"Electricity Trade & Capacity Expansion Options in West Africa"

Demonstration of Generation Expansions for 2002 to 2012

PURDUE UNIVERSITY
F.T. Sparrow, Diakalia Sanogo, Brian H. Bowen
March 25, 2002

Demonstration results are shown of WAPP ten-year generation expansions, from 2002 to 2012, with the assumption that the cost of natural gas remains constant across the region (specified, as \$2.5 per 10^6 Btu, by ECOWAS at World Bank Meeting of March 6-7, 2002). Two demonstration scenarios are considered. The second scenario differs from the first only in that it delays the operation of the Nigeria to Benin transmission line by four years.

Total regional costs to WAPP, for the ten-year horizon, amount to \$8.932 billions. There is a \$130 million increase to the region with scenario #2 (1.45% increase). There is also substantial cost incurred from unserved energy (\$140 per MWh) and the unmet reserve penalty (\$2 million per MW). The total cost of these two shortages amounts to \$2507.11 millions (28% of total regional cost). The bulk of this occurs in Guinea where there is a massive increase in demand taking place before the large increase in supply can occur with the proposed new hydropower station at Complexe Suoapiti.

It's important to note that with constant gas prices across the region that the exporting role of Nigeria for electricity is nolonger significant. Exports to Benin are clearly much reduced in Scenario #2. More hydropower is also built in Nigeria in Scenario #2 and reason for this is yet to be identified. Until satisfactory validation of the ECOWAS data is completed all of these results are only for demonstration purposes.

A one page report is provided for each of the 14 ECOWAS countries showing generation expansions. The maximum load carrying capability (MW) between each country is also shown for each of the five periods in the ten-year horizon (five period model). The WAPP new generation expansion needs for the ten years (7312 MW in Scenario #1) more than doubles the existing generation capacity across the region (5,668 MW ECOWAS Data Set #5).

By table the two demonstration scenarios list the following:

- Table 1; ECOWAS Projected Annual Electricity Demand Growth Rates.
- Tables 2 – 15; Country Reports.
- Tables 16 & 17; Cost of Unserved Energy & Unmet MW.
- Table 18; WAPP Proposed Generation Expansion Projects.
- Table 19; Existing ECOWAS Generation Capacity.
- Table 20; Total new generation expansions.

Two Scenarios are considered:

Scenario #1

- A ten year ECOWAS planning horizon is considered, 2002 to 2012.
- The data used in the model is the ECOWAS Electricity Data Set #5 (September 2001).
- The electricity demand annual growth rates are taken from the Data Set #5, as shown in Table 1:-

Table 1: ECOWAS Projected Annual Electricity Demand Growth Rates

	2002/4	2005/6	2007/8	2009/10	2011/12
1. Benin	5.5%	5.8%	5.8%	5.9%	5.9%
2. Burkina Faso	4.9%	4.9%	4.9%	4.9%	4.9%
3. Cote D'Ivoire	5.9%	5.4%	4.6%	3.9%	5.0%
4. Gambia	3.3%	0.01%	3.1%	0.01%	2.9%
5. Ghana	5.3%	3.9%	3.8%	3.9%	3.9%
6. Guinea	2.2%	51.6%	1.0%	1.1%	1.2%
7. Guinea Bissau	0.01%	1.9%	2.0%	2.4%	2.4%
8. Liberia	10.7%	0.01%	9.2%	15.0%	6.1%
9. Mali	5.1%	6.5%	4.3%	3.4%	2.6%
10. Niger	5.3%	5.3%	5.3%	5.3%	5.3%
11. Nigeria	9.1%	7.7%	8.6%	8.1%	8.1%
12. Senegal	4.9%	9.0%	4.9%	5.1%	5.7%
13. Sierra Leone	4.2%	3.8%	4.0%	3.9%	4.1%
14. Togo	1.9%	3.0%	1.7%	1.6%	2.1%

- The cost of natural gas is the same in each country (Cote D'Ivoire, Ghana, Togo, Benin, Nigeria), set at \$2.5 per 10^6 Btu.

Scenario #2

- All of the conditions are the same as in Scenario #1 except for the date at which power can be exported from Nigeria to Benin. In Scenario #1 the electricity exports from Nigeria to Benin are permitted to start in 2004 while in Scenario #2 they are permitted to start in 2008.

Table 2: WEST AFRICA POWER POOL
GENERATION CAPACITY EXPANSIONS (MW), 2002 – 2012

BENIN

Generation Technology & Power Flow Direction	**SCENARIO #1** (Benin – Nigeria starts trade in 2004) WAPP Total Cost = $8.932 billions					
	New MW Capacity					
	2003/04	2005/06	2007/08	2009/10	2011/12	Total
Old Thermal Expansion	-	-	-	-	-	0
New Thermal Expansion	-	-	-	-	29	29
Hydropower Expansion	-	-	-	-	5	5
Maximum Annual Power Flow (MW):						
from Nigeria	-	150	118	96	59	
from Togo	55	-	-	-	-	
to Nigeria	-	-	-	-	-	
to Togo	-	73	45	-	-	
	SCENARIO #2 (Benin – Nigeria starts trade in 2008) WAPP Total Cost = $9.062 billions					
Old Thermal Expansion	-	-	-	-	-	0
New Thermal Expansion	-	-	31	-	5	36
Hydropower Expansion	-	-	-	5	-	5
Maximum Annual Power Flow (MW):						
from Nigeria	-	-	-	57	74	
from Togo	55	57	39	-	-	
to Nigeria	-	-	-	-	-	
to Togo	-	-	-	-	-	

Benin Summary:
In Scenario #2 Benin builds new thermal generation at an earlier stage and imports continue longer from Togo.

Table 3: WEST AFRICA POWER POOL
GENERATION CAPACITY EXPANSIONS (MW), 2002 – 2012

BURKINA FASO

Generation Technology & Power Flow Direction	**SCENARIO #1** (Benin – Nigeria starts trade in 2004) WAPP Total Cost = $8.932 billions					
	New MW Capacity					
	2003/04	2005/06	2007/08	2009/10	2011/12	Total
Old Thermal Expansion	-	-	-	-	-	0
New Thermal Expansion	-	-	-	-	-	0
Hydropower Expansion	-	-	-	-	-	0
Maximum Annual Power Flow (MW):						
from Ivory Coast	31	35	43	53	65	
	SCENARIO #2 (Benin – Nigeria starts trade in 2008) WAPP Total Cost = $9.062 billions					
Old Thermal Expansion	-	-	-	-	-	0
New Thermal Expansion	-	-	-	-	-	0
Hydropower Expansion	-	-	-	-	-	0
Maximum Annual Power Flow (MW):						
from Ivory Coast	31	35	43	53	65	

Burkina Faso Summary:
In both scenarios Burkina Faso is an electricity importing nation with all supplies coming from Cote D'Ivoire.

Table 4: WEST AFRICA POWER POOL
GENERATION CAPACITY EXPANSIONS (MW), 2002 – 2012

GAMBIA

Generation Technology & Power Flow Direction	**SCENARIO #1** (Benin – Nigeria starts trade in 2004) WAPP Total Cost = $8.932 billions					
	New MW Capacity					
	2003/04	2005/06	2007/08	2009/10	2011/12	Total
Old Thermal Expansion	-	-	-	-	-	0
New Thermal Expansion	-	-	-	-	-	0
Hydropower Expansion	-	-	-	-	-	0
Maximum Annual Power Flow (MW):						
from Senegal	-	-	-	21	21	
	SCENARIO #2 (Benin – Nigeria starts trade in 2008) WAPP Total Cost = $9.062 billions					
Old Thermal Expansion	-	-	-	-	-	0
New Thermal Expansion	-	-	-	-	-	0
Hydropower Expansion	-	-	-	-	-	0
Maximum Annual Power Flow (MW):						
from Senegal	-	-	-	21	21	

Gambia Summary:
In both scenarios Gambia is an electricity importing nation with all imports coming from Senegal.

Table 5: WEST AFRICA POWER POOL
GENERATION CAPACITY EXPANSIONS (MW), 2002 – 2012

GHANA

Generation Technology & Power Flow Direction	**SCENARIO #1** (Benin – Nigeria starts trade in 2004) WAPP Total Cost = $8.932 billions					
	New MW Capacity					
	2003/04	2005/06	2007/08	2009/10	2011/12	Total
Old Thermal Expansion	-	-	-	-	-	0
New Thermal Expansion	-	330	-	-	-	330
Hydropower Expansion	-		154	-	-	154
Maximum Annual Power Flow (MW):						
from Iv. Coast	265	260	-	250	245	
from Togo	-	-	-	54	51	
to Ivory Coast	-	-	20	-	-	
to Togo	142	83	-	-	-	
	SCENARIO #2 (Benin – Nigeria starts trade in 2008) WAPP Total Cost = $9.062 billions					
Old Thermal Expansion	-	-	-	-	-	
New Thermal Expansion	-	275	-	-	46	321
Hydropower Expansion	-	-	154	-	-	154
Maximum Annual Power Flow (MW):						
from Iv. Coast	265	260	255	250	245	
from Togo	-	-	19	50	51	
to Ivory Coast	-	-	-	-	-	
to Togo	142	143	20	-	-	

Ghana Summary:
In Scenario #2 Ghana imports more electricity from Cote D'Ivoire.

Table 6: WEST AFRICA POWER POOL
GENERATION CAPACITY EXPANSIONS (MW), 2002 – 2012

GUINEA

Generation Technology & Power Flow Direction	**SCENARIO #1** (Benin – Nigeria starts trade in 2004) WAPP Total Cost = $8.932 billions					
	New MW Capacity					
	2003/04	2005/06	2007/08	2009/10	2011/12	Total
Old Thermal Expansion	-	-	-	-	-	0
New Thermal Expansion	-	-	-	-	-	0
Hydropower Expansion	-	-	538	43	1	582
Maximum Annual Power Flow (MW):						
to Ivory Coast	-	-	-	56	56	
to Senegal	-	-	-	208	208	
	SCENARIO #2 (Benin – Nigeria starts trade in 2008) WAPP Total Cost = $9.062 billions					
Old Thermal Expansion	-	-	-	-	-	0
New Thermal Expansion	-	-	-	-	-	0
Hydropower Expansion	-	-	538	28	15	581
Maximum Annual Power Flow (MW):						
to Ivory Coast	-	-	-	27	27	
to Senegal	-	-	-	223	229	

Guinea Summary:
In Scenario #2 electricity exports to Cote D'Ivoire are halved and exports to Senegal are slightly increased.

Table 7: WEST AFRICA POWER POOL
GENERATION CAPACITY EXPANSIONS (MW),
2002 – 2012

GUINEA BISSAU

Generation Technology & Power Flow Direction	**SCENARIO #1** (Benin – Nigeria starts trade in 2004) WAPP Total Cost = $8.932 billions					
	New MW Capacity					
	2003/04	2005/06	2007/08	2009/10	2011/12	Total
Old Thermal Expansion	11	1	1	-	-	13
New Thermal Expansion	-	-	-	-	-	0
Hydropower Expansion	-	-	-	-	-	0
Maximum Annual Power Flow (MW):						
from Senegal	-	-	-	15	16	
	SCENARIO #2 (Benin – Nigeria starts trade in 2008) WAPP Total Cost = $9.062 billions					
Old Thermal Expansion	11	1	1	-	-	13
New Thermal Expansion	-	-	-	-	-	0
Hydropower Expansion	-	-	-	-	-	0
Maximum Annual Power Flow (MW):						
from Senegal	-	-	-	15	16	

Guinea Bissau Summary:
No changes. In both scenarios Guinea Bissau builds 13 MW new thermal and imports from Senegal.

Table 8: WEST AFRICA POWER POOL
GENERATION CAPACITY EXPANSIONS (MW),
2002 – 2012

COTE D'IVOIRE

Generation Technology & Power Flow Direction	**SCENARIO #1** (Benin – Nigeria starts trade in 2004) WAPP Total Cost = $8.932 billions					
	New MW Capacity					
	2003/04	2005/06	2007/08	2009/10	2011/12	Total
New Thermal Expansion	-	-	294	115	11	420
Hydropower Expansion	-	-	-	-	-	0
Maximum Annual Power Flow (MW):						
From Ghana	-	-	19	-	-	
From Guinea	-	-	-	54	54	
From Mali	-	-	-	90	76	
From Liberia	-	-	-	2	2	
to B. Faso	35	40	48	60	74	
to Ghana	284	279	-	268	262	
to Liberia	-	-	4	4	5	
to Mali	-	-	100	-	-	
	SCENARIO #2 (Benin – Nigeria starts trade in 2008) WAPP Total Cost = $9.062 billions					
New Thermal Expansion	-	-	319	-	101	420
Maximum Annual Power Flow (MW):						
From Guinea	-	-	-	26	26	
From Mali	-	-	-	90	86	
From Liberia	-	-	2	-	3	
to B. Faso	35	40	48	60	74	
to Ghana	284	279	273	268	262	
to Liberia	-	-	2	4	5	
to Mali	-	-	100	-	-	

Cote D'Ivoire Summary:
In Scenario #1 Cote D'Ivoire builds new thermal power at an earlier stage and exports less to Ghana.

Table 9: WEST AFRICA POWER POOL
GENERATION CAPACITY EXPANSIONS (MW), 2002 – 2012

LIBERIA

Generation Technology & Power Flow Direction	**SCENARIO #1** (Benin – Nigeria starts trade in 2004) WAPP Total Cost = $8.932 billions					
	New MW Capacity					
	2003/04	2005/06	2007/08	2009/10	2011/12	Total
Old Thermal Expansion	-	-	-	-	-	0
New Thermal Expansion	-	-	-	-	-	0
Hydropower Expansion	-	-	9	4	3	16
Maximum Annual Power Flow (MW):						
from Iv. Coast	-	-	4	4	4	
To Iv. Coast	-	-	1	2	2	
	SCENARIO #2 (Benin – Nigeria starts trade in 2008) WAPP Total Cost = $9.062 billions					
Old Thermal Expansion	-	-	-	-	-	-
New Thermal Expansion	-	-	-	-	-	-
Hydropower Expansion	-	-	11	-	5	16
Maximum Annual Power Flow (MW):						
from Iv. Coast	-	-	2	4	4	
To Iv. Coast	-	-	2	-	3	

Liberia Summary:
Little change. In both scenarios Liberia builds 16MW of new hydropower with small imports of electricity from Cote D'Ivoire.

Table 10: WEST AFRICA POWER POOL
GENERATION CAPACITY EXPANSIONS (MW), 2002 – 2012

MALI

Generation Technology & Power Flow Direction	**SCENARIO #1** (Benin – Nigeria starts trade in 2004) WAPP Total Cost = $8.932 billions					
	New MW Capacity					
	2003/04	2005/06	2007/08	2009/10	2011/12	Total
Old Thermal Expansion	-	-	-	43	-	43
New Thermal Expansion	-	-	-	-	-	0
Hydropower Expansion	-	-	22	-	-	22
Maximum Annual Power Flow (MW):						
from Iv. Coast	-	-	90	-	-	
To Iv. Coast	-	-	-	100	84	
To Senegal	92	74	129	-	114	
	SCENARIO #2 (Benin – Nigeria starts trade in 2008) WAPP Total Cost = $9.062 billions					
Old Thermal Expansion	-	-	-	43	-	43
New Thermal Expansion	-	-	-	-	-	0
Hydropower Expansion	-	-	22	-	-	22
Maximum Annual Power Flow (MW):						
from Iv. Coast	-	-	90	-	-	
To Iv. Coast	-	-	-	100	96	
To Senegal	97	77	129	14	22	

Mali Summary:
In Scenario #2 electricity exports significantly decrease to Senegal in the final period.

Table 11: WEST AFRICA POWER POOL
GENERATION CAPACITY EXPANSIONS (MW), 2002 – 2012

NIGER

Generation Technology & Power Flow Direction	**SCENARIO #1** (Benin – Nigeria starts trade in 2004) WAPP Total Cost = $8.932 billions					
	New MW Capacity					
	2003/04	2005/06	2007/08	2009/10	2011/12	Total
Old Thermal Expansion	-	-	-	-	-	0
New Thermal Expansion	-	-	-	-	-	0
Hydropower Expansion	39	10	-	-	-	49
Maximum Annual Power Flow (MW):						
from Nigeria	1	-	1	6	12	
to Nigeria	15	22	19	15	12	
	SCENARIO #2 (Benin – Nigeria starts trade in 2008) WAPP Total Cost = $9.062 billions					
Old Thermal Expansion	-	-	-	-	-	0
New Thermal Expansion	-	-	-	-	-	0
Hydropower Expansion	39	69	-	-	-	108
Maximum Annual Power Flow (MW):						
from Nigeria	1	-	-	-	-	
to Nigeria	15	67	72	62	51	

Niger Summary:
Niger doubles its new hydropower capacity in Scenario #2 and increases its exports to Nigeria.

Table 12: WEST AFRICA POWER POOL
GENERATION CAPACITY EXPANSIONS (MW), 2002 – 2012

NIGERIA

Generation Technology & Power Flow Direction	**SCENARIO #1** (Benin – Nigeria starts trade in 2004) WAPP Total Cost = $8.932 billions					
	New MW Capacity					
	2003/04	2005/06	2007/08	2009/10	2011/12	Total
Old Thermal Expansion	1,237	223	-	-	-	1,460
New Thermal Expansion	-	45	988	1,129	1,652	3,814
Hydropower Expansion	-	143	-	-	-	143
Maximum Annual Power Flow (MW):						
from Niger	14	21	18	15	11	
to Benin	-	158	124	101	63	
to Niger	1	-	1	6	12	
	SCENARIO #2 (Benin – Nigeria starts trade in 2008) WAPP Total Cost = $9.062 billions					
Old Thermal Expansion	1,237	223	-	-	-	1,460
New Thermal Expansion	-	45	1,002	896	1,531	3,474
Hydropower Expansion	-	400	-	-	-	400
Maximum Annual Power Flow (MW):						
from Niger	14	64	68	59	49	
to Benin	-	-	-	60	78	
to Niger	1	-	-	-	-	

Nigeria Summary:
In Scenario #2 Nigeria builds 257MW of more new hydropower than in Scenario #1 but 340MW less of new thermal. Exports to Benin are clearly much reduced in Scenario #2.

Table 13: WEST AFRICA POWER POOL
GENERATION CAPACITY EXPANSIONS (MW), 2002 – 2012

SENEGAL

Generation Technology & Power Flow Direction	**SCENARIO #1** (Benin – Nigeria starts trade in 2004) WAPP Total Cost = $8.932 billions					
	New MW Capacity					
	2003/04	2005/06	2007/08	2009/10	2011/12	Total
Old Thermal Expansion	30	-	-	32	-	62
New Thermal Expansion	-	-	-	-	-	0
Hydropower Expansion	-	-	37	33	-	70
Maximum Annual Power Flow (MW):						
from Guinea	-	-	-	205	205	
from Mali	79	64	111	-	98	
to Gambia	-	-	-	21	22	
to G. Bissau	-	-	-	16	17	
	SCENARIO #2 (Benin – Nigeria starts trade in 2008) WAPP Total Cost = $9.062 billions					
Old Thermal Expansion	30	-	-	32	-	62
New Thermal Expansion	-	-	-	-	-	-
Hydropower Expansion	-	-	37	10	24	71
Maximum Annual Power Flow (MW):						
from Guinea	-	-	-	220	226	
from Mali	83	66	111	12	19	
to Gambia	-	-	-	21	22	
to G. Bissau	-	-	-	16	17	

Senegal Summary:
Electricity trade imports, in Scenario #2 slightly increase from Guinea but decrease from Mali.

Table 14: WEST AFRICA POWER POOL
GENERATION CAPACITY EXPANSIONS (MW), 2002 – 2012

SIERRA LEONE

Generation Technology & Power Flow Direction	**SCENARIO #1** (Benin – Nigeria starts trade in 2004) WAPP Total Cost = $8.932 billions					
	New MW Capacity					
	2003/04	2005/06	2007/08	2009/10	2011/12	Total
Old Thermal Expansion	-	-	-	-	-	0
New Thermal Expansion	-	-	-	-	-	0
Hydropower Expansion	-	-	-		-	0
Maximum Annual Power Flow (MW): None						
	SCENARIO #2 (Benin – Nigeria starts trade in 2008) WAPP Total Cost = $9.062 billions					
Old Thermal Expansion	-	-	-	-	-	0
New Thermal Expansion	-	-	-	-	-	0
Hydropower Expansion	-	-	-	-	-	0
Maximum Annual Power Flow (MW): None						

Sierra Leone Summary:
Sierra Leone is self-sufficient because of its hydropower. No trade takes place in both scenarios.

Table 15: WEST AFRICA POWER POOL
GENERATION CAPACITY EXPANSIONS (MW), 2002 – 2012

TOGO

Generation Technology & Power Flow Direction	**SCENARIO #1** (Benin – Nigeria starts trade in 2004) WAPP Total Cost = $8.932 billions					
	New MW Capacity					
	2003/04	2005/06	2007/08	2009/10	2011/12	Total
Old Thermal Expansion	-	-	-	-	-	0
New Thermal Expansion	-	-	43	57	-	100
Hydropower Expansion	-	-	-	-	-	0
Maximum Annual Power Flow (MW):						
From Benin	-	69	43	-	-	
From Ghana	132	77	-	-	-	
to Benin	58	-	-	-	-	
to Ghana	-	-	-	58	55	
	SCENARIO #2 (Benin – Nigeria starts trade in 2008) WAPP Total Cost = $9.062 billions					
Old Thermal Expansion	-	-	-	-	-	0
New Thermal Expansion	-	-	100	-	-	100
Hydropower Expansion	-	-	-	-	-	0
Maximum Annual Power Flow (MW):						
From Benin	-	-	-	-	-	
From Ghana	132	132	18	-	-	
to Benin	58	60	41	-	-	
to Ghana	-	-	20	54	55	

Togo Summary:
In Scenario #2 Togo builds new thermal capacity at an earlier stage and imports more from Ghana and exports more to Benin.

Table 16: WEST AFRICA POWER POOL
Cost of Unserved Energy ($ millions/period) per Country, 2002 – 2012

Country	**SCENARIO #1** (Benin – Nigeria starts trade in 2004) WAPP Total Cost = $8.932 billions					
	Cost of Unserved Energy ($ millions)					
	2002/04	2005/06	2007/08	2009/10	2011/12	Total ($Millions)
Benin	-	-	-	-	-	**0**
Burk. Faso	-	-	-	-	-	**0**
Gambia	-	31.10	26.52	0.01	0.01	**57.64**
Ghana	-	-	-	-	-	**0**
Guinea	132.36	275.78	-	-	-	**408.14**
G. Bissau	19.689	16.60	14.26	0.01	0.01	**50.56**
Ivory Coast	-	-	-	-	-	**0**
Liberia	3.30	4.31	-	-	-	**7.61**
Mali	-	-	-	-	-	**0**
Niger	-	-	-	-	-	**0**
Nigeria	-	-	-	-	-	**0**
Senegal	-	-	-	-	-	**0**
S. Leone	-	-	-	-	-	**0**
Togo	-	-	-	-	-	**0**
	SCENARIO #2 (Benin – Nigeria starts trade in 2008) WAPP Total Cost = $9.062 billions					
Benin	-	-	-	-	-	**0**
Burk. Faso	-	-	-	-	-	**0**
Gambia	-	31.10	26.52	0.013	0.01	**57.64**
Ghana	-	-	-	-	-	**0**
Guinea	132.36	275.78	-	-	-	**408.14**
G. Bissau	19.69	16.60	14.26	0.01	0.01	**50.56**
Ivory Coast	-	-	-	-	-	**0**
Liberia	3.30	4.31	-	-	-	**7.61**
Mali	-	-	-	-	-	**0**
Niger	-	-	-	-	-	**0**
Nigeria	-	-	-	-	-	**0**
Senegal	-	-	-	-	-	**0**
S. Leone	-	-	-	-	-	**0**
Togo	-	-	-	-	-	**0**

Table 17: WEST AFRICA POWER POOL
Cost of Unserved MegaWatts
($ millions/period) per Country, 2002 – 2012

Country	**SCENARIO #1** (Benin – Nigeria starts trade in 2004) WAPP Total Cost = $8.932 billions					
	Cost of Unserved MegaWatts ($ millions)					
	2002/04	2005/06	2007/08	2009/10	2011/12	Total ($Millions)
Benin	-	-	-	-	-	**0**
Burk. Faso	-	-	-	-	-	**0**
Gambia	-	51.33	45.10	-	-	**96.43**
Ghana	-	-	-	-	-	**0**
Guinea	439.97	1,428.20	-	-	-	**1,868.17**
G. Bissau	-	-	-	-	-	**0**
Ivory Coast	-	-	-	-	-	**0**
Liberia	10.11	8.45	-	-	-	**18.56**
Mali	-	-	-	-	-	**0**
Niger	-	-	-	-	-	**0**
Nigeria	-	-	-	-	-	**0**
Senegal	-	-	-	-	-	**0**
S. Leone	-	-	-	-	-	**0**
Togo	-	-	-	-	-	**0**
	SCENARIO #2 (Benin – Nigeria starts trade in 2008) WAPP Total Cost = $9.062 billions					
Benin	-	-	-	-	-	**0**
Burk. Faso	-	-	-	-	-	**0**
Gambia	-	51.33	45.10	-	-	**96.43**
Ghana	-	-	-	-	-	**0**
Guinea	439.97	1,428.20	-	-	-	**1,868.17**
G. Bissau	-	-	-	-	-	**0**
Ivory Coast	-	-	-	-	-	**0**
Liberia	10.11	8.45	-	-	-	**18.56**
Mali	-	-	-	-	-	**0**
Niger	-	-	-	-	-	**0**
Nigeria	-	-	-	-	-	**0**
Senegal	-	-	-	-	-	**0**
S. Leone	-	-	-	-	-	**0**
Togo	-	-	-	-	-	**0**

Table 18(a): WAPP Proposed Generation Expansion Projects (ECOWAS Data Set # 5)

	StationName	Technology	New MW Thermal	New MW Hydro
1. Benin	CCpurdue	PGNCC	200	
	Adjaralla East	HN		48
	Dyodyonga	HN		26
2. Burkina Faso	OuagaIII	PGNT	75	
	Noumbiel	HN		60
3. Cote D'Ivoire	4th Centrale	PGNT	450	
	Azito2	PGNCC	1820	
	CC250	PGNCC	1650	
	Soubre	HN		395
4. Gambia			0	
5. Ghana	TICO-Takoradi3	PGNCC	330	
	TEMA	PGNCC	1980	
	Bui	HN		400
	Juale	HN		87
	Pwalugu	HN		48
	Hemang	HN		93
6. Guinea	Tiopo	HN		120
	ComplexeSuoapiti	HN		975
	Fomi	HN		90
	Fello Sounga	HN		82
	Gaoual	HN		39
	Morisanako	HN		100
	Koukoutamba	HN		281
	Guilde	HN		45
7. Guinea Bissau	Saltinho	HN		20
8. Liberia	Luke	PGNSC	39	
	Bushrod	PGNSC	10	
	MtCoffee	HN		64
9. Mali	Gouina-MLI	HN		69
	Felou-MLI	HN		70
	Petit Kenie	HN		56
	Markala	HN		5
10. Niger	Dyodyonga North	HN		26
	Gambou	HN		122
	Kandadj	HN		132

Table 18(b): WAPP Proposed Generation Expansion Projects (ECOWAS Data Set # 5)

	StationName	Technology	New MW Thermal	New MW Hydro
11. Nigeria	Kwale	PGNCC*	350	
	Abuja-Shell	PGNCC*	800	
	Alscon Smelter	PGNCC*	200	
	AGIP	PGNCC*	500	
	MOBIL	PGNCC*	340	
	Onitsha	PGNCC*	2000	
	Ajaokuta	PGNCC*	500	
	Ikom	PGNCC*	2000	
	Swede Power	PGNCC*	500	
	Zungeru	PGNCC*	500	
	Mambila	PGNCC*	2000	
	Dankowa	PGNCC*	35	
	Lokoja	PGNCC*	500	
	Abuja EPP	PGNSC	30	
	Oji	PGNSC	120	
	Ompadec-Nafcon	PGNT	45	
	Kainji (expansion on existing hydro station)	H		400
12. Senegal	Gouina-Sen	HN		35
	Felou-Sen	HN		35
13. Sierra Leone			0	
14. Togo	CCpurdue	PGNCC	100	
	Adjaralla-West	HN		48
		MW Totals	**17074**	**3971**

Key:
PGNCC is new Combined Cycle station (natural gas)
HN is new hydropower station
H is an existing hydropower station
PGNT is new turbine station
PGNSC is new small thermal station (coal ,oil)
* Project names provided by NEPA at Dakar WAPP Conference, March 19-22, 2001. In the WAPP model all these are aggregated into one new CC station because no data has yet been provided for them.

Table 19(a): Existing ECOWAS Generation Capacity

(ECOWAS Data Set #5, September 2001)

Station Name	*MW*	*Station Type*	*Station Code #*
1. Benin			
Akpakpa	31.0	PGO	Ben Stat1
Cotonou	20.0	PGO	Ben Stat2
AllSmallDiesels	7.6	PGO	Ben Stat3
Nangbeto East	32.5	H	Ben Stat1
2. BurkinaFaso			
OuagaI	15.2	PGO	BFa Stat1
OuagII	38.0	PGO	BFa Stat2
Kossodo	16.0	PGO	BFa Stat3
BoboI	5.9	PGO	BFa Stat4
BoboII	17.0	PGO	BFa Stat5
Bagre	16.0	H	BFa Stat1
Kompienga	14.0	H	BFa Stat2
Niofila&Tourni (1.5+0.5)	2.0	H	BFa Stat3
3. Côte d'Ivoire			
TAG5000	80.0	PGO	ICo Stat1
Azito 1	300.0	PGO	ICo Stat2
VridiCiprel	210.0	PGO	ICo Stat3
Ayame1	22.0	H	ICo Stat1
Ayame2	30.0	H	ICo Stat2
Kossou	175.0	H	ICo Stat3
Taabo	210.0	H	ICo Stat4
Buyo	165.0	H	ICo Stat5
Faye	5.0	H	ICo Stat6

Table 19(b): Existing ECOWAS Generation Capacity

(ECOWAS Data Set #5, September 2001)

Station Name	*MW*	*Station Type*	*Station Code #*
4. Gambia			
Kotu	22.8	PGO	Gam Stat1
5. Ghana			
TAPCOtakoradi-1	330.0	PGO	Gha Stat1
TICOtakoradi-2	220.0	PGO	Gha Stat2
Akosombo	912.0	H	Gha Stat1
Kpong	160.0	H	Gha Stat2
6. Guinea			
TomboI	12.4	PGO	Gui Stat1
TomboII	8.6	PGO	Gui Stat2
TomboIII	44.0	PGO	Gui Stat3
TinkissoKinkon (ROR,1.5+3.2)	4.7	H	Gui Stat1
Donkea	15.0	H	Gui Stat2
Baneah	5.0	H	Gui Stat3
GrandeChutes(ROR)	27.0	H	Gui Stat4
Garafiri	75.0	H	Gui Stat5
7. Guinea Bissau			
Bissau Central	8.3	PGO	Gbi Stat1

Table 19(c): Existing ECOWAS Generation Capacity

(ECOWAS Data Set #5, September 2001)

Station Name	*MW*	*Station Type*	*Station Code #*
8. Liberia			
Skodas (I – 5)	7.2	PGO	Lib Stat1
9. Mali			
Darsalam1	10.0	PGO	Mal Stat1
Darsalam2	20.0	PGO	Mal Stat2
Balingue	18.0	PGO	Mal Stat3
Sotuba	5.4	H	Mal Stat1
Selingue	44.0	H	Mal Stat2
Manantali-MLI	134.0	H	Mal Stat3
10. Niger			
TahouaMalbaza	20	PGO	Ngr Stat1
ZinderMaradi(Cold Reserve)	20	PGO	Ngr Stat2
Goudel(Cold Reserve)	505	PGO	Ngr Stat3
NiameyII(Cold Reserve)	12.0	PGO	Ngr Stat4
11. Nigeria			
Afam	360.0	PGO	Nga Stat1
Delta	160.0	PGO	Nga Stat2
Lagos (Egbin)	600.0	PGO	Nga Stat3
Sapele (Ogorode)	230.0	PGO	Nga Stat4
Ijora	20.0	PGO	Nga Stat5
Kainji	760.0	H	Nga Stat1
Jebba	578.4	H	Nga Stat2
Shiroro	600.0	H	Nga Stat3

Table 19(d): Existing ECOWAS Generation Capacity

(ECOWAS Data Set #5, September 2001)

Station Name	*MW*	*Station Type*	*Station Code #*
12. Senegal			
Cap des Biches (C3TAG)	51.9	PGO	Sen Stat1
Cap des Biches (C3Vap)	76.7	PGO	Sen Stat2
Cap des Biches (C4Dies)	52.3	PGO	Sen Stat3
Cap des Biches (C5Dies)	16.0	PGO	Sen Stat4
Cap des Biches GT1(GT1)	50.0	PGO	Sen Stat5
Bel Air Vapeur (C2Vap)	14.8	PGO	Sen Stat6
Bel Air TAG (TAG4)	32.0	PGO	Sen Stat7
Kahone Diesel	9.5	PGO	Sen Stat8
Bel Air Diesel	7.6	PGO	Sen Stat9
St Louis Diesel	4.8	PGO	Sen Stat9
Manantali-SEN	66	H	Sen Stat1
13. Sierra Leone			
KingTom1	3.0	PGO	SLe Stat1
KingTom2	9.2	PGO	SLe Stat2
KingTom3	9.2	PGO	SLe Stat3
KingTom4	3.84	PGO	SLe Stat4
KingTom5	5.0	PGO	SLe Stat5
KingTom6	6.3	PGO	SLe Stat6
Bo	5.03	PGO	SLe Stat7
Bumbuna	50.0	H	SLe Stat1
Goma	4.0	H	SLe Stat2
14. Togo			
TAG-Lomé (Cold Reserve)	20.0	PGO	Tog Stat1
CTL (Cold Reserve)	20.0	PGO	Tog Stat2
CentraleDeKARA	5.5	PGO	Tog Stat3
Sulzer-Lomé (Cold Reserve)	12.0	PGO	Tog Stat4
NagbetoWest	32.5	H	Tog Stat1

Table 20: Demonstration Total Generation Expansions for 2002 to 2012 (MW)

	Scenario #1		Scenario #2	
	New Thermal Expansions	New Hydropower Expansions	New Thermal Expansions	New Hydropower Expansions
1. Benin	29	5	36	5
2. Burkina Faso	0	0	0	0
3. Cote D'Ivoire	420	0	420	0
4. Gambia	0	0	0	0
5. Ghana	330	154	321	154
6. Guinea	0	582	0	581
7. Guinea Bissau	13	0	13	0
8. Liberia	0	16	0	16
9. Mali	43	22	43	22
10. Niger	0	49	0	108
11. Nigeria	5274	143	4934	400
12. Senegal	62	70	62	71
13. Sierra Leone	0	0	0	0
14. Togo	100	0	100	0
TOTALS	**6271**	**1041**	**5929**	**1357**
	7312		**7286**	

Existing generation capacity across the WAPP (ECOWAS Data Set #5) amounts to 5,668 MW. The Scenario #1 optimal increase in generation capacity is 7,312 MW. This is a 129% increase in capacity. The high electricity demand growth rates, especially for Nigeria, are critically important values for future WAPP pool planning purposes. Confirmation of WAPP electricity growth rates is therefore vital work. The assistance from ENERDATA of France will be a very valuable help in the ECOWAS planning process.