the main energy producing country and the largest exporter of energy. Table 2 further reveals that Guinea and Ghana have the largest share in hydropower production (73% and 63%) compared to other WAPP member states; this also explains Ghana's relatively low GEF. Niger, Burkina Faso and Senegal import their deficiency, while Mali has to cope with a shortage in energy supply.

¹² WAPP/EEEOA Power Systems Operations Results (2013) as well as from latest database collected from WAPP members for the purpose of WAPP GEF calculation in 2014.



When looking at total net energy generation, the three top energy producing countries (Nigeria, Ghana and Cote d'Ivoire) account for about 90% of the total energy generated within the entire WAPP region. Half of the remaining 10% is produced by Senegal as shown in Figure 6.

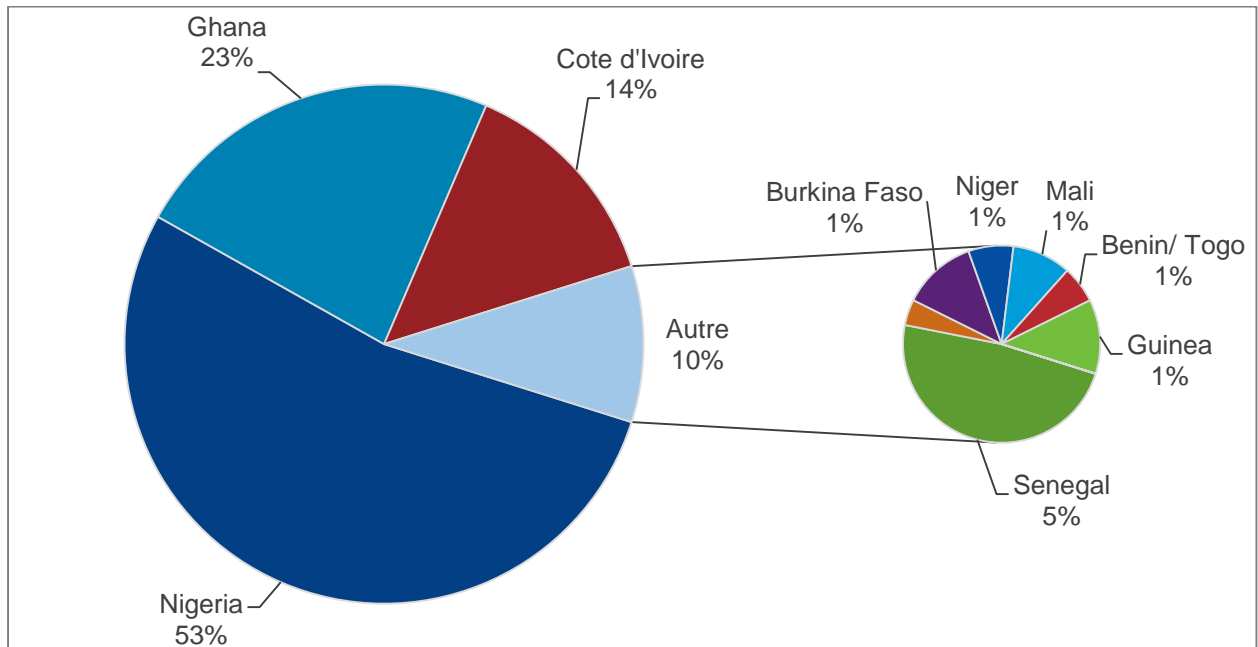


Figure 6. Total Energy Generated per country in 2013¹²

Figure 7 below shows the change in installed capacity for the WAPP countries over the past three years, from 2011 to 2013. In Nigeria, Ghana, Cote d'Ivoire and Niger the installed capacity has increased during this time period. The countries with the largest energy shares have also seen the largest increase in installed capacity over the last three years.

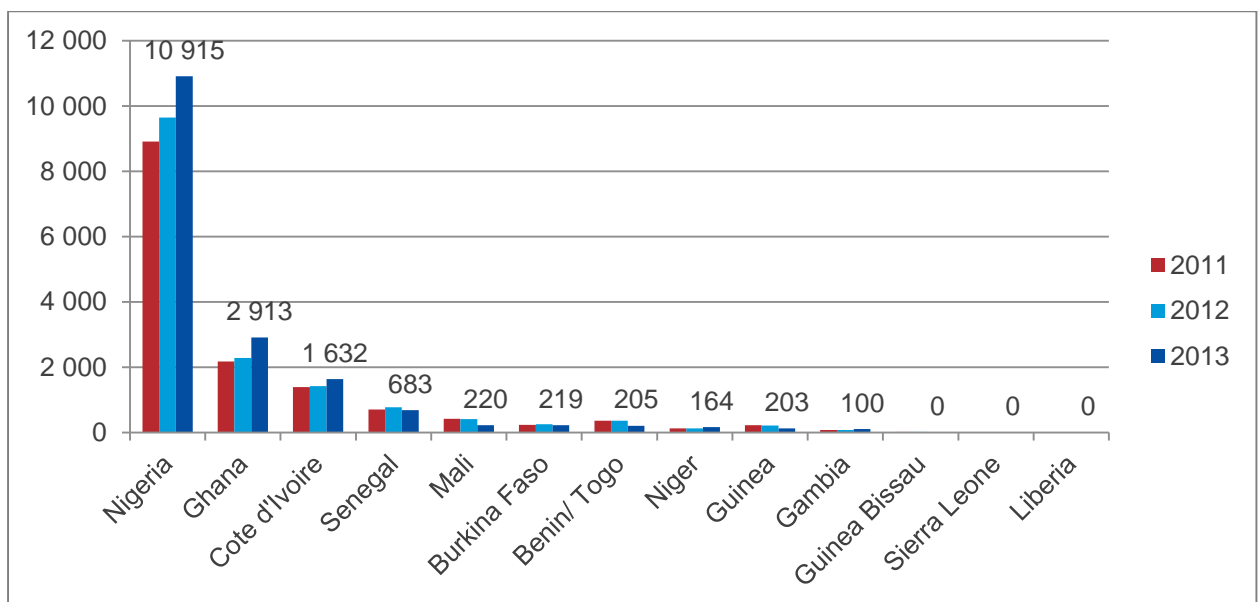


Figure 7. Installed Capacity in MW from 2011 - 2013¹²



National Grid Emission Factors (GEFs)

The summary of the WAPP members' GEFs, is presented in Table 3. The figure in brackets shows the latest year of known GEF. More detailed versions of this table can be found in Appendix 2, where the list of WAPP members' key stakeholders is presented as well.

Table 3. Overview of WAPP members' Grid Emission Factor (GEF)

WAPP member	Number of GEFs previously calculated	Latest GEF in tCO ₂ /MWh (year)
Senegal	3	0.67 (2008)
Cote d'Ivoire	6	0.65 (2013)
Indicative calculation of WAPP GEF (see Appendix 1 for details)	-	0.60 ¹⁴ (0.588-0.620 based on project type and crediting period)
Nigeria	4	0.59 (2008)
Mali	1	0.58 (2006)
Burkina Faso	1	0.57 (2010)
Togo & Benin	1	0.41 (2011)
Ghana	2	0.38 (2010)
Niger	-	-
Members that are not yet connected to the WAPP network		
Sierra Leone	1	0.24 (2014) ¹³
Guinea	2	0.34 (2014) ¹³
Guinea Bissau	1	0.66 (2014) ¹³
Liberia	1	0.58 (2014) ¹³
The Gambia	2	0.58 (2014) ¹³

The range of country specific GEFs is quite large. The differences amongst countries' GEFs can be explained mainly by the extent of power generation from renewable technologies (e.g. hydropower). Lower GEFs mean a higher share of renewable power generation in that country.

Impact of a WAPP GEF

In this assignment the WAPP GEF is calculated using the most recently available grid data and information collected from WAPP members. The WAPP GEF is based on Climate Focus/Ecosur Afrique in-house GEF model used in other GEF assignments and is considered as an appropriate measure for this feasibility study.¹⁴

¹³ In this study the calculation of GEF was also carried out for countries that are not yet connected to the WAPP network, these are: The Gambia, Guinea Bissau, Guinea, Liberia and Sierra Leone. The calculated GEF is based on equal weight factors for Operating Margin ($W_{OM}=0.5$) and Build Margin ($W_{BM}=0.5$) for renewable projects in their first crediting period. These countries are eligible to include off-grid power units in GEF calculations as per Step 2 of the tool. The GEF calculations for those countries are included in separate spreadsheets.

¹⁴ The WAPP GEF is calculated based on the available grid data and information collected from WAPP members during the feasibility study. The calculation is based on Simple OM (2010-2012) and BM (2012). The calculated WAPP GEF is a Combined Margin based on equal weight factors for Operating Margin ($W_{OM}=0.5$) and Build Margin ($W_{BM}=0.5$) for renewable projects in their first crediting period. This figure is generated for the purpose of discussions under this specific chapter only and cannot be referred to as the final WAPP GEF for the SBL purpose. The WAPP GEF final calculation is included in a separate report. It is



When a regional WAPP GEF is introduced, countries with a GEF higher than the WAPP GEF would likely lose credited emission reductions (e.g. in case of renewable energy and energy efficiency projects where the baseline emissions play a big role) compared to if they used their national GEFs. This is specially the case when the use of WAPP GEF as a SBL becomes compulsory and replaces national GEFs of those countries who adopt a regional GEF (e.g. WAPP GEF) as a SBL. The preliminary WAPP GEP of 0.60 tCO₂/MWh is lower than the previously calculated GEFs of Senegal and Cote d'Ivoire as WAPP connected countries. Which means most likely these countries will have to compromise their national GEFs when adopting a WAPP GEF. The WAPP GEF on the other hand is in favour of Nigeria and Ghana as the largest power producers within the WAPP. However, the national GEFs presented in the table are not the most updated figures, thus the above analysis may slightly change depending on the most up-to-date national GEFs.

Countries with a lower GEF would gain from a regional WAPP GEF. This means that, for example, Ghana could gain more credited emission reductions through a CDM project activity that uses WAPP GEF as the baseline compared to when using Ghana's national GEF. The opposite argument applies as well, for instance in this case Senegal and Cote d'Ivoire may lose carbon credits when applying WAPP GEF for a e.g. renewable energy project as the grid baseline compared to when they use their own national GEFs. The comparisons put above for Ghana, Senegal and Cote d'Ivoire are solely to understand the possible impacts of WAPP GEF, while the national GEF of these countries are not the most up-to-date (except for Cote d'Ivoire's GEF from 2013).

Data availability status for GEF calculation

The following table provides a summary of national grid data and information availability per country. It includes the latest data vintage and applicable Operational Margin (OM) method applied based on their data availability.

Table 4. Status on national grids data/information availability for GEF calculation sorted by Grid Data Availability¹⁵

WAPP member	Grid data submitted?	Data vintage (year)	Is data complete?	Is there a grid map included?	OM method applicable to the national grid based on data provided so far	Comments on grid data availability
Nigeria	Yes	2009-2012	90% ¹⁶	Yes	Simple OM	2013 data unavailable
Ghana	Yes	2009-2013	Yes	Yes	Simple adjusted OM	-
Burkina Faso	Yes	2009-2013	Yes	Yes	Simple OM	-
Benin	Yes	2009-2013	Yes	Yes	Simple OM	-
Togo	Yes	2009-2013	Yes	Yes	Simple OM	-
Senegal	Yes	2009-2013	Yes	Yes	Simple OM	-

worthy to note that the fuel consumption data was incomplete for power plant AFAM VI in Nigeria thus a conservative energy conversion factor method (Option A2 in paragraph 44 of the tool) was used to include this power plant in the calculations.

¹⁵ Information provided in this table is based on the latest status of grid data/information collection from the WAPP member states available as of September 10, 2014.

¹⁶ The fuel consumption data was incomplete for power plant AFAM VI in Nigeria thus a conservative energy conversion factor method (Option A2 in paragraph 44 of the tool) was used to include this power plant in the calculations.



Guinea	Yes	2009-2013	Yes	Yes	Average OM	-
Sierra Leone	Yes	2009-2013	Yes	No	Average OM	-
Cote d'Ivoire	Yes	2009-2013	Yes	Yes	Simple OM	-
Niger	Yes	2009-2013	Yes	Yes	Simple OM	-
Mali	Yes	2009-2013	Yes	Yes	Simple adjusted OM or Average OM	-
Gambia	Yes	2009-2013	Yes	No	Simple OM	-
Guinea Bissau	Yes	2009-2013	Yes	No	Simple OM	-
Liberia	Yes	2009-2013	Yes	No	Simple OM	-



4 WAPP grid and inter-connections

The WAPP transmission lines need to be analysed for the eligibility under the “Tool to calculate the emission factor for an electricity system, Version 04.0”. This includes a check on the transmission lines capacity and whether any transmission constraints can be observed. For this purpose the WAPP grid and its interconnected transmission lines need to be identified to have their technical features checked against any transmission constraints (see sub-section WAPP trade analysis “transmission constraint check”).

WAPP grid and inter-connections

The WAPP has published the Update of the ECOWAS Revised Master Plan for the Generation and Transmission of Electrical Energy (WAPP, 2011)¹⁷, in which different power generation and transmission projects are analysed and evaluated from a techno-economic perspective. The economic evaluation of different planning scenarios in the WAPP has been done using a power-system optimisation tool, which combines different policy actions and uncertainties. The WAPP Master Plan uses these scenarios to identify priority investment projects. This chapter introduces the most up-to-date structure of the WAPP grid network, including the inter-connected transmission lines between the WAPP member states.

As shown in Figure 1, the WAPP grid - when fully commissioned - will cover 14 countries: Benin, Burkina Faso, Côte d’Ivoire, Gambia, Ghana, Guinea, Guinea Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone and Togo. For a better understanding of all the interconnected transmission lines between WAPP countries, a simplified map is shown in Figure 8 below. Countries are identified via their international three-letter code, and numbers are assigned to the transmission lines between two neighbouring countries (e.g. Nigeria (NGA) trades power with Niger (NER) through two existing lines 1 and 2).

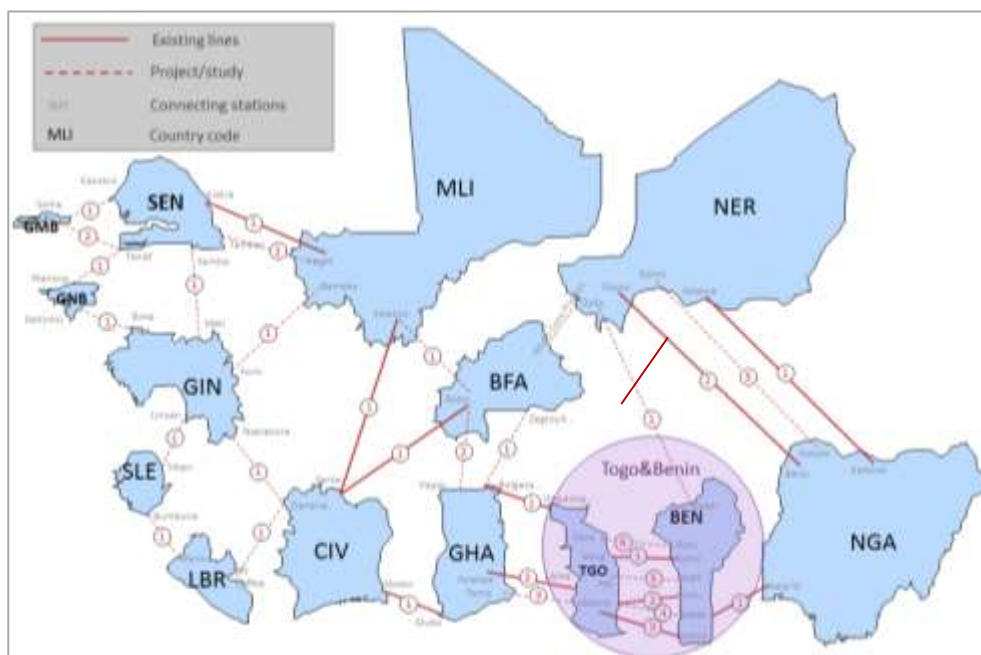


Figure 8. Simplified map of WAPP members and their interconnected transmission lines.

¹⁷ [Revised ECOWAS Master Plan for the Generation and Transmission of Electrical Energy, 2011](#)



Within the WAPP operational and technical framework, Togo and Benin are always considered as one interconnected body. The following table shows an overview of the existing inter-connected transmission lines between the WAPP countries. The planned and ongoing transmission line projects are presented in Appendix 2.

Table 5. Overview of the existing interconnected transmission lines in the WAPP (WAPP Secretariat 2014)¹⁸

Country 1	Country 2	Line Voltage in kV	Line Capacity in MW (Aggregated)
Nigeria	Niger	132 x 2	169
Nigeria	Togo & Benin	330	686
Ghana	Togo & Benin	161 x 2	300
Ghana	Cote d'Ivoire	225	327
Cote d'Ivoire	Burkina Faso	225	327
Cote d'Ivoire	Mali	225	327
Burkina Faso	Niger	330	637
Mali	Senegal	225	100

According to the above table as well as the latest data and maps acquired from the WAPP Secretariat the WAPP member states that are physically connected through an interconnected network of transmission lines are: Nigeria, Ghana, Côte d'Ivoire, Senegal, Benin & Togo, Burkina Faso, Mali and Niger.

These countries are considered capable of exchanging electrical power directly through their interconnected transmission lines. The rest of the WAPP members cannot currently trade power within the WAPP interconnected network. However, as listed in Appendix 2, there are either ongoing or planned projects to connect all the WAPP countries with each other.

¹⁸ Data/information on the WAPP network from the WAPP Secretariat

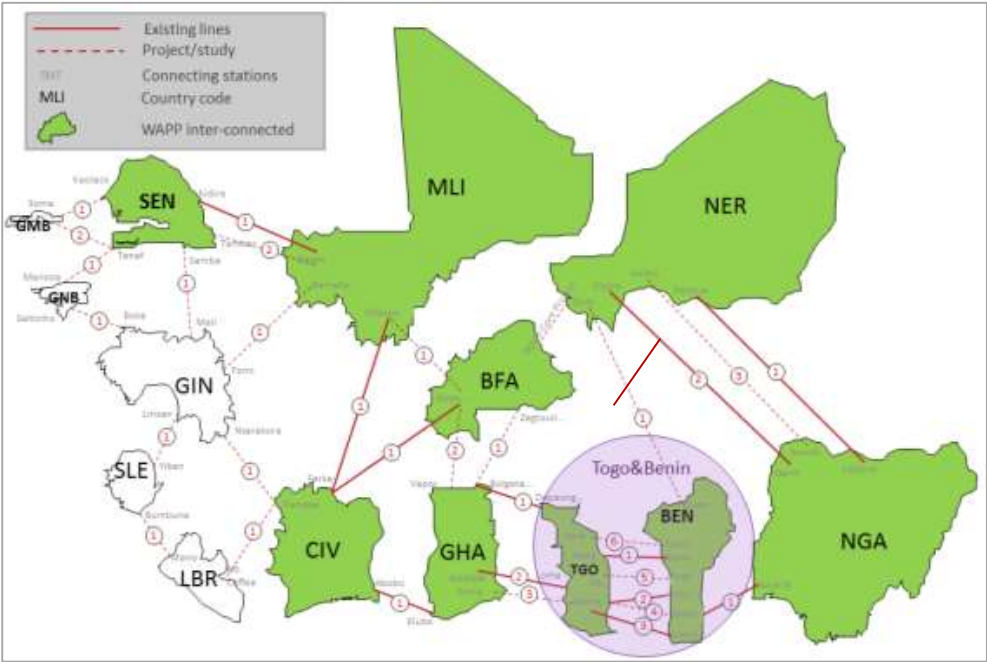


Figure 9. WAPP interconnected countries

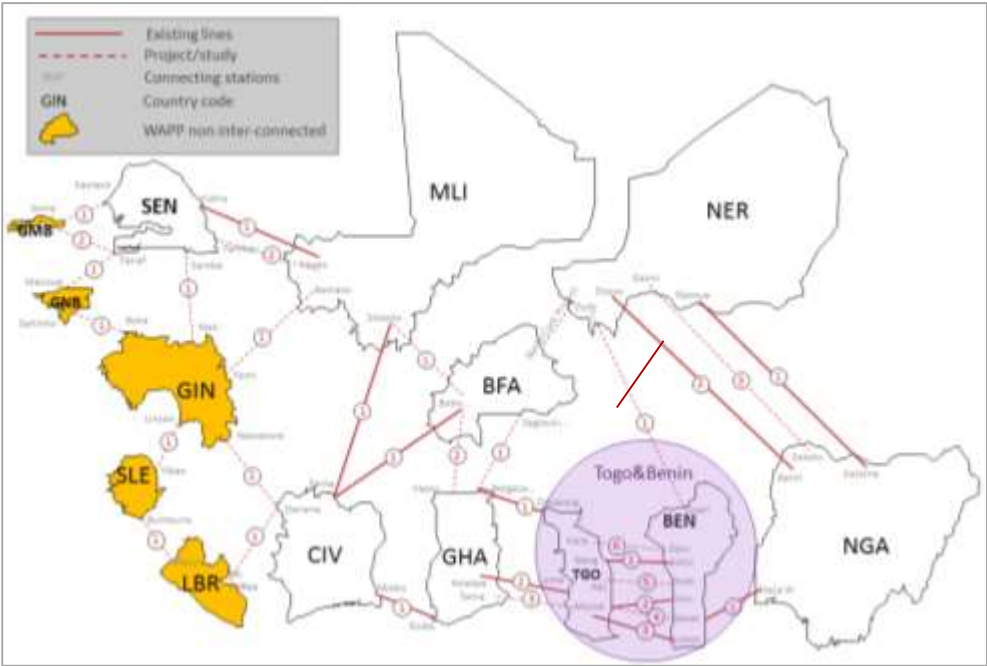


Figure 10. WAPP disconnected countries

WAPP electricity market

The ECOWAS Regional Electricity Regulatory Authority (ERERA) is the regulator of regional cross-border trade of electricity in West Africa. The ECOWAS member states have committed to contribute to a stable interconnected electricity market in the region through the adoption of a number of legal and institutional frameworks prepared by ERERA.



Despite several effective political and economic initiatives for the development and completion of the WAPP as a fully integrated power grid in the ECOWAS region, the trade between the WAPP countries is limited by the existing infrastructure as well as delays in planned transmission projects.

Information on existing transmission infrastructure is based on the WAPP Master Plan 2011¹⁷ and data/information received from the WAPP Secretariat. Figure 11 shows the status of the WAPP electricity market by net import/export per country between 2011 and 2013. It is clear from the figure that countries with the highest power generation ranking such as Nigeria, Ghana and Côte d'Ivoire are the largest exporters, while others are sole importers. Mali exports mainly to Senegal to supply Senegal and Mauritania power quotas from Manantali and Félou hydropower plants, which are jointly owned by Mali, Mauritania and Senegal within the OMVS. It is also clear from the figure that some countries such as Gambia, Guinea, Guinea Bissau, Sierra Leone and Liberia made no import/export due to the fact that these countries are completely disconnected from the WAPP power network. It is noteworthy that some countries such as Liberia have limited power import to rural areas at the borders (e.g. from Côte d'Ivoire). These occur in isolated grids with no connection to the national power grids. These limited trades are not reflected in the following figure.

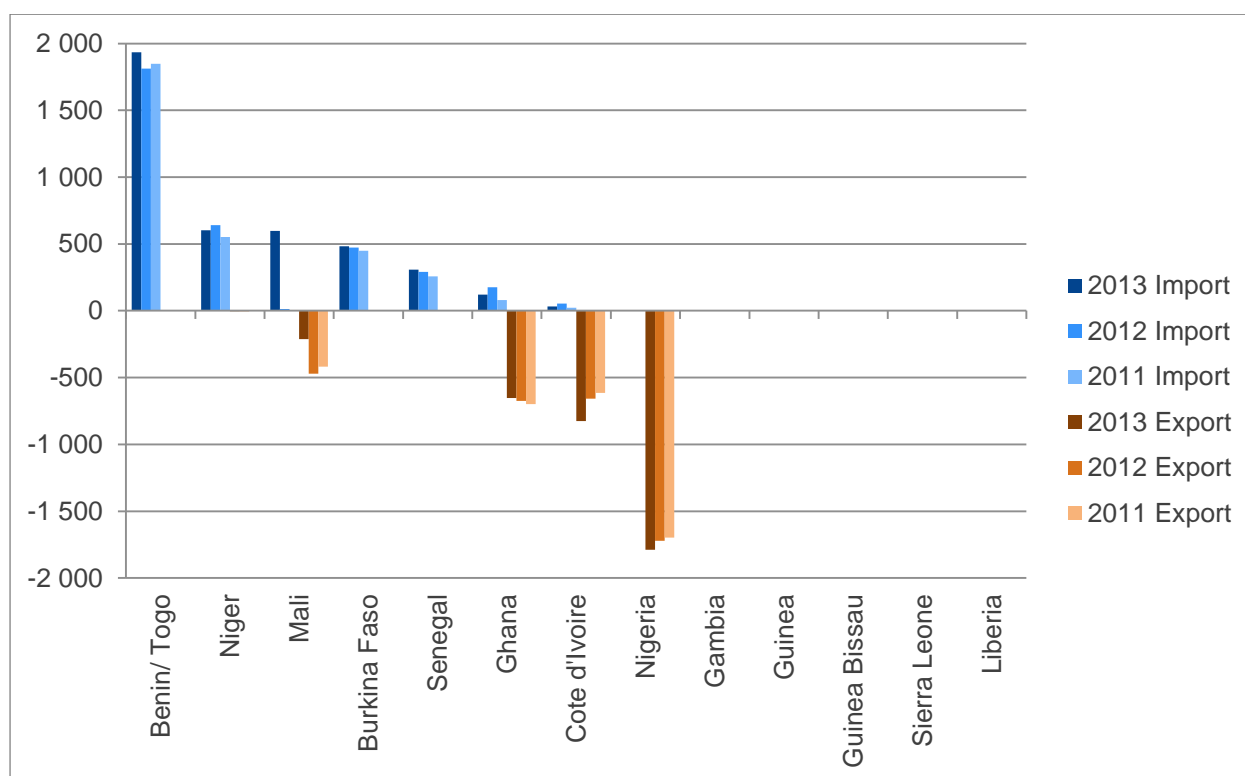


Figure 11. Power export/import in GWh within the WAPP members 2011-2013¹²

WAPP trade analysis (transmission constraint check)

As mentioned earlier, the WAPP transmission lines need to be analysed for the eligibility under the "Tool to calculate the emission factor for an electricity system, Version 04.0"¹. This includes a check on the transmission lines capacity and whether any transmission constraints can be observed. The transmission constraints were checked by comparing the operational capacity of the transmission lines



with their current load factor. The Tool suggests that transmission constraints do not exist if a transmission line operates at 90% or less of its capacity for 90% or more of the year.

For the analysis, data on load capacity of the transmission lines, as well as the current electricity trades between the WAPP member states were collected through the WAPP Secretariat in Cotonou.

Table 6 summarises the features of the transmission lines and the outcome of the transmission constraint analysis. The table shows the actual trades for years 2012 and 2013 between the WAPP member states through each transmission line. The trades were evaluated for both directions, i.e. trade from country A to country B and vice versa. The actual trades (in MWh) were divided by the maximum operational capacities per transmission line (in MWh) to lead to current load factor per line. If the load factor for both directions was below 90%, it was concluded that there is no existing transmission constraint (i.e. Transmission constraint check: Ok). If a country within the WAPP cannot pass the transmission constraint test, it means that the country is not eligible to be considered within the WAPP electricity network for the GEF calculation. The transmission constraint check in this assignment shows that none of the interconnected transmission lines face any transmission constraints. Hence the existing interconnected WAPP network consisting of Nigeria, Ghana, Côte d'Ivoire, Senegal, Benin & Togo, Burkina Faso, Mali and Niger can be considered as one region for a WAPP GEF establishment as a SBL.

In this analysis the transmission lines between Togo and Benin are considered as one (i.e. Togo&Benin) as the lines between the countries mainly have regional power transfer purposes and are not targeted for sole national import/exports (although they are partially used for stabilising the national supply/demand).

For the country codes and transmission line numbers used in the table refer to the simplified WAPP map presented in Figure 8.

Table 6. WAPP trade analysis; Transmission constraint check within the WAPP interconnected network 2012-2013

Export From	Line No.	Import To	Line Voltage (kV)	Maximum load capacity (MW)	Power transmission (MWh)		Operational Load Factor		Transmission constraint check (<90%)	
					2012	2013	2012	2013	2012	2013
NGA	1	NER	132	40	151,963	160,953	43%	46%	OK	OK
NGA	2	NER	132	80	468,311	383,764	67%	55%	OK	OK
NGA	1	BEN/TGO	330	630	1,184,352	1,374,976	21%	25%	OK	OK
NER	1	NGA	132	40	0	0	0%	0%	OK	OK
NER	2	NGA	132	80	0	0	0%	0%	OK	OK
TGO/BEN	1	NGA	330	630	0	0	0%	0%	OK	OK
TGO/BEN	1	GHA	34	30	0	0	0%	0%	OK	OK
TGO/BEN	2	GHA	2x161	300	0	0	0%	0%	OK	OK
GHA	1	TGO/BEN	34	30	0	0	0%	0%	OK	OK
GHA	2	TGO/BEN	2x161	300	599,765	560,007	23%	21%	OK	OK
GHA	1	CIV	225	220	54,275	616,377	3%	32%	OK	OK
BFA	1	CIV	225	121	0	0	0%	0%	OK	OK



Export From	Line No.	Import To	Line Voltage (kV)	Maximum load capacity (MW)	Power transmission (MWh)		Operational Load Factor		Transmission constraint check (<90%)	
					2012	2013	2012	2013	2012	2013
CIV	1	GHA	225	220	175,427	119,344	9%	6%	OK	OK
CIV	1	BFA	225	121	469,427	448,687	44%	42%	OK	OK
CIV	1	MLI	225	70	13,341	230,816	2%	38%	OK	OK
MLI	1	CIV	225	70	0	0	0%	0%	OK	OK
MLI	1	SEN	225	150	290,317	212,546	22%	16%	OK	OK
SEN	1	MLI	225	150	0	0	0%	0%	OK	OK

WAPP future power imports

Future power imports to the WAPP region can potentially change the WAPP GEF based on two main factors:

1. Emission factor or carbon intensity of the imported electricity (tCO₂/MWh) ; and
2. The amount of import compared to the total internal power generation in the WAPP region.

The major channels of power import are envisaged as follows:

- Mauritania, mainly from its gas powered plants;
- Chad. Although lacking resources such as coal, natural gas and hydroelectricity potential, the country has considerable crude oil reserves; and
- Cameroon and DRC; with potential hydropower resources.

Table 7. Impact of WAPP's future power import on WAPP GEF

Import from	Power source and possible EF (tCO ₂ /MWh) ¹⁹	Possible impact on WAPP GEF ²⁰
Mauritania	Natural gas, 0.3 ~ 0.4	Will reduce WAPP GEF
Chad	Crude oil, 0.6 ~0.9	Will increase WAPP GEF
Cameroon and DRC	Hydro, zero	Will reduce WAPP GEF

In order to understand and predict any future changes in WAPP GEF further WAPP import projections need to be taken into account including the amount of power import and the grid carbon intensity of the exporter country.

¹⁹ The ranges in the table are approximate, based on average performance of power plants.

²⁰ Please note that the magnitude of the impact is also directly dependent on the amount of power import from these countries. If the power import compared to the total power generation within the WAPP is not significant, the impact is minor.



5 Off-grid inclusion in GEF

In WAPP member states off-grid diesel-based power generation is significant. Since the emission factor of a diesel generator is generally higher than the one from a grid mix involving thermal power plants, it is therefore logical to consider possible inclusion of off-grid power in the WAPP GEF calculation. This will encourage the replacement of diesel-based power by cleaner technologies through carbon project activities.

In the methodology followed herein, ("Tool to calculate the emission factor for an electricity system" (version 4.0), presents two options for calculating off-grid power:

- Option IIa (Section 6.2.3): based on available data on off-grid power units in the country. This option is not applicable due to a lack of necessary data.
- Option IIb (Section 6.2.3) where the following conditions apply:
 - (a) The project activity is located in (i) a Least Developed Country (LDC); or (ii) a Small Island Developing States (SIDS) or in (iii) a country with less than 10 registered CDM projects at the starting date of validation; and
 - (b) The project activities consist of grid-connected renewable power generation; and
 - (c) It can be demonstrated that there is a load shedding program in place to compensate the deficit of the generation capacities.

However in the specific circumstances of WAPP, Option IIb can only be applied to integrate off-grid energy production when calculating certain national GEFs, rather than being applied for a regional WAPP GEF. The reason is that neither Nigeria, Ghana nor Côte d'Ivoire are LDC/SIDS, and although Ghana and Côte d'Ivoire may be eligible by having less than 10 registered CDM projects (2 CDM projects and 7 PoAs in Ghana, 5 projects and 1 PoA in Côte d'Ivoire), Nigeria cannot become eligible for this option within the WAPP states. Hence it is not possible to use Option IIb when calculating the WAPP GEF for a region comprising both eligible and non-eligible countries.²¹

²¹ Those projects that can apply Option IIb in a national GEF may only do so for their first crediting period, and must be grid-connected renewable energy projects. For all other projects, the GEF will not take into account off-grid power. When Option IIb is opted for, a default emission factor of 0.8 t CO₂/MWh and a default estimate for off-grid power generation (at 10% of the total generation for each year) are applied as described in the tool.



6 WAPP GEF options

Based on the WAPP electricity market analysis and the available interconnected transmission lines the following options are detected for the GEF calculations in the WAPP region:

- **Option 1:** Regional GEF for the interconnected WAPP:
Due to the limited extent of the WAPP interconnected network only some countries may have an overarching regional GEF. These nine countries are: Nigeria, Ghana, Côte d'Ivoire, Togo&Benin, Burkina Faso, Niger, Mali and Senegal (see Figure 9). These countries' electricity networks were checked against any existing transmission constraints and have successfully passed the test (see Table 6);
- **Option 2:** National GEFs for the disconnected WAPP:
The countries that remain disconnected from the WAPP regional interconnected power network will continue to rely on their national GEF calculations for prospective climate/carbon projects (see Figure 10). These five countries are: Liberia, Sierra Leone, Guinea, Guinea Bissau and the Gambia.
- **Option 3 (alternative for option 1):** Sub-regional GEFs:
This option is suggested for countries with comparable GEF values that may not adopt a regional WAPP GEF (such as when a country would prefer to keep their national GEFs rather than replacing it with a lower regional WAPP GEF). One of the main criteria for countries to have a common GEF under this option is to have a direct link for power trade/exchange, meaning that in addition to being neighbours they need to have common transmission lines with no transmission constraints. Looking at the national GEFs of the WAPP member states, the only countries who have direct power exchange with a similar GEF are Ghana (0.38 tCO₂/MWh) and Togo&Benin (0.41 tCO₂/MWh) (see Table 3). It is noteworthy to mention that in case a regional WAPP GEF is developed and adopted by all WAPP members, this option is no longer feasible.



7 Conclusion and recommendations

The overall conclusions of this feasibility study are outlined as follows:

- Lack of reliable most recent grid data/information, specifically data related to fuel consumption per power plants, among WAPP member states remains one of the main challenges, especially when it comes to analysis of prospective grid changes and dynamics of the WAPP.
- The WAPP GEF value calculated at 0.60 tCO₂/MWh¹⁴ (see Appendix 1) lies moderate among WAPP members' GEFs (see Table 3). Concrete analysis on possible impact of the WAPP GEF on WAPP members is not possible in this study since the national GEFs of the WAPP members are not the most up-to-date.
- Default off-grid inclusion method from the tool (option IIb) cannot be considered in the calculation of the regional WAPP GEF but might be considered for national GEFs where the conditions are met in accordance with the *tool*¹.
- The WAPP cannot yet be considered as a fully integrated interconnected power network.
- Out of fourteen member states, nine members are considered as interconnected WAPP members: Nigeria, Ghana, Côte d'Ivoire, Togo&Benin, Burkina Faso, Niger, Mali and Senegal;
- The WAPP electricity market analysis showed no transmission constraints within the interconnected WAPP members including Nigeria, Ghana, Côte d'Ivoire, Togo&Benin, Burkina Faso, Niger, Mali and Senegal;
- Five WAPP member states remain disconnected in the WAPP with zero cross-border transmission capacity: Liberia, Sierra Leone, Guinea, Guinea Bissau and the Gambia;

Recommendations

Based on the outcome of the feasibility study we recommend pursuing the following actions:

- Establishment of a regional WAPP GEF as a Standardised Baseline (SBL) for the interconnected WAPP member states includes Nigeria, Ghana, Cote d'Ivoire, Togo&Benin, Burkina Faso, Niger, Mali and Senegal;
- Establishment of national GEFs for countries not yet integrated into the interconnected WAPP network. These countries include Liberia, Sierra Leone, Guinea, Guinea Bissau and the Gambia; out of which Liberia, Guinea and Guinea Bissau do not have any official GEF calculated yet. The calculation of national GEFs will remain dependent of sufficient data supply from respective WAPP members;



8 Outline for further capacity building

During the completion of the current feasibility study the consultants faced several challenges that may be avoided through appropriate capacity building activities in the context of WAPP GEF data collection, GEF calculation, SBL submission and update. The current chapter presents a capacity building outline that may be considered in order to facilitate a smoother process when dealing with WAPP GEF. It is also noteworthy to mention the useful role of the UNFCCC Regional Collaboration Center (RCC) in Lome for supporting the DNAs and other relevant stakeholder in knowledge transfer and relevant capacity building activities.

Data needs and data collection

During the assignment it was observed that there is lack of capacity within the WAPP states in regards to data needs for the determination of GEF on both national and WAPP network level. This issue led to substantial delays in delivering the draft feasibility study as well as the WAPP GEF calculations. The proposed capacity building outline for data needs and data collection is as follows:

- Workshop on data/information needs²² and QA/QC²³ for the determination of national GEF and WAPP GEF;
- Workshop on data management and data sorting in order to facilitate the GEF calculation;
- Introduction of data templates in order to harmonize the data collection efforts among the WAPP states;²⁴

Methodological tools and SBL approaches

The knowledge on approved UNFCCC tools and methodologies for the determination of GEF as a SBL is an important factor for a successful implementation of such assignments. Relevant capacity building activities may be as follows:

- Workshop on the available approved UNFCCC tools for GEF calculation; e.g. The tool to calculate emission factor for an electricity system (Version 4.0)¹;
- Workshop on available guidelines on sector specific SBLs; e.g. The Guidelines for the establishment of sector specific Standardized baseline (Version 2.0)¹⁰;

SBL submission and update²⁵ procedures

Once the SBLs are designed, they need to be approved by host countries DNAs and submitted according to available UNFCCC procedures. Proposed capacity building outline on submission and update of a SBL is as follows:

- Workshop on 'Procedure for development, revision, clarification and update of standardised baselines' (version 03.1)²⁶

²² [Determining coverage of data and validity of standardized baselines \(Version 1.0\)](#)

²³ [Guidelines for quality assurance and quality control of data used in the establishment of standardized baselines \(Version 2.0\)](#)

²⁴ Data templates have been produced and submitted to UNEP DTU Partnership and the WAPP Secretariat. The data collection during this assignment has been done through the introduction of these templates.

²⁵ The validity period of a Standardized Baseline being limited to 3 years

²⁶ [Procedure for development, revision, clarification and update of standardized baselines \(Version 03.1\)](#)



It shall be noted however that a concept note by the CDM Executive Board on further revision of the standardised baseline regulatory framework states that proposed guidelines for the rules and requirements for application of SBLs are in progress. Thus the submission procedure may be revised in future. In the absence of explicit UNFCCC decision concerning the mandatory or optional application of SBL, the use of the WAPP GEF could be proposed as an option by the DNAs (see the Uganda emission factor SBL stating that the project proponents may choose between the SBL and calculating their own GEF, unlike the previous GEF SBL for Southern Africa which was mandatory). This would allow countries with emission factors significantly different from the WAPP average the choice to use it or calculate their specific GEF, with particular regard to the possibility of updating national factors compared to 2010-2012 vintage selected for the WAPP GEF.

In addition, funding may be requested from the UNFCCC secretariat to support the validation costs (EOD assessment report) of SBL for (groups of) countries, each with fewer than 10 registered CDM projects as of 31/12/2010 (all WAPP countries)²⁷.

²⁷ Appendix 2 of the "Procedure for development, revision, clarification and update of standardised baselines"



Appendix 1: Detailed GEF calculation

Step 1: Identify the relevant electricity systems;

According to the overview of the existing interconnected transmission lines in the WAPP as well as the latest data and maps acquired from the WAPP Secretariat the WAPP member states that are physically connected through an interconnected network of transmission lines are: Nigeria, Ghana, Côte d'Ivoire, Senegal, Benin & Togo, Burkina Faso, Mali and Niger.

These countries are considered capable of exchanging electrical power directly through their interconnected transmission lines. The rest of the WAPP members cannot currently trade power within the WAPP interconnected network. However, as listed in Appendix 2, there are either ongoing or planned projects to connect all the WAPP countries with each other.

The transmission constraint check in this assignment shows that none of the interconnected transmission lines face any transmission constraints. Hence the existing interconnected WAPP network consisting of Nigeria, Ghana, Côte d'Ivoire, Senegal, Benin & Togo, Burkina Faso, Mali and Niger can be considered as one region for a WAPP GEF establishment as a SBL. On the other hand, national GEFs are the only possible calculations for countries not yet integrated into the interconnected WAPP network: Liberia, Sierra Leone, Guinea, Guinea Bissau and the Gambia.

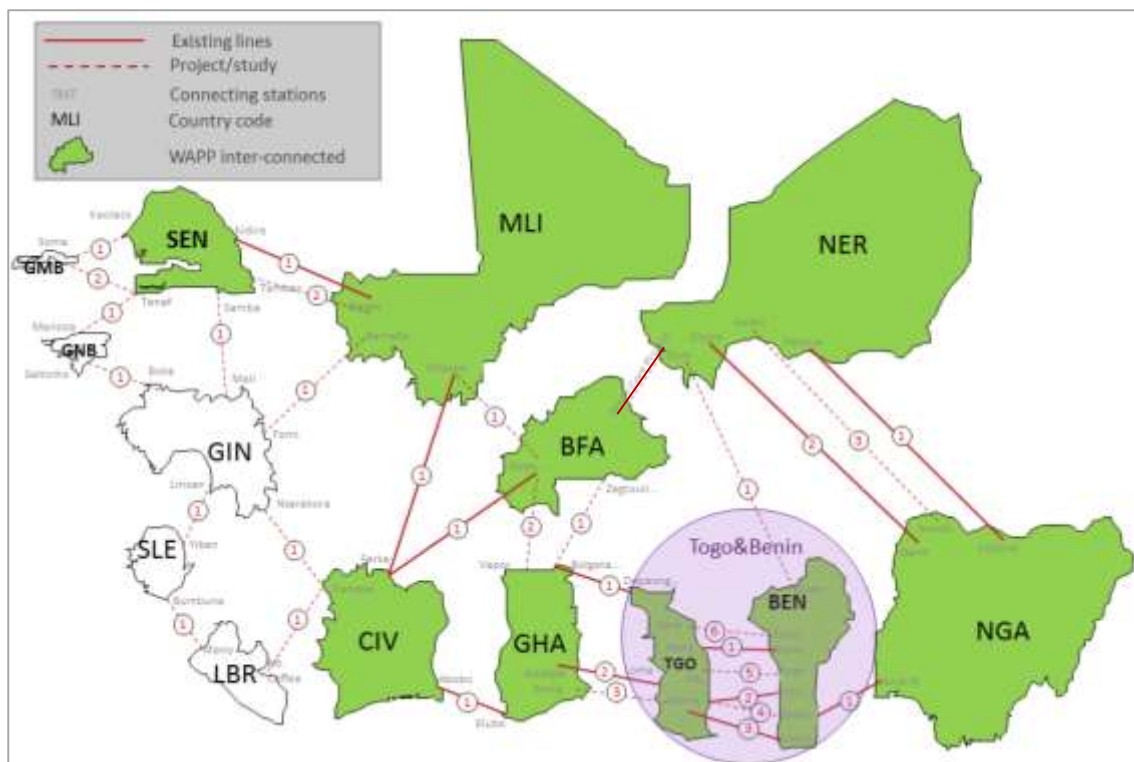


Figure 12. WAPP interconnected countries (green system) and isolated WAPP members (white systems)



Step 2: Choose whether to include off-grid power plants in the project electricity system

The “Tool to calculate the emission factor for an electricity system” (version 4.0) presents two options for calculating off-grid power:

Option IIa (Section 6.2.3): based on available data on off-grid power units in the country. This option is not applicable due to a lack of necessary data.

Option IIb (Section 6.2.3) where the following conditions apply:

The project activity is located in (i) a Least Developed Country (LDC); or (ii) a Small Island Developing States (SIDS) or in (iii) a country with less than 10 registered CDM projects at the starting date of validation; and

The project activities consist of grid-connected renewable power generation; and

It can be demonstrated that there is a load shedding program in place to compensate the deficit of the generation capacities.

However, Option IIb can only be applied to integrate off-grid energy production when calculating *national* GEFs, rather than being applied for a regional WAPP GEF. The reason is that neither Nigeria, Ghana nor Côte d’Ivoire are LDC/SIDS, and although Ghana and Côte d’Ivoire may be eligible by having less than 10 registered CDM projects (2 CDM projects and 7 PoAs in Ghana, 5 projects and 1 PoA in Côte d’Ivoire), Nigeria cannot become eligible for this option within the WAPP states. Hence it is not possible to use Option IIb when calculating the WAPP GEF for a region comprising both eligible and non-eligible countries.

Those projects that can apply Option IIb in a national GEF may only do so for their first crediting period, and must be grid-connected renewable energy projects. For all other projects, the GEF will not take into account off-grid power. When Option IIb is opted for, a default emission factor of 0.8 t CO₂/MWh and a default estimate for off-grid power generation (at 10% of the total generation for each year) are applied as described in the tool.

Conclusion: Off-grid power units are not included in the WAPP GEF calculation.

Step 3: Select a method to determine the operating margin (OM);

According to the methodology, the calculation of the operating margin emission factor ($EF_{grid,OM,y}$) should be based on one of the following methods:

- (a) Simple OM,
- (b) Simple adjusted OM,
- (c) Dispatch data analysis OM,
- (d) Average OM.

The Simple OM method can only be used if low-cost/must-run resources constitute less than 50% of total grid generation (excluding off-grid power plants) in the five most recent years (2009-2013). Low-cost/must-run resources are the power plants with low marginal generation cost, in WAPP’s case they



are the hydropower plants. As illustrated below, during this period low-cost/must-run resources accounted for an average 23.5% of electricity generation, therefore the Simple OM method can be applied for the calculation of the GEF.

Table 8. 5-year average low-cost/must-run resources share in WAPP generation

Years	2009	2010	2011	2012	2013	AVG
Total WAPP (MWh)	31,246,756	36,338,337	38,501,818	42,256,048	14,347,665	32,538,125
Low cost/must run (MWh)	9,930,618	9,323,535	8,742,084	8,498,497	1,774,859	7,653,919
Share of Low cost/must run (%)	31.78%	25.66%	22.71%	20.11%	12.37%	23.52%
Syr average Low cost / must run:	23.52%	Simple OM Possible?		YES		

Two data vintages can be used in calculating: Ex-ante and Ex-post, both of which are captured in the Tool:

- Ex-ante: This is based on the 3-year generation-weighted average by using the most recent data available at the time of updating the OM EF. If the OM EF is calculated for submitting a project for validation, there will be no need for monitoring and recalculating the emission factor during the crediting period.
- Ex-post: The EF will have to be updated for the year in which the power plant displaces grid electricity. This emission factor should be updated annually for the rest of the crediting period during the monitoring.

For the calculation of GEF, option (a) Simple OM based on ex-ante data is applied: 2010 to 2012 vintage (due to unavailability of 2013 data for Nigeria).

Step 4: Calculate the operating margin emission factor according to the selected method;

The simple OM emission factor is calculated as the generation weighted average CO₂ emissions per unit net electricity generation (tCO₂/MWh) of all generating power plants serving the system, not including low-cost/must-run power plants/units.

For simple OM Option A (Article 41 in the tool) is used to calculate the OM emission factor based on the net electricity generation of each power plant and an emission factor for each power plant as follows:

$$EF_{grid,OMsimple,y} = \frac{\sum_m EG_{m,y} \times EF_{EL,m,y}}{\sum_m EG_{m,y}} \quad \text{(Equation 1)}$$

Where:

- $EF_{grid,OMsimple,y}$ = Simple operating margin CO₂ emission factor in year y (tCO₂/MWh)
 $EG_{m,y}$ = Net quantity of electricity generated and delivered to the grid by power unit m in year y (MWh)
 $EF_{EL,m,y}$ = CO₂ emission factor of power unit m in year y (tCO₂/MWh)
 m = All power units serving the grid in year y except low-cost/must-run power units
 y = The relevant year as per the data vintage chosen in Step 3



Determination of $EF_{EL,m,y}$

According to the tool, the emission factor of each power unit m is determined as follows:

Option A1: If for a power unit m data on fuel consumption and electricity generation is available, the emission factor ($EF_{EL,m,y}$) is determined as follows:

$$EF_{EL,m,y} = \frac{\sum_i FC_{i,m,y} \times NCV_{i,y} \times EF_{CO2,i,y}}{EG_{m,y}} \quad (\text{Equation 2})$$

Where:

- $EF_{EL,m,y}$ = CO₂ emission factor of power unit m in year y (tCO₂/MWh)
- $FC_{i,m,y}$ = Amount of fuel type i consumed by power unit m in year y (Mass or volume unit)
- $NCV_{i,y}$ = Net calorific value (energy content) of fuel type i in year y (GJ/mass or volume unit)
- $EF_{CO2,i,y}$ = CO₂ emission factor of fuel type i in year y (tCO₂/GJ)
- $EG_{m,y}$ = Net quantity of electricity generated and delivered to the grid by power unit m in year y (MWh)
- m = All power units serving the grid in year y except low-cost/must-run power units
- i = All fuel types combusted in power unit m in year y
- y = The relevant year as per the data vintage chosen in Step 3

Option A2: If for a power unit m only data on electricity generation and the fuel types used is available, the emission factor should be determined based on the CO₂ emission factor of the fuel type used and the efficiency of the power unit, as follows:

$$EF_{EL,m,y} = \frac{EF_{CO2,m,i,y} \times 3.6}{\eta_{m,y}} \quad (\text{Equation 3})$$

Where:

- $EF_{EL,m,y}$ = CO₂ emission factor of power unit m in year y (tCO₂/MWh)
- $EF_{CO2,m,i,y}$ = Average CO₂ emission factor of fuel type i used in power unit m in year y (tCO₂/GJ)
- $\eta_{m,y}$ = Average net energy conversion efficiency of power unit m in year y (ratio)
- m = All power units serving the grid in year y except low-cost/must-run power units
- i = All fuel types combusted in power unit m in year y
- y = The relevant year as per the data vintage chosen in Step 3

Table 9. Simple OM Emission Factors for WAPP (2010-2012)

Years	2010	2011	2012	Period
WAPP Connected Total Yearly Thermal Energy Production for OM (MWh)	27,014,802	29,759,734	33,757,551	90,532,086
WAPP Connected Total Yearly Thermal emissions for OM (tCO ₂)	15,644,479	17,014,490	19,082,961	51,741,930
WAPP Connected Year Specific Operating Margin (Simple OM)	0.5791	0.5717	0.5653	
WAPP Connected Yearly Share of thermal generation 2010-2012	29.84%	32.87%	37.29%	100.00%
Weighted Average Simple OM for the WAPP		0.5715		

Due to large number of data and power plants, please refer to the attached WAPP GEF calculation spreadsheet for further details.



Step 5: Calculate the build margin (BM) emission factor;

The BM EF is calculated using ex-ante data from 2012 vintage.

Sample group of power plants used to calculate the BM EF

To calculate the BM EF, it is necessary to determine the sample group (SET_{sample}) of power plants m based on the most recent data is available (see Figure 4), for which the following criteria are met:

- The sample group (SET_{sample}) consists of at least the five most recent power plants ($SET_{5\text{units}}$) to feed electricity to the grid. If $SET_{5\text{units}}$ accounts for less than 20% of the annual electricity generation, the sample group is expanded to include the next operational power plant until sample group m accounts for 20% of the annual electricity generation.
- Capacity additions from retrofits of power plants should not be included in the calculation of the build margin emission factor.
- Exclude the power plants that are CDM registered projects (if applicable).
- Exclude the power plants that started operations more than 10 years ago (if applicable).

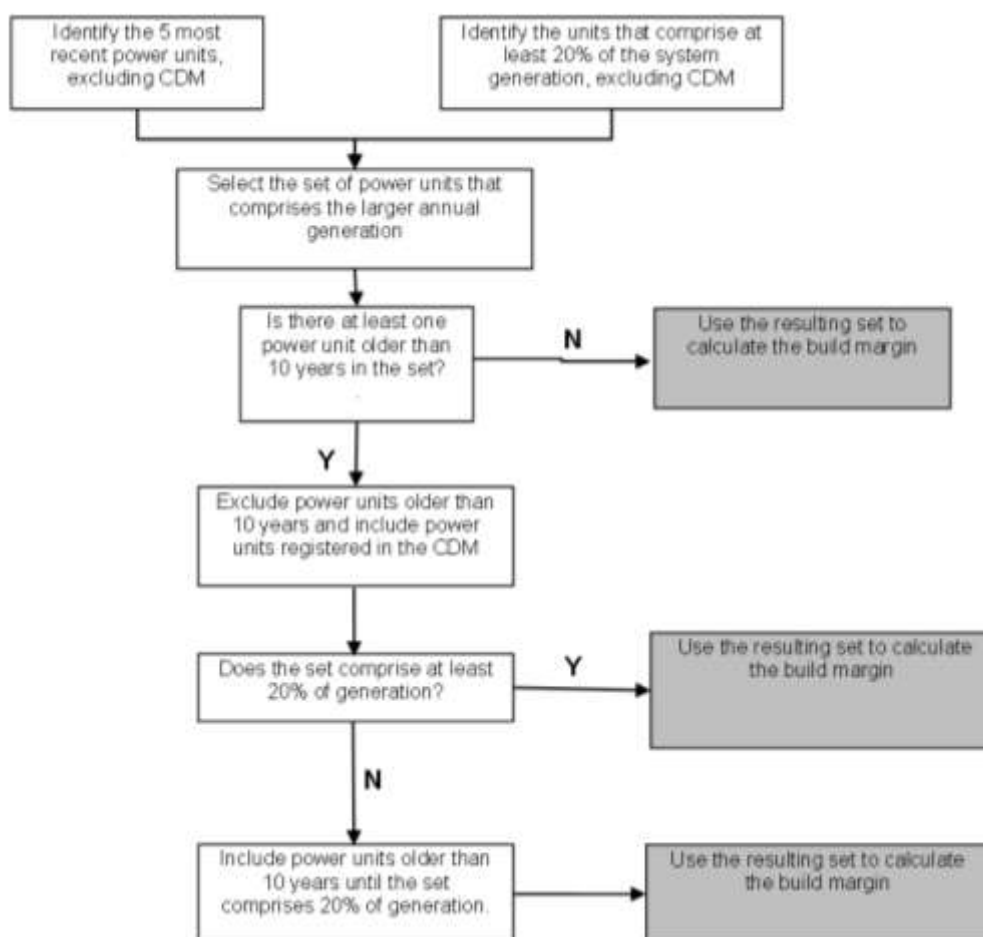


Figure 13. Procedure to determine the sample group of power units m used to calculate the build margin

The sheet “Step 5 Build Margin” in the attached spreadsheet summarizes the sample group of power plants used in determining EF. This group meets the requirements summarized above (Article 71).

**Table 10: Share of power plants power generation chosen for BM calculation**

Total Σ EG without CDM and retrofits (MWh)	13,069,865	
Criteria	SET 5 units	SET 20%
Total Power generation for BM (MWh)	808,710	3,140,867
Emissions for BM (tCO ₂)	518,530	1,996,599
Build Margin excl. off-grid	0.6411	0.6356
Selected BM for the WAPP (tCO₂/MWh)	0.6356	

Due to large number of data and power plants, please refer to the attached WAPP GEF calculation spreadsheet for further details.

Step 6: Calculate the combined margin (CM) emission factor.

After calculating the OM and BM emission factors the combined margin (CM) emission factor or the baseline emission factor (EF_y) is calculated using the following equation:

$$EF_{grid,CM,y} = w_{OM} \cdot EF_{grid,OM,y} + w_{BM} \cdot EF_{grid,BM,y} \quad \text{(Equation 4)}$$

Where:

$EF_{grid,CM,y}$	=	Baseline emission factor (tCO ₂ /MWh),
$EF_{grid,OM,y}$	=	Operating margin CO ₂ emission factor in year y (t CO ₂ /MWh)
$EF_{grid,BM,y}$	=	Build margin CO ₂ emission factor in year y (t CO ₂ /MWh)
w_{OM}	=	Weighting of operating margin emission factor (%)
w_{BM}	=	Weighting of operating margin emission factor (%)

Options for calculating weighted average CM emission factor are summarized depending on the crediting period and project activity:

- For wind and solar power generation projects, $w_{OM} = 0.75$, $w_{BM} = 0.25$ for all crediting periods
- For all other projects, $w_{OM} = 0.5$, $w_{BM} = 0.5$ for the first crediting period, and $w_{OM} = 0.25$, $w_{BM} = 0.75$ for second and third crediting period

Table 11: Options for calculating w_{OM} and w_{BM}

Option	w_{OM}	w_{BM}
CM EF for First, Second and Third crediting periods for wind and solar	0.75	0.25
CM EF for First crediting period for all other projects	0.5	0.5
CM EF for Second and Third crediting period for all other projects	0.25	0.75

Note: The criteria and alternatives available for the determination of w_{OM} and w_{BM} weights different from the default values displayed are described in Table 3 of "Guidance on Selecting alternative weights" from step 6 of the Tool to calculate the emission factor for an electricity system¹.

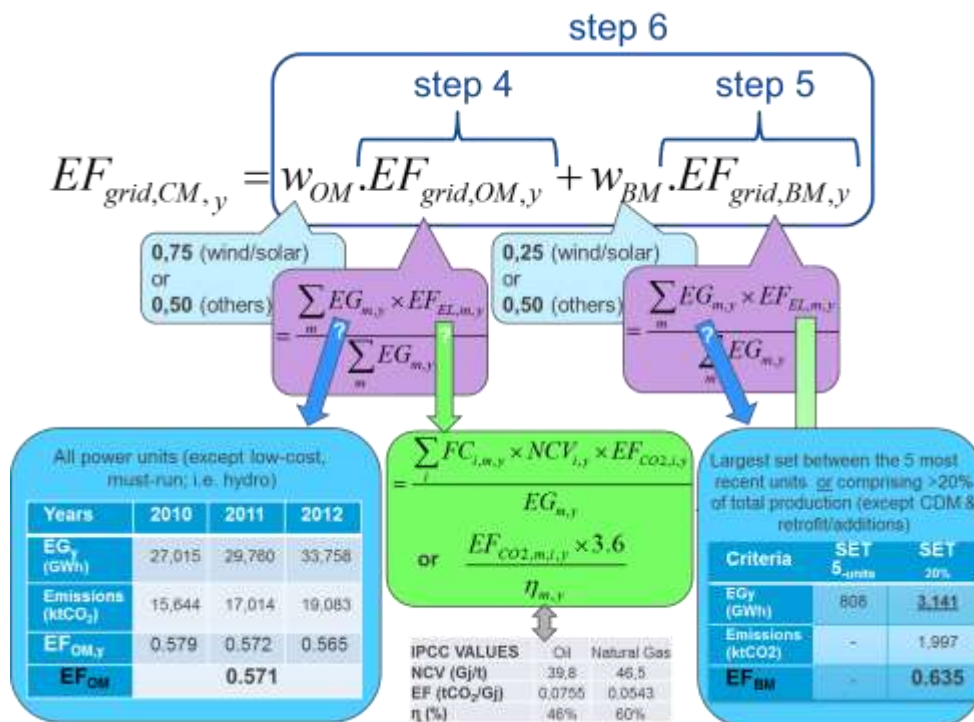


Figure 14. Summary of combined margin emission factor calculation

WAPP GEF results

Table 12: Combined Margin GEF results for the WAPP based on project type and crediting period options

Project types	1st crediting period					2nd or 3rd crediting period				
	OM	BM	CM	Wom	Wbm	OM	BM	CM	Wom	Wbm
Solar and Wind power project	0.5715	0.6357	0.588	0.75	0.25	0.5715	0.6357	0.588	0.75	0.25
Other renewables	0.5715	0.6357	0.604	0.5	0.5	0.5715	0.6357	0.62	0.25	0.75
Other projects	0.5715	0.6357	0.604	0.5	0.5	0.5715	0.6357	0.62	0.25	0.75

Note: The unusual outcome of a higher BM emission factor compared to OM emission factor is due to the lack of specific fuel consumption for major thermal plants (such as AFAM VI in Nigeria) leading to the application of conservative default values for their respective emission factors, lowering the resulting OM emission factor.

Standalone WAPP members GEF results

Table 13: Combined Margin GEF results for the standalone WAPP countries based on project type and crediting period options

Project types	1st crediting period					2nd or 3rd crediting period				
	OM	BM	CM	Wom	Wbm	OM	BM	CM	Wom	Wbm



Gambia	Solar and Wind power project	0,5892	0,5892	0,5892	0,75	0,25	0,5682	0,5682	0,5682	0,75	0,25
	Other renewables	0,5892	0,5892	0,5892	0,5	0,5	0,5682	0,5682	0,5682	0,25	0,75
	Other projects	0,5682	0,5682	0,5682	0,5	0,5	0,5682	0,5682	0,5682	0,25	0,75
Guinea Bissau	Solar and Wind power project	0,6818	0,6525	0,6745	0,75	0,25	0,6700	0,6377	0,6619	0,75	0,25
	Other renewables	0,6818	0,6525	0,6672	0,5	0,5	0,6700	0,6377	0,6458	0,25	0,75
	Other projects	0,6700	0,6377	0,6539	0,5	0,5	0,6700	0,6377	0,6458	0,25	0,75
Guinea	Solar and Wind power project	0,3036	0,3704	0,3203	0,75	0,25	0,2539	0,3274	0,2723	0,75	0,25
	Other renewables	0,3036	0,3704	0,3370	0,5	0,5	0,2539	0,3274	0,3090	0,25	0,75
	Other projects	0,2539	0,3274	0,2907	0,5	0,5	0,2539	0,3274	0,3090	0,25	0,75
Liberia	Solar and Wind power project	0,5892	0,5892	0,5892	0,75	0,25	0,5682	0,5682	0,5682	0,75	0,25
	Other renewables	0,5892	0,5892	0,5892	0,5	0,5	0,5682	0,5682	0,5682	0,25	0,75
	Other projects	0,5682	0,5682	0,5682	0,5	0,5	0,5682	0,5682	0,5682	0,25	0,75
Sierra Leone	Solar and Wind power project	0,2202	0,2679	0,2321	0,75	0,25	0,1622	0,2147	0,1753	0,75	0,25
	Other renewables	0,2202	0,2679	0,2440	0,5	0,5	0,1622	0,2147	0,2016	0,25	0,75
	Other projects	0,1622	0,2147	0,1884	0,5	0,5	0,1622	0,2147	0,2016	0,25	0,75

Notes:

- Simple OM calculation method applied to Gambia, Guinea Bissau and Liberia, while Average OM method applied to Guinea and Sierra Leone due to higher hydropower shares;
- Default off-grid inclusion (to the extent of 10 per cent of the total electricity generation, as per Option IIb) only apply for the first crediting period and for projects consisting of grid-connected renewable power generation.

WAPP GEF spreadsheet

The West African Power Pool (WAPP) Grid Emission Factor (GEF) spreadsheet is an inseparable attachment to the present report.

The calculation of the West African Power Pool (WAPP) Grid Emission Factor (GEF) was possible using Climate Focus's in-house developed model. This model is based on the UNFCCC GEF model that was under review at the time this assignment was being concluded. Hence the consultants were not able to make direct use of the UNFCCC GEF model for the WAPP GEF calculations.

The model requires specific technical and computational knowledge on both data preparation and model operation levels. This knowledge may be transferred to the relevant stakeholders through capacity building and training sessions of which an outline has been prepared in the feasibility study report.



Appendix 2: WAPP data and information

Table 14. Country specific and combined WAPP net grid generation, Low-Cost Must-Run (LC:MR) generation and share of LC:MR in relation to net grid generation.

Country	Data description	Last three most recent years			Year 3 in the previous column	3yrs avg.	% of total WAPP
		Year 1	Year 2	Year 3			
Nigeria	Net grid generation [GWh]	27,692	29,489	29,459	2013	28,880	55%
	LC:MR generation [GWh]	6,658	6,455	6,101		6,405	
	LC:MR share [%]	24.0%	21.9%	20.7%		22%	
Ghana	Net grid generation [GWh]	11,200	12,146	12,867	2013	12,071	20%
	LC:MR generation [GWh]	7,561	8,070	8,232		7,954	
	LC:MR share [%]	67.5%	66.4%	64.0%		66%	
Côte d'Ivoire	Net grid generation [GWh]	6,029	6,932	7,570	2013	6,844	13%
	LC:MR generation [GWh]	1,774	1,785	1,606		1,722	
	LC:MR share [%]	29.4%	25.8%	21.2%		25%	
Burkina Faso	Net grid generation [GWh]	472	542	655	2013	556	1%
	LC:MR generation [GWh]	82	97	106		95	
	LC:MR share [%]	17.4%	17.9%	16.1%		17%	
Benin & Togo	Net grid generation [GWh]	411	451	326	2013	396	3%
	LC:MR generation [GWh]	202	164	72		146	
	LC:MR share [%]	49.1%	36.4%	22.1%		36%	
Niger	Net grid generation [GWh]	268	140	397	2013	268	0%
	LC:MR generation [GWh]	-	-	-		-	
	LC:MR share [%]	0.0%	0.0%	0.0%		0%	
Mali	Net grid generation [GWh]	1,063	1,142	1,157	2012	1,121	2%
	LC:MR generation [GWh]	695	727	783		735	



Country	Data description	Last three most recent years			Year 3 in the	3yrs avg.	% of total WAPP
	LC:MR share [%]	65.4%	63.7%	67.7%		66%	
	Net grid generation [GWh]	2,560	2,917	3,064		2,847	
Senegal	LC:MR generation [GWh]	250	225	296	2013	257	5%
	LC:MR share [%]	9.8%	7.7%	9.7%		9%	
Guinea	Net grid generation [GWh]	554	735	654	2013	648	1.3%
	LC:MR generation [GWh]	414	491	482		463	
	LC:MR share [%]	74.8%	66.8%	73.7%		72%	
	Net grid generation [GWh]	241	246	228		238	
Gambia	LC:MR generation [GWh]	-	-	-	2013	-	0.5%
	LC:MR share [%]	0.0%	0.0%	0.0%		0%	
Guinea Bissau	Net grid generation [GWh]	32	27	0	2013	20	0.0%
	LC:MR generation [GWh]	-	-	-		-	
	LC:MR share [%]	0.0%	0.0%	-		-	
	Net grid generation [GWh]	8	11	353		124	
Liberia	LC:MR generation [GWh]	-	-	-	2013	-	0.2%
	LC:MR share [%]	0.0%	0.0%	0.0%		0%	
Sierra Leone	Net grid generation [GWh]	138	132	179	2013	150	0.2%
	LC:MR generation [GWh]	-	39	140		60	
	LC:MR share [%]	0.0%	29.9%	78.3%		36%	
	Net grid generation [GWh]					54,163	
WAPP total	LC:MR generation [GWh]		-			17,836	
	LC:MR share [%]					32.93%	



Table 15. Planned or ongoing transmission line projects within the WAPP (IRENA 2013 and the WAPP Secretariat 2014)

From	To	Stations	Voltage (kV)	Capacity per line (MW)	Distance (km)	Losses	Total investment (USD million)	Investment cost (USD/kW)	Earliest year
Dorsale 330 kV (committed)									
Ghana	Togo/Benin	Volta - Sakete	330	655,2	240	2,50%	90,0	137,4	2013
Côte d'Ivoire	Ghana	Riviera - Presea	330	655,2	240	2,00%	90,0	137,4	2015
CLSG (committed)									
Côte d'Ivoire	Liberia	Man (CI) – Yekepa (LI)	225	337,6	140	2,50%	59,7	176,9	2014
Liberia	Guinea	Yekepa (LI) – Nzerekoré (GU)	225	337,6	140	2,50%	59,7	176,9	2014
Liberia	Sierra Leone	Yekepa (LI) - Buchanan (LI) – Monrovia (LI)- Bumbuna (SI)	225	303,4	580	6,79%	247,5	815,6	2014
Sierra Léone	Guinea	Bumbuna (SI) –Lisan (GU)	225	333,7	190	2,50%	811	242,9	2014
OMVG (committed)									
Senegal	Guinea	Kaolack (SEN)-Linsan (GU)	225	286,3	800	9,37%	289%	1 012,3	2017
Senegal	Gambia	Birkelane (SE) – Soma (GA)	225	340,7	100	2,50%	36,2	106,3	2017
Gambia	Guinea - Bissau	Soma (GA) – Bissau (GB)	225	329,1	250	2,93%	90,6	275,3	2017
Guinea - Bissau	Guinea	Mansoa (GB) – Linsan (GU)	225	309,6	500	5,86%	181,2	585,0	2017
Corridor Nord									
Nigeria	Niger	Birnon Kebbi (NG) – Niamey (NI)	330	653,1	268	3,14%	143,1	219,1	2014
Niger	Togo / Benin	Zabori (NI) – Bembéréké (TB)	330	649,7	312	3,65%	166,6	256,4	2014
Niger	Burkina Faso	Niamey (NI) – Ouagadougou (BU)	330	637,5	469	5,49%	250,4	392,8	2014



From	To	Stations	Voltage (kV)	Capacity per line (MW)	Distance (km)	Losses	Total investment (USD million)	Investment cost (USD/kW)	Earliest year
Hub Intrazonal									
Ghana	Burkina Faso	Han (GH) – Bobo Dioulasso (BU)	225	332,2	210	2,50%	67,0	201,7	2014
Burkina	Mali	Bobo Dioulasso – Sikasso (MA)	225	305,8	550	6,44%	175,5	573,9	2015
Mali	Côte d'Ivoire	Ségou (MA) – Ferkessedougou (CI)	225	319,7	370	4,33%	136,9	428,3	2016
Guinea	Mali	Fomi (GU) – Bamako (MA)	225	321,3	350	4,10%	117,6	366,1	2010
Dorsale Médiane									
Nigeria	Togo / Benin	Kaindiji (NG) – Kara/Bembéréké/Parakou (TB)	330	646,7	350	4,10%	164,6	254,6	2020
Togo / Benin	Ghana	Kara / Bembéréké / Parakou (TB) – Yendi (GH)	330	654,5	250	2,93%	117,6	179,7	2020
OMVS									
Mali	Sénégal	Kayes (MA) – Tambacounda (SE)	225	329,1	250	2,93%	94,6	287,6	2018

**Table 16. Overview of WAPP members' key players and stakeholders**

WAPP members		(WAPP) operational focal point	Government focal point	stakeholders	Source or relevant comments
WAPP connected	Nigeria	(ex) Power Holding Company of Nigeria (PHCN), Corporate Headquarters Maitama, Abuja, Nigeria	Federal Ministry of Power	Generation: 6 priv. Transmission: TCN Distribution: 11 priv. Regulation: NERC	Privatization of the country's 11 distribution companies and the 6 generation companies since September 2013
	Ghana	Energy Commission, Energy Efficiency & Climate Change http://www.ecgonline.info/	Ministry of Energy	Generation: VRA + IPP Transmission (National Interconnected Transmission System (NITS)): GridCo Distribution: ECG + NED Regulation: Energy Commission & PURC	ECOWAS ERA
	Côte d'Ivoire	CIE + Société des Energies de Côte d'Ivoire (CI-ENERGIES) - planification	Ministry of Energy, Directeur du Suivi et de la Réglementation de l'Energie (DSRE)	Generation: CIE + IPP Transmission: CIE Distribution: CIE Regulation: ANARE	



WAPP members		(WAPP) operational focal point	Government focal point	stakeholders	Source or relevant comments
	Burkina Faso	SONABEL, http://www.sonabel.bf/statist/chiff_caract.htm	Ministère des Mines, des Carrières et de l'Energie	Generation: SONABEL Transmission: SONABEL Distribution: SONABEL (+FDE) Regulation: ARSE	
	Togo & Benin	WAPP Secretariat	(Benin) Direction Générale de l'Energie (DGE) (Togo) Ministère des Mines et de l'Energie	Generation, Transmission: CEB Distribution: CEET (Togo) & SBEE (Benin) Regulation: ARSE	RCC Lomé
	Niger	NIGELEC Société nigérienne d'électricité (http://www.nigelec.ne/)	Ministère de l'Energie et du Pétrole	Generation, transmission, distribution: NIGELEC Régulation:	-
	Mali	Energie du Mali (http://www.edm-sa.com.ml/)	Ministre de l'Energie et de l'Hydraulique	Generation, Transmission & Distribution: EDM Regulation: CREE	
	Senegal	SENELEC www.senelec.sn Dakar	Direction de l'Energie	Generation: SENELEC + IPP Transmission & Distribution: SENELEC Regulation: CRSE	Ousmane SARR (ASER, COMNAC)



WAPP members		(WAPP) operational focal point	Government focal point	stakeholders	Source or relevant comments
(OMVS)	<i>multi</i>	SOGEM http://www.sogem-omvs.org Bamako	OMVS (Guinée, Mali, Mauritanie Sénégal)	Production, Transport : SOGEM, EDM SA, Senelec, SOMELEC, EDG	
(OMVG, CLSG)	Guinea	EDG http://www.edgguinee.com	Ministère d'Etat en charge de l'Énergie et de l'Environnement (MEE)	Generation, transmission & distribution: EDG Regulation: -	
(OMVG)	Gambia	National Water & Electricity Company (NAWEC) www.nawec.gm Banjul	Ministry of Energy	Generation: NAWEC + IPP Transmission & Distribution: NAWEC Regulation: PURA	
(OMVG)	Guinea Bissau	Direction Général de l'Énergie (DGE) Secretaria de estado da energia, dos recursos naturais e do ambiente (state secretary for energy, natural resources and environment)	General Directorate for Energy (GDE) Ministry of Energy in Guinea Bissau	Empresa Publica de Electricidade e Aguas da Guine Bissau (EAGB) rua eduardo Mondlane Bissau phone: +245 20 11 84	http://www.reegle.info/policy-and-regulatory-overviews/GW



WAPP members		(WAPP) operational focal point	Government focal point	stakeholders	Source or relevant comments
(CLSG)	Liberia	LEC Headquarters, Waterside Monrovia, Liberia http://www.lecliberia.com/	Ministry of Land, Mines and Energy (MLME,) Department of Energy	Liberia Electricity Corporation	http://enipedia.tudelft.nl/wiki/Liberia_Electricity_Corp
(CLSG)	Sierra Leone	NPA	Ministry of Energy and Power (DNA)	National Power Authority Dr. Zubairu Kaloloko General Manager	http://enipedia.tudelft.nl/wiki/Sierra_Leone#Energy_Companies

Table 17. Overview of WAPP members' GEF status and publicly available grid data sources

Data availability		GEF calc.	Latest GEF value/data	CDM-DNA	Sources, statistics, others (prior to current assignment)	Energy imports/exports
WAPP connected	Nigeria	4	0,59 tCO ₂ /MWh (2008)	Federal Ministry of Environment Special Climate Change Unit, No. 7, Tito Broz Street, Off Jimmy Carter Street, Asokoro, Abuja, Nigeria Dr. Samuel A. Adejuwon (jareadejuwon@yahoo.com) Acting Head of the Special Climate Change Unit Phone: +(234-8) 099325886; (234-9) 7803363	2005-2008: CDM GEF data request to PHCN (PIN) 2008-2010: Generation profile, System-Operator.pptx 2011-2012: Performance Report (Min Power)	Export: yes Import: no



Data availability		GEF calc.	Latest GEF value/data	CDM-DNA	Sources, statistics, others (prior to current assignment)	Energy imports/exports
	Ghana	1	0,38 tCO ₂ /MWh (2010) +DNA GEF 2009	Ministry of Environment Science Technology and Innovation P.O. Box M232 Accra Ghana, Mr. Peter Justice Dery (peterjdery@yahoo.com) National Climate Change Coordinator Phone: (+233) 302673511 / 622626 Mobile: 0243646749	2005-2010: CDM GEF data request to ECG (PDD 5381 & PoA 7522) 2011-2012 National Energy Statistics	Export: yes Import: yes
	Côte d'Ivoire	5	0,65 tCO ₂ /MWh (2013)	Ms. Rachel Boti-Douayoua (rbdouayoua@gmail.com, botirach@yahoo.fr) CDM-DNA Coordinator Phone: +225 22 43 23 10 / +225 01 03 28 95	2005-2010: CDM GEF data request to CIE (PDD 8819) 2009-2011: PDD 8456 2011-2012: ANARE statistics	Export: yes Import: yes
	Burkina Faso	1	0,57 tCO ₂ /MWh (2010)	Secrétariat Permanent du Conseil National pour l'Environnement et le Développement Durable (SP/CONEDD) Avenue Bassawarga, Porte No. 392, 6486 Ouagadougou 01, Burkina Faso Mme. Mama Christine Liehoun (mcliehoun@yahoo.fr) Secrétaire Exécutive Phone: 00226 50 31 31 66, cell: 00226 70 24 69 73	2005-2009: CDM GEF data request to SONABEL (PIN) 2010-2012: annual report SONABEL 2012	Export: no Import: yes
	Togo & Benin	-	0,41 tCO ₂ /MWh (2011)	MINISTÈRE DE L'ENVIRONNEMENT, DE L'HABITAT ET DE L'URBANISME 01 BP 3621 DE/MEHU COTONOU République du Bénin Monsieur Ibila DJIBRIL (idjibril@yahoo.fr; idjibril@mehubenin.net) Point Focal Phone: (229) 98 94 38 Direction de l'Environnement B.P. 4825 Lomé Togo M. Koffi Volley (denv_togo@yahoo.fr, koffivolley@yahoo.fr, koffivolley@gmail.com) Phone: (228) 2 221-3321/ -5197	2006-2010: CEB statistics 2007-2011: CDM GEF data request to SBEE (PIN)	Export: no Import: yes



Data availability		GEF calc.	Latest GEF value/data	CDM-DNA	Sources, statistics, others (prior to current assignment)	Energy imports/ exports
	Niger	-	-	Secretariat Executif du CNEDD, Cabinet du Premier Ministre, B.P. 10193 NY, Niamey, Niger; Docteur Kamayé Maâzou (biocnedd@intnet.ne, kamayemaazou@yahoo.fr) Secrétaire Exécutif du CNEDD Phone: (+227) 207 22 559/ (+227) 207 242 64 /(+227) 969 8	2006-2008: Annuaire Statistiques	Export: no Import: yes
	Mali (OMVS)	1	0,58 tCO ₂ /MWh (Felou Mali/Senegal 2006, by WB-CF & EcoSecurities)	Agence de l'Environnement et du Développement Durable (AEDD) BP 2357, Bamako, Mali; Monsieur Boubacar Sidiki Dembele (aedd@environnement.gov.ml, boubacarsdembele@gmail.com) Phone: (+223) 2023 1074	2004-2008: CDM GEF data request to EDM (PIN) 2008-2012: EDM webdata	Export: yes Import: yes
	Senegal (OMVS)	3	0,67 tCO ₂ /MWh (2008)	Direction de l'Environnement et des Etablissements Classés 106, Rue Carnot, Dakar, BP 6557 Dakar Etoile (denv@sentoo.sn) Phone: (221) 821 07 25	2006-2008: CDM GEF data request to SENELEC (PDD 3286, 2009 PDD 5846) 2007-2010: rapport annuel SENELEC 2011-2013: SENELEC/CRSE report	Export: no Import: yes
(OMVG 2017, CLSG 2017, OMVS)	Guinea	1 (PIN)	0,49 tCO ₂ /MWh (2008)	Ministère du Développement Durable et de l'Environnement, Conakry, Guinée Dr. Ahmed Faya Traore (traoraf@yahoo.fr) Project Changement Climatique, Suppléant au Coordonnateur Phone: (224 60) 37 95 69 Mr. Mamadou Saliou Diallo (saliouprof@yahoo.fr) Coordonnateur Phone: (224-60) 27 89 09	2005-2008: CDM GEF data request to EDG (PIN) 2010-2011: EDG report 2011	N/A



Data availability		GEF calc.	Latest GEF value/data	CDM-DNA	Sources, statistics, others (prior to current assignment)	Energy imports/ exports
(OMVG 2017)	Gambia	1 (val)	0,724 tCO ₂ /MWh (2012)	The Ministry of Environment, Parks and Wildlife, Ms. Fatou Ndeye Gaye (fatndeye@yahoo.co.uk) Phone: +220-4399447 / 997 4119 The Ministry of Environment, Parks and Wildlife, Mr. Bubacarr Jallow (bubazj@gmail.com) Principal Climate Change Officer	2010-2013: CDM GEF data request to NAWEC (WB-PDD The Gambia National CFL Distribution Program)	N/A
(OMVG 2017)	Guinea Bissau	-	-	Secretaria de Estado do Ambiente e Desenvolvimento Durável, Bairro Santa Luzia, Antiga QG - Bissau República da Guiné-Bissau, Viriato Luís Soares Cassamá (cassamavilus@gmail.com) DNA Focal Point Phone: +245 678 40 46	2006-2008: GTZ country chapter (EAGB) 2008: IRENA country profile	N/A
(CLSG 2017)	Liberia	-	-	Environmental Protection Agency of Liberia 4th Street, Sinkor P. O. Box 4024 Monrovia, Liberia, Mr. Benjamin S. Karmorh, Jr. (benkarmorh@yahoo.com) Phone: (231-6)51 8928	2004-2008: GTZ country chapter (LEC) 2008: IRENA country profile	N/A
(CLSG 2017)	Sierra Leone	1	0,40 tCO ₂ /MWh (2010)	Ministry of Energy and Power, Benjamine Kamara (benjaminkamara@gmail.com) Director - Energy Division Phone: (232) 76 369538	2006-2010: CDM GEF data request to NPA (PDD 9556)	N/A



Appendix 3: WAPP members' grid ID



1. Nigeria

Capital city	Abuja	Electricity use per capita (kWh)	126
Population (M.)	158.3	Ease of Doing Business	147/189
GDP per capita	\$ 1,224	CDM projects registered (in prog.)	13 (5)

Electricity situation in brief

Electricity in Nigeria is supplied through large-scale thermal power and hydroelectric power plants and a 330 kV and 132 kV nationwide transmission network through the Power Holding Company of Nigeria (PHCN), until privatization of the country's 11 distribution companies and the 6 generation companies since September 2013. Most of the generating facilities are old and outdated, yet cannot be overhauled due to the lack of reserve capacity.

Overview of power sector structure and policy framework

The Nigerian Electricity Power Authority (NEPA) was established as a vertically integrated monopoly with responsibility to generate, transmit and distribute electricity throughout the country, until sector privatization. The Transmission Company of Nigeria (TCN) retains transmission mandate.

Renewable energy objectives & resources brief

At present, there are no special incentives for distributors, manufacturers and users of RE systems. In 2025, the electricity demand is projected to increase to 29,000 MW with new RE satisfying up to 10 % of the country's overall energy demand. Biomass is a leading source of energy for Nigeria, which is also situated in a belt of high sunshine. Besides, hydro power resources are estimated to about 3,500 MW.

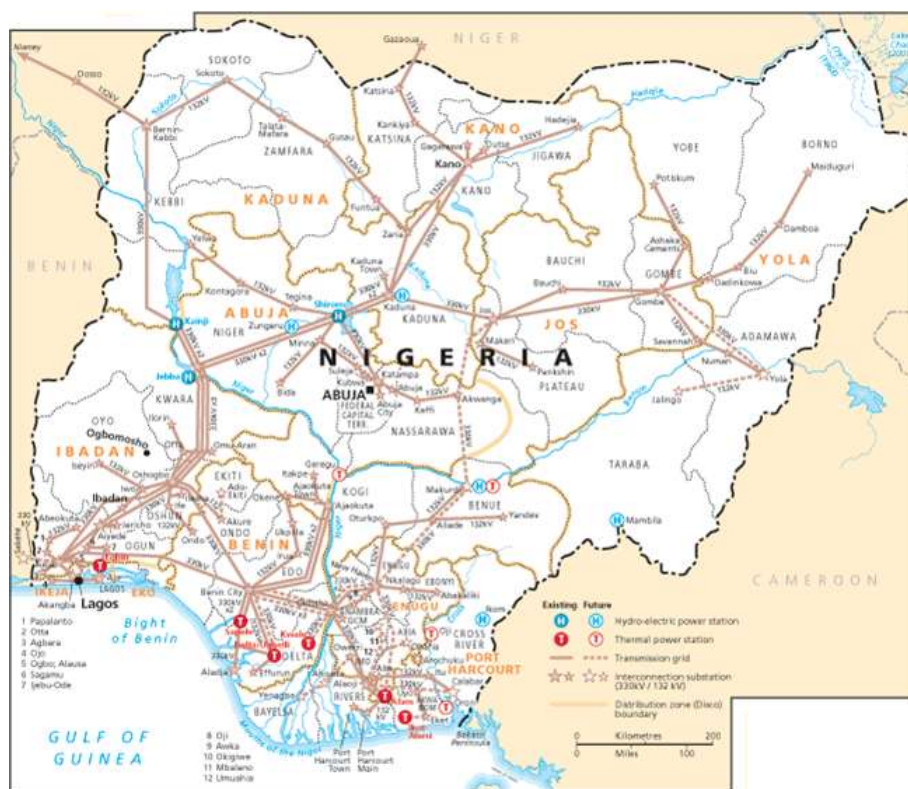
Market risks and barriers

Price distortions, poor regulatory environment and inadequate infrastructure define the current energy market conditions in Nigeria reducing the scope for competition, growth and innovation in the market. The Nigerian business environment is characterized by weak infrastructure, poorly implemented incentives, massive smuggling, counterfeiting and dumping of products, lack of standardization required for international competitiveness, unfavourable international trade rules, a national trade policy stance which is endemically unpredictable, high transaction costs at ports, complicated customs clearance procedures, tariffs and non-tariff barriers.

installed capacity (MW)	10,915	2013 total generation (GWh)	29,459
renewable energy share	20% of GWh total	Grid Emission factor (tCO ₂ /MWh)	0.59
WAPP interconnections	Niger, Benin		
main RE projects			

WAPP stakeholders

Entity(ies):	Transmission Company of Nigeria (TCN)	Address:	TCN Headquarters, Maitama, Abuja
Contact person:	Emmanuel A. Anumaka	Email:	eaanumaka@gmail.com
Position:	AGM System Planning & Economics	Tel:	+234(0)8023043013





2. Ghana

Capital city	Accra	Electricity use per capita (kWh)	266
Population (M.)	24.3	Ease of Doing Business	67/189
GDP per capita	\$ 1,287	CDM projects registered (in prog.)	6 (5)

Electricity situation in brief

In the last few years, the predominant source of electric power and major energy source in Ghana was hydro, but Ghana is a net importer of electricity. In order to meet the Volta River Authority's (VRA) planned generation capacity, electricity generated in Ghana is complemented with imports from Côte d'Ivoire, a neighbouring country. Ghana, however, also exports electricity to neighbouring countries such as Togo, Burkina Faso and Benin.

Overview of power sector structure and policy framework

The main actors for energy planning and regulation in Ghana are the relevant public institutions responsible for producing and enacting laws that regulate the distribution and tariffs: The Volta River Authority (VRA) is responsible for the generation of electricity in Ghana, in addition to Independent Power Producers. The Ghana Grid Company is responsible for power transmission and supplies electricity in bulk to the Electricity Company of Ghana (ECG) and NEDCo for onward distribution. The Energy Commission and the Public Utilities Regulatory Commission (PURC) function as technical and commercial regulatory agencies respectively. Recently, the private sector has been involved in the promotion of RE as an additional contributor to the national energy mix.

Renewable energy objectives & resources brief

The Energy Commission has recommended the integration of RE technologies as alternative sources to the energy mix of Ghana. 10% of electricity generation should origin from renewables by 2020 according to Parliament's set target. Hydro remains the highest RE potential, with 3 major hydroelectric plants already operating.

Market risks and barriers

The Government of Ghana has committed itself to establishing a new "Golden Age of Business" for the private sector. Various incentives and benefits are generally offered to most investors under Ghana's new Investment Promotion Act (GIPC). Through the GIPC, the Government is now a facilitator and promoter of investments, unlike previously when its interest was in investment regulation.

installed capacity (MW)	2,814	2013 total generation (GWh)	12,867
renewable energy share	63% of GWh total	Grid Emission factor (tCO ₂ /MWh)	0.38
WAPP interconnections	CI, Togo, Burkina (2015)		
main RE projects	155 MW Nzema solar PV		

WAPP stakeholders

Entity(ies):	Ghana Grid Co. Ltd	Address:	CS 7979, Tema
Contact person:	Bernard Modey	Email:	bernard.modey@gridcogh.com
Position:	Director, System Operations		





3. Côte d'Ivoire

Capital city	Yamoussoukro	Electricity use per capita (kWh)	209
Population (M.)	24 (est.)	Ease of Doing Business	167/189
GDP per capita	\$ 1,056	CDM projects registered (in prog.)	6

Electricity situation in brief

Most of the electricity is generated through conventional thermal power stations (> 70 %), with hydroelectricity supplying the remainder. The 432 MW CIPREL gas power station, located in Abidjan's suburbs, produces more than a third of the country's electricity. Electricity is exported through the West African Power Pool (WAPP).

Overview of power sector structure and policy framework

The Ivorian Electricity Company (CIE) has been granted public concession for the power utility and exploits electricity generation, conveyance, distribution and export facilities on behalf of the State (General Direction of Energy, Ministry of Petroleum and Energy). The National Regulatory Agency (ANARE) is the regulatory authority for the electricity sector, while the newly created CI-ENERGIES is responsible for management of planification and investments.

Renewable energy objectives & resources brief

In 2005, the decision to establish a Renewable Energy Directorate has set a distinctive hallmark in the official RE development policy. The Electricity Code adopted by the Assembly in March 2014 should promote, among other, the development of the RE sub-sector in Côte d'Ivoire; the set target being 15% by 2020. The most prominent RE potential is hydro power, with four large identified hydroelectric sites that have not been developed yet. There is also a huge potential for energy generation based on renewable biomass and residues from agro-industrial plantations and facilities.

Market risks and barriers

The business environment in Côte d'Ivoire is ruled by effective national and regional legal institutions and instruments (OHADA treaty, Labor Code, Environment Code, etc.). Simplifications in legal and fiscal framework conditions for the implementation and promotion of RE are ongoing.

installed capacity (MW)	1,632	2013 total generation (GWh)	7,570
renewable energy share	21%	Grid Emission factor (tCO ₂ /MWh)	0.65
WAPP interconnections	Ghana, Burkina, Mali. CLSG (2017)		
main RE projects	225 MW Tiboto Hydro, 275 MW Soubre hydro (2017), BIOVEA 42 MW biomass		

WAPP stakeholders contacts

Entity(ies): CI-ENERGIES

Contact person/position:

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Serge AHOUSOU, DEP

4. Burkina Faso

Capital city	Ouagadougou	Electricity use per capita (kWh)	43
Population (M.)	16.3	Ease of Doing Business	154/189
GDP per capita	\$ 542	CDM projects registered (in prog.)	1 (1)

Electricity situation in brief

The electricity consumption of Burkina Faso is met by local production and imports from Ghana and Côte d'Ivoire. The monopolist SONABEL is fully responsible for the production, import and distribution of electricity in Burkina Faso.

Overview of power sector structure and policy framework

In the overall reorganization of the electricity sector adopted in 2007 to regulate the national electric energy supply, several authorities are involved: the Ministry of Energy (responsible for energy policy, general control and planning), and the Ministry of Trade (responsible for the fixation of the electricity price)

Renewable energy objectives & resources brief

Given the considerable potential of RE resources in Burkina Faso, a guiding principle for PV was outlined in a commitment to promote the development of a national solar central plant. Burkina Faso has strong potential in the field of solar energy, including potential in rural areas - sufficient for a decentralized electricity production.

Market risks and barriers

Due to the lack of financial resources, many companies in Burkina Faso need to operate with supplier credits or documentary credits. Besides corruption, the lack of local expertise and outdated technical equipment, high costs for research and development as well as mostly capital intensive technologies are substantial barriers for the broad implementation of RE.

installed capacity (MW)	219	2013 total generation (GWh)	655
renewable energy share	16%	Grid Emission factor (tCO ₂ /MWh)	-
WAPP interconnections	Cote d'Ivoire, Niger. Likely to be connected to Ghana, Mali		
main RE projects			

WAPP stakeholders

Entity(ies): SONABEL

Contact person: Tou Adama

Position: Head of transport

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Email: adama.tou@sonabel.bf



5. Bénin

Capital city	Cotonou	Electricity use per capita (kWh)	86
Population (M.)	9.2	Ease of Doing Business	174/189
GDP per capita	\$ 720	CDM projects registered (in prog.)	-

Electricity situation in brief

The electricity sector of Benin is state-owned and managed by the Benin National Power Utility (SBEE), the exclusive owner of thermal power stations and the national electricity network. The existing shortage in energy production capacity results in an insecurity of power supply (mainly caused by a lack of production capacities) and has forced industrial enterprises to set up stand-by power generators of their own.

Overview of power sector structure and policy framework

The Ministry of Energy and Water is responsible for the overall electricity sector and all related policies in this field. The Communauté Electrique du Bénin (CEB) is the state-owned international electricity company of Benin and Togo. CEB is fully in charge of the production, distribution and import of electricity in both countries and is therefore jointly owned and managed by Benin and Togo. The Benin National Power Utility (SBEE) is largely involved in the overall electricity distribution within the national territory of Benin.

Renewable energy objectives & resources brief

The existing policies for renewable energy aim to promote and develop the utilization of available RE resources in order to satisfy the demand of energy in remote and rural areas (50% of rural electricity from renewables by 2025). A significant potential of sustainable biomass resources is available for heat and electricity production, as well as important hydro resources.

Market risks and barriers

In spite of already implemented mechanisms that support the investment in the energy sector, it is difficult to register for a purchase agreement as potential investors have to discuss their application with two state monopolists (CEB for the production and the SBEE for the distribution of energy). There are also some risks in legal aspects. Outdated technology, the lack of technical knowledge and inadequate finance are major barriers in the implementation of RE in Benin. Also, no incentive measures like exemption from taxes or other benefits are available for potential investors.

installed capacity (MW)	172	Total generation (GWh)	231
renewable energy share	18.9%	Grid Emission factor (tCO ₂ /MWh)	0.41
WAPP interconnections	Togo, Nigeria. Likely to be connected to Niger (2018)		
main RE projects	147-MW Adjarala hydro		

6. Togo

Capital city	Lomé	Electricity use per capita (kWh)	99
Population (M.)	6.8	Ease of Doing Business	157/189
GDP per capita	\$ 465	CDM projects registered (in prog.)	1 (1)

Electricity situation in brief

The national production capacity includes thermal and hydropower installations under the management of the CEB, the Electric Energy Company of Togo (CEET) and some independent producers. Additional imports of electricity origin from Ghana, Côte d'Ivoire and Nigeria.

Overview of power sector structure and policy framework

The energy sector of Togo is very complex due to numerous institutions involved in the sector. The Ministry of Mines, Energy and Water develops and implements policies for the overall energy sector. Many other institutions and organizations from private and public sector also participate in the overall management of this sector. This includes the CEB, the CEET and the Regulation Authority of the Electricity Sector (ARSE).

Renewable energy objectives & resources brief

In Togo, there are currently no dedicated policies for Renewable Energies. Biomass is the highest RE potential in Togo, estimated at 2.6 million toe and mainly consisting of wood, charcoal, and vegetable waste.

Market risks and barriers

There is a significant lack of regulatory instruments for private investments to the sector. Up to now, there are no mechanisms or incentives that are suitable to attract investors from the private sector. Recent laws regulate the establishment of appropriate prices, properties and services which should help to prevent market distortions and discriminatory practices.

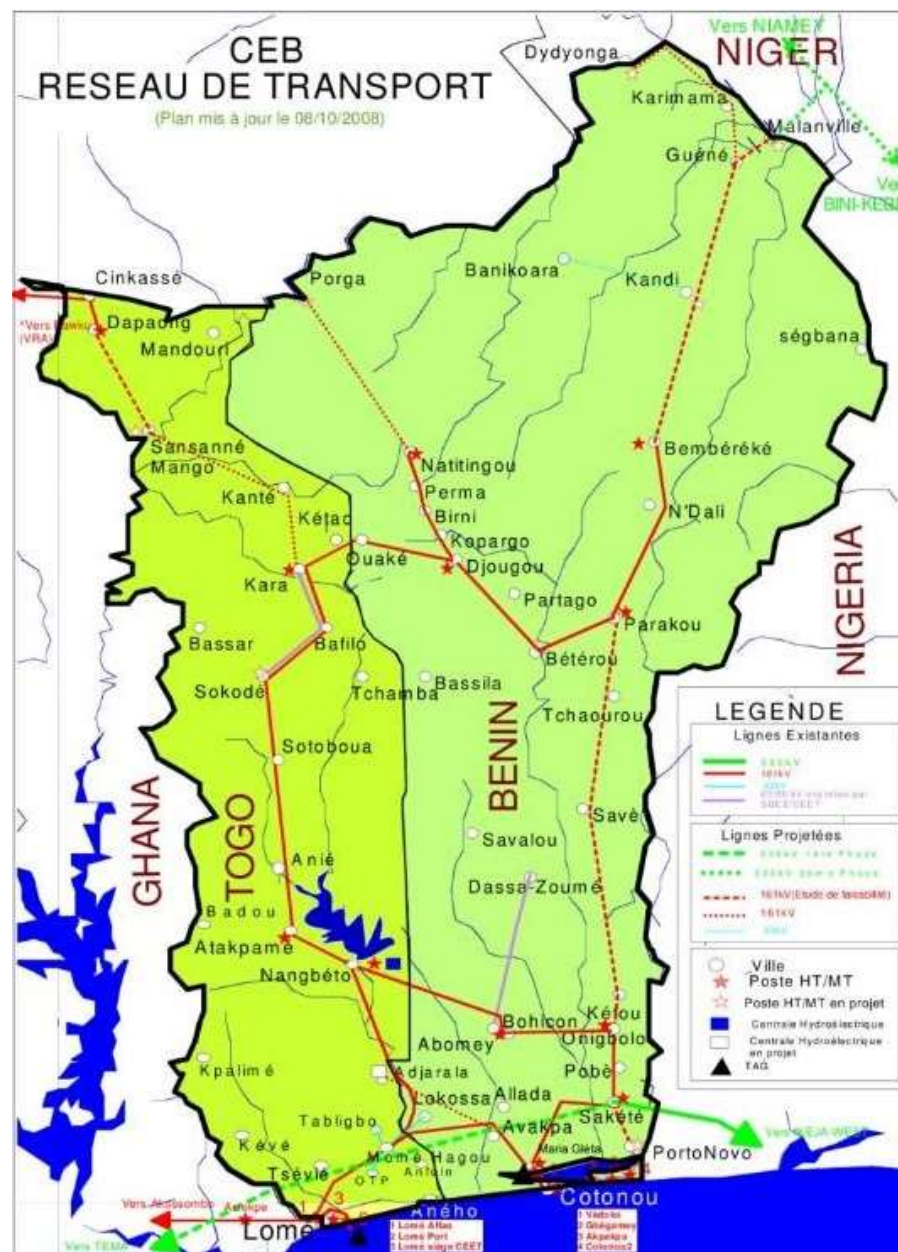
installed capacity (MW)	168	Total generation (GWh)	220
renewable energy share	20.3%	Grid Emission factor (tCO ₂ /MWh)	-
WAPP interconnections	-		
main RE projects	-		

WAPP stakeholders

Entity(ies): CEB
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Email: n.kindadoussi@cebnet.org





7. Niger

Capital city	Niamey	Electricity use per capita (kWh)	43
Population (M.)	15.9	Ease of Doing Business	176/189
GDP per capita	\$ 349	CDM projects registered (in prog.)	1

Electricity situation in brief

In Niger, 87 % of the electricity is imported from Nigeria through an interconnecting network. The local thermal coal and diesel production represents 13 %.

Overview of power sector structure and policy framework

The import, transport, distribution and production of electricity are controlled by the Ministry of Mining and Energy (MME). NIGELEC, a national electrical company created in 1968, has the monopoly of the transport and distribution of the electricity power supply nationwide.

Renewable energy objectives & resources brief

Up to now, RE is not subject to any legislative text of Niger. A law on renewable energy, however, is currently being formulated. Through this law, the Government can provide support in the form of loans, subsidies, fiscal advantages etc. in order to promote the increased utilization of RE. Wind power potential exists in the North (average wind speed of 5 m/s) as well as solar potential country-wide.

Market risks and barriers

In view of administrative, economic and political issues, no significant risks are identified for investments in Niger. In the promotion of the private sector, the legal security of business is a major objective aiming at the implementation of business jurisdiction.

installed capacity (MW)	164	2013 total generation (GWh)	397
renewable energy share	0%	Grid Emission factor (tCO ₂ /MWh)	-
WAPP interconnections	Nigeria (Benin, ...)		
main RE projects			

WAPP stakeholders

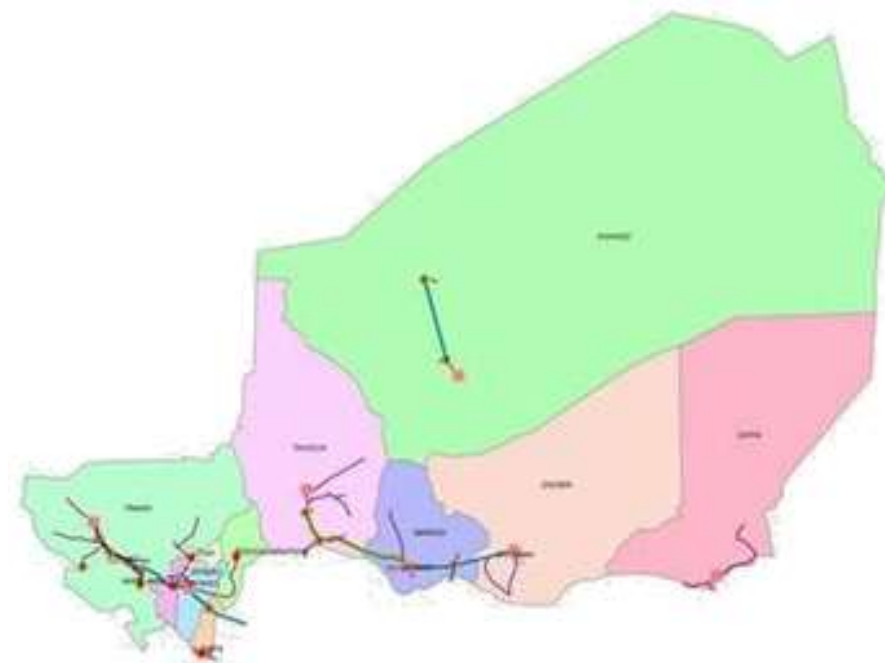
Entity(ies): NIGELEC

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Contact person: Djibril MAILELE

Email: djibril.mailele@hec.ca

Position: Head of
production & transport





8. Mali

Capital city	Bamako	Electricity use per capita (kWh)	111
Population (M.)	15.4	Ease of Doing Business	155/189
GDP per capita	\$ 602	CDM projects registered (in prog.)	1 (1)

Electricity situation in brief

The electricity industry was state owned up to year 2000 reforms in the sector. IPS West Africa is now holding 34 % of the Malian utility “Énergie du Mali” (EDM-SA). In addition to the Interconnected Network facilities, EDM-SA operates nineteen isolated centers equipped with diesel generators and two centers supplied by a network from Côte d'Ivoire.

Overview of power sector structure and policy framework

The Ministry of Energy, Mines and Water (MEMW) supervises the entire electricity policy and planning activities. A deep reform of the sector resulted in : the privatization of the utility “Énergie du Mali (EDM - SA)”, the creation of the Commission of Electricity and Water Regulation (CREE), the establishment of a legislative and regulatory policy, regulation, planning and coordination of the electricity sector, the disengagement of the Government from operational activities of electricity industry, in particular production, transmission, and distribution, and the opening of the electricity sector to private operators of any origin.

Renewable energy objectives & resources brief

Mali doesn't have a structured renewable energy market. The RE sub-sector still appears mainly as informal. However, Mali has always had a proactive policy with regard to renewable energies, targeting 25% of electricity generation from renewables by 2020. Main renewable energy potential is from solar (average solar radiation of 6 kWh/m² per day), hydro power (less than 15 % of national potential currently exploited) and wind.

Market risks and barriers

The Code of Investments in Mali established a privileged tax system in order to promote the investments of private (national and foreign) capital for production activities and service deliveries. However, there is a lack of enforcement of the existing energy policy, and no dedicated body for quality control at the borders of the country aiming to select good comparative standards for the market.

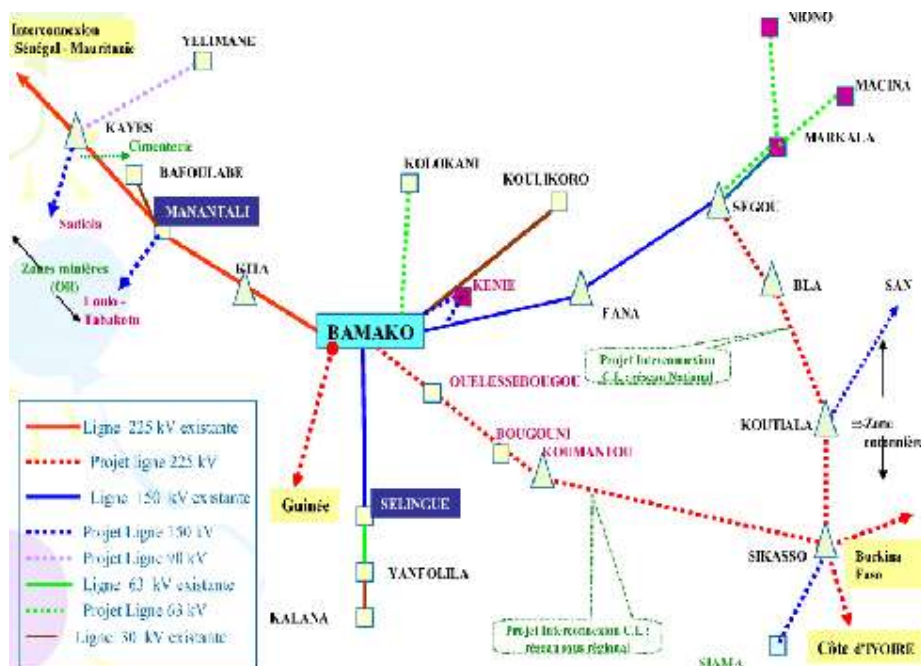
installed capacity (MW)	220	2013 total generation (GWh)	519
renewable energy share	43%	Grid Emission factor (tCO ₂ /MWh)	0.58
WAPP interconnections	Senegal, CI		
main RE projects	60 MW Felou (Mali/Senegal shared) Hydropower II		

WAPP stakeholders

Entity(ies): EDM

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9. Senegal

Capital city	Dakar	Electricity use per capita (kWh)	158
Population (M.)	12.9	Ease of Doing Business	178/189
GDP per capita	\$ 1,007	CDM projects registered (in prog.)	6 (4)

Electricity situation in brief

Electricity consumption in Senegal has risen at an average of 6 % per annum over the past ten years. The electrical system of SENELEC consists of two subsystems: the interconnected system network and that of the non-interconnected system. A part of the generated energy is not supplied to the transmission and distribution systems due to switching disruptions and outages.

Overview of power sector structure and policy framework

SENELEC (Société Nationale d'Électricité du Sénégal) had a monopoly for the grid-connected generation, transmission and distribution of Senegal's electricity. Now an unbundling is planned so that generation and distribution are opened for private investors.

Renewable energy objectives & resources brief

Senegal has a very high yet still unexploited solar energy potential. However, the Senegalese government expects to increase the role of renewable energies in the future, targeting 15% of primary energy from renewables by 2025.

Market risks and barriers

Sharp increase in energy losses is based on system malfunctions (at a rate of 88 %), insufficient production capacities and cancellations from big clients. Feed-in of the electricity in the SENELEC grid by large excedentary industries has not been achieved due to contractual difficulties.

installed capacity (MW)	683	2013 total generation (GWh)	2,592
renewable energy share	0%	Grid Emission factor (tCO ₂ /MWh)	0.67
WAPP interconnections	Mali. Likely to be connected through the OMVG (2017)		
main RE projects	60 MW Felou (Mali/Senegal shared) Hydropower II -		

WAPP stakeholders

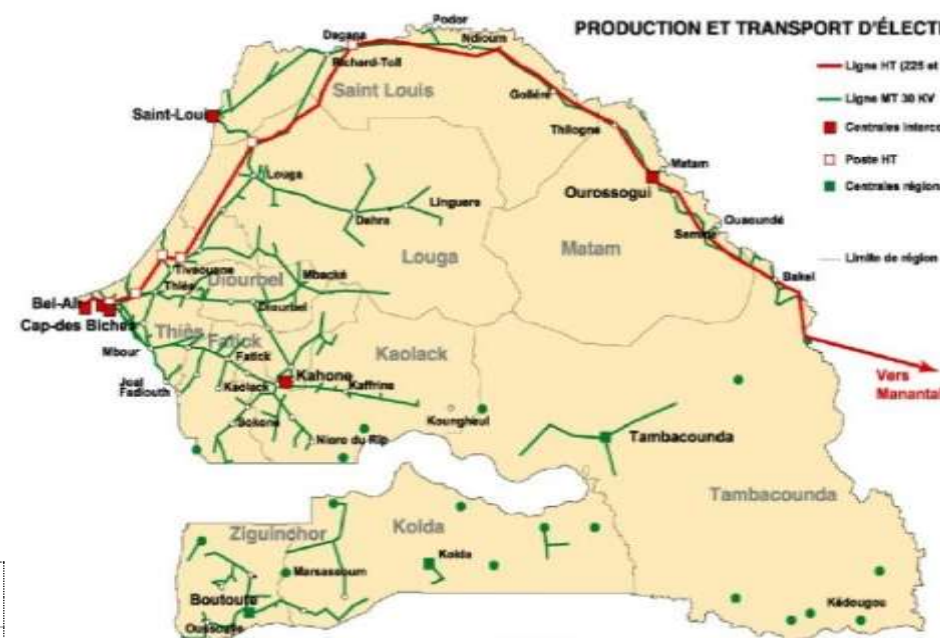
Entity(ies): SENELEC

Contact person: Abdoulaye DIA

Position: Head of transport and power procurement

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Dakar

Email: abdoulaye.dia@senelec.sn





10. Guinea

Capital city	Conakry	Electricity use per capita (kWh)	102
Population (M.)	10.3	Ease of Doing Business	175/189
GDP per capita	\$ 437	CDM projects registered (in prog.)	-



Electricity situation in brief

The installed electricity production capacity equals approximately 239 MW and is provided by 9 hydroplants and 18 thermal power plants. Due to particularly dilapidated state of the electric power industry (access, billing and recovery rates), Guinea is suffering from a severe drop of its electrification rate.

Overview of power sector structure and policy framework

The Ministry of Energy and Hydraulics (MEH) is in charge of the supervision, control and regulation of the sector. The Electricité de Guinée (EDG) Company is in charge of the electricity sector.

Renewable energy objectives & resources brief

There is no institutional framework for Renewable Energies (RE). Electricity Master Plan under validation (2008). Guinea has a considerable Hydro Power potential of about 6,000 MW, as well as wind power potential which assessment however lacks a systematic and concise approach.

Market risks and barriers

At present, the sector's development remains highly dependent on the establishment of an intervention framework promoting private operators' involvement. In addition, the political instability of the country also represents a risk constraining the country's economic growth in general and the energy sector's growth in particular.

installed capacity (MW)	203	2013 total generation (GWh)	654
renewable energy share	73%	Grid Emission factor (tCO ₂ /MWh)	0.49
WAPP interconnections	Isolated. Likely to be connected through the OMVG and CLSG (2017)		
main RE projects	515 MW Souapiti Hydropower 118 MW Kassa B Hydropower		

WAPP stakeholders

Entity(ies): EDG
Contact person: BARRY ALPHA OUMAR
Position: Production &
Transport director

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11. Gambia

Capital city	Banjul	Electricity use per capita (kWh)	136
Population (M.)	1.8	Ease of Doing Business	150/189
GDP per capita	\$ 461	CDM projects registered (in prog.)	(1)

Electricity situation in brief

The electricity power supply of Gambia was highly inadequate, erratic and extremely unreliable until the August 2006 commissioning of the first IPP power plant in Brikama (26 MW).

Overview of power sector structure and policy framework

The energy sector of Gambia is controlled by the Department of State for Petroleum, Energy and Mineral Resources (DoSPEMR). At the moment, the national utility of NAWEC is the only provider of grid-electricity in the rural areas.

Renewable energy objectives & resources brief

There is no legislation for the RE sector at the moment. It is, however, expected to be formulated under the Renewable Energy and Energy Efficiency program of the GEF-UNIDO Energy Program for West Africa. Solar energy is one of the most promising RE sources of the country.

Market risks and barriers

The Gambian Government has made the process for private sector participation as transparent as possible in order to minimize the issue of corruption. Yet, capacity for trained personnel has been recognized as inadequate.

installed capacity (MW)	100	2013 total generation (GWh)	228
renewable energy share	0%	Grid Emission factor (tCO ₂ /MWh)	0.724
WAPP interconnections	Isolated. Likely to be connected through the OMVG (2017)		
main RE projects	-		

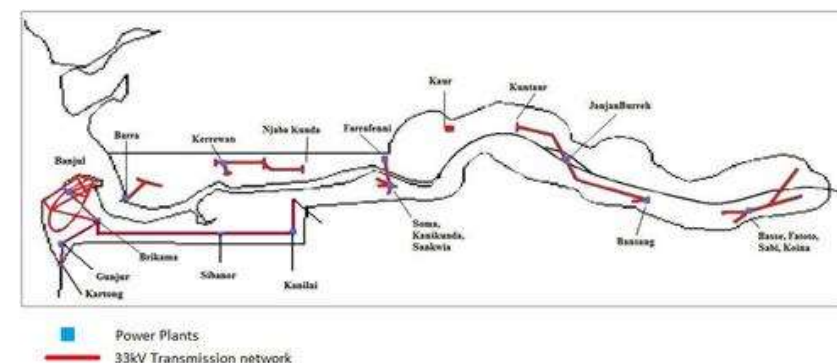
WAPP stakeholders

Entity(ies): NAWEC

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Contact person: Pateh Sowe

Email: patehsowe2002@yahoo.com





12. Guinea Bissau

<i>Capital city</i>	Bissau	<i>Electricity use per capita (kWh)</i>	10
<i>Population (M.)</i>	1.6	<i>Ease of Doing Business</i>	180/189
<i>GDP per capita</i>	\$ 533	<i>CDM projects registered (in prog.)</i>	-

Electricity situation in brief

Guinea-Bissau's infrastructures of electricity production are in a bad state and the capacity is very insufficient. There is a considerable lack and malfunction of infrastructures for electricity production.

Overview of power sector structure and policy framework

The electric system of Guinea-Bissau is managed by the Electricity and Water Company of Guinea-Bissau (Electricidade e Águas de Guinea-Bissau – EAGB). At the regulatory level, the Ministry of Energy delivers import and export licenses for all types of energy products and technologies.

Renewable energy objectives & resources brief

Up to now, there are no regulations, incentives and legislative framework conditions that support the implementation of RE in Guinea-Bissau. Main RE potential lies in solar (promising insolation of 3,000h per year) and biomass.

Market risks and barriers

The political instability after the civil war is still discouraging national and international investments. Other substantial risks and barriers include corruption, high costs, insufficient human resources and the absence of a coherent institutional and regulatory framework. The most critical technical barrier is the lack of accurate data on available RE resources.

installed capacity (MW)	11	historical total generation (GWh)	27
renewable energy share	0%	Grid Emission factor (tCO ₂ /MWh)	-
WAPP interconnections	Isolated. Likely to be connected through the OMVG (2017)		
main RE projects	-		

WAPP stakeholders

Entity(ies): EAGB



13. Liberia

Capital city	Monrovia	Electricity use per capita (kWh)	87
Population (M.)	4.1	Ease of Doing Business	144/189
GDP per capita	\$ 240	CDM projects registered (in prog.)	1

Electricity situation in brief

All power generation facilities were severely damaged during the 14-year civil war, reducing the installed capacity from about 412 MW down to 25 MW. There are no reliable data on the overall electrical energy consumption in Liberia as there are numerous privately owned generators of various capacities scattered across the country.

Overview of power sector structure and policy framework

the Liberia Electricity Corporation (LEC) is the only institution responsible for the generation, transmission, distribution and sale of electricity under policy guidance of the Ministry of Lands, Mines and Energy

Renewable energy objectives & resources brief

The draft National Energy Policy (NEP) declares that by 2015, the share of RE in the overall energy consumption shall account for 30 % of the electricity production. Main RE potential lies in biomass, which Liberia is endowed with abundant resources, and hydro power (which used to deliver above 70 MW before the civil war).

Market risks and barriers

The stagnation of the Liberian economy due to the prolonged internal conflict has created numerous impediments to investment and market development. The lack of energy policy and infrastructure (especially electricity), roads and good transport systems are major barriers for investment and trade. Moreover, the current monopoly of the National Power Utility continues to be an obstacle to private investment in the power sector. And last, but not least, endemic corruption on all levels of the society continues to be a major risk for the national market.

installed capacity (MW)	25	2013 total generation (GWh)	-
renewable energy share	0%	Grid Emission factor (tCO ₂ /MWh)	-
WAPP interconnections	Isolated. Likely to be connected through the CSLG (2017)		
main RE projects	64 MW Mount Coffe hydro rehabilitation		

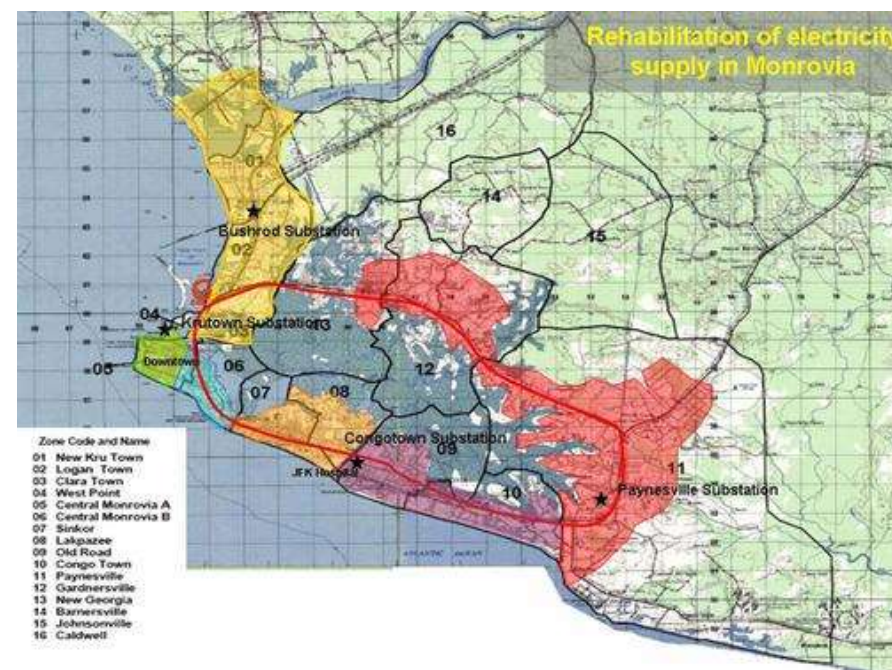
WAPP stakeholders

Entity(ies): LEC

Address: P. O. Bos 10-165, 1000 Monrovia, 10 Liberia

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Email: kentelco@gmail.com





14. Sierra Leone

Capital city	Freetown	Electricity use per capita (kWh)	11
Population (M.)	5.8	Ease of Doing Business	142/189
GDP per capita	\$ 326	CDM projects registered (in prog.)	1

Electricity situation in brief

The electricity industry consists of the Western Area grid centered in Freetown and the provincial systems (of which only Bo-Kenema Power Services still operates, following destruction during civil conflict). The estimated national private generation is in the order of 80 MW. The insecurity of power supply coupled with the inadequate distribution capacity of the NPA has forced most businesses to rely on an energy generation of their own in spite of its high costs.

Overview of power sector structure and policy framework

The National Power Authority Act of 1982 established the NPA as the entity with the sole responsibility for carrying out power generation (including Hydro Power), transmission, distribution and supply in the country.

Renewable energy objectives & resources brief

As defined in the energy policy draft document, the main policy target for electricity is to provide access for 35 % of the population by 2015. Hence, no contribution of Renewable Energy to electricity was mentioned. Main RE potential lies in biomass and hydro power.

Market risks and barriers

The lack of an energy sector policy as well as a legal and regulatory framework is a significant barrier to private sector entry in the electricity supply chain. The current financial situation in the power sector is very unsatisfactory. Illegal connections and the lack of a proper customer census are some of the factors contributing to this situation.

installed capacity (MW)	80	2013 total generation (GWh)	188
renewable energy share	24%	Grid Emission factor (tCO ₂ /MWh)	0.4
WAPP interconnections	Isolated. Likely to be connected through the CSLG (2017)		
main RE projects	86 MW Bikongor Hydropower, Addax Bioenergy, Bumbuna II		

WAPP stakeholders

Entity(ies): NPA

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Countries ID sources:

- WAPP secretariat annual report (2013)
- IRENA country profiles (2013)
- GTZ country chapters (2009)
- WAPP members' updates (2014)