

A USAID Research Funded Project

Benin's Electricity Trade and Generation Needs for the Period 2001 to 2020

Brian H. Bowen
F.T. Sparrow

PURDUE UNIVERSITY
Power Pool Development Group
West Lafayette

February 26, 2001

Summary

The Benin electricity peak demand increases, from the 2000 level of 73MW to 408MW by 2020. This is with a high demand growth rate of 8% for most of the 20 year time horizon. With the free trade scenario then Benin becomes a big importer of electrical energy (MWh) from Nigeria and is a big exporter to Togo (a major wheeler of electricity with free trade). The country trades MW reserves from Nigeria to Togo in both the free trade and no trade scenarios but substantially more during the free trade scenario. The total minimum cost to the ECOWAS region, for the 20 year capacity expansion period, is over 20 billion USD, with 2% of this cost being allotted to Benin.

All of the 75MW, planned for the new Adjaralla East and Dyodyonga South hydropower capacity, is built in both demonstration scenarios with the 50% and 100% autonomy factor. With the open trade scenario (AF = 50%) this new hydro is built more gradually over the whole 20 year horizon, with electricity trade supplementing domestic demand. In the no trade scenario the whole new station is built in the first 10 years of the full horizon. As free trade is encouraged then so too the amount of new international transmission line capacity is increased by 170%. There is also a much larger capacity expansion on the old transmission line of 150% when the free trade scenario is considered.

This report is based on the February 13, 2001, demonstration version of the ECOWAS regional electricity trade model. Parameter values come from the ECOWAS Data Set #4 (February 2001).

1. Benin's Growth Forecast for Electricity Demand

The initial level of Benin's electricity demand is 73MW and rises to 129MW for the end of 2005. By 2020 the projected peak demand is 408MW (Table 1). Two scenarios are considered for the generation expansion. The first is with 50% autonomy factors for energy trade in MWh and trade of reserves in MW. Secondly the scenario is one of full autonomy with energy and power autonomy factors both set at 100%.

Table 1 Benin's Projected Peak Electricity Demand, 2001 to 2020

Year	2005	2010	2015	2020
PEAK DEMAND (MW) (From input files)	129	189	278	408

2. Benin's existing and optimal generation expansion capacity

The existing generation capacity in Benin is shown in Table 2 and details of all the Benin parameter values are in Tables 6 and 7 in the Appendix.

Table 2 The Existing and Proposed Generation Stations in Benin

<i>Station Name</i>	<i>MW</i>	<i>Station Type</i>	<i>Station Code #</i>
1. Benin – Received Dec15, 2000			
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
Adjaralla East	48.5	HN	Ben Stat1
Dyodyonga South	26.0	HN	Ben Stat2

There is a delay in the full expansion of the new hydropower plant but finally in both expansion scenarios the full amount of new MW capacity is built. There is a much more significant construction of new international transmission MW load capacity when there is a policy for promoting free trade (Table 3).

Table 3 Benin and Capacity Expansions for 2001 to 2020

	AFs = 0.5	AFs = 1.0
New Hydropower Expansion (MW)	74 (2001-2020)	75 (2001-2010)
Existing transmission expansions (MW)	Ben – Togo = 1397	Ben – Togo = 515
Proposed new Transmission expansions (MW)	Ben - Nga = 1653	Ben - Nga = 665

3. Benin's Electricity Capacity Expansion Costs

The total expansion costs for Benin with free trade (\$417 million over the 20 year horizon) is about 20% of the total cost with no energy trade (Table 4). There are high unserved MW and energy costs when electricity trade is heavily restricted with the current expansion plan.

Table 4 Benin's Expansion Costs for the Period 2001 to 2020

COSTS	AFs = 0.5	AFs = 1.0
ECOWAS Total Cost (\$ 10 ⁶ present value)	20,112.0	26,620.0
Benin Total Cost (\$ 10 ⁶ present value)	417.0	2,046.0
Capital Cost of New hydropower stations (\$ 10 ⁶ present value)	79.0	134.8
Expansion cost for existing transmission line, Ben-Tog, (\$ 10 ⁶ present value)	18.0	5.6
Expansion cost for new transmission line, Ben-Nga, (\$ 10 ⁶ present value)	68.2	6.5
Water costs (existing & new hydro) (\$ 10 ⁶ present value)	1.3	1.4
New hydropower Fixed O & M costs (\$ 10 ⁶ present value)	11.1	19.1
Variable O & M costs – New Hydro (\$ 10 ⁶ present value)	6.8	0.4

4. Benin's Electricity Trade with Nigeria and Togo

Benin exports 142,500 GWh to Togo over the 20 year period when a relatively free trade scenario takes place (Table 5). Imports to Togo, from Nigeria, are 152,500 GWh. Similarly large amounts of MW reserves are also traded during the free trade scenario. With MW reserves however a significant amount of trade still takes place when there is no energy trade (Table 6).

Table 5 Maximum Electricity Trade (GWh energy)for Benin, 2001 - 2020

	AFs = 0.5	AFs = 1.0
Electricity Exports (Maximum Total GWh per period)		
To – Nigeria	0	0
To – Togo	142,300	0
Electricity Imports (Maximum Total GWh per period)		
From - Nigeria	152,500	0
From - Togo	1,300	0

Table 6 Maximum Electricity Trade (MW Reserves) & Benin, 2001 - 2020

	AFs = 0.5	AFs = 1.0
Electricity Exports (MW)		
To - Nigeria	17 (2006-10)	0
To – Togo	1363 (2011-15)	611 (2011-15)
Electricity Imports (MW)		
From - Nigeria	1544 (2016-20)	625 (2011-15)
From - Togo	87 (2006-10)	15 (2006-2010)

Appendix I

Table 6 Existing ECOWAS Thermal Stations

Station Name	Station Code #	PGOinit (MW)	Oexpcost (\$/MWh)	PGOexpstep (MW)	PGOmax (MW)	FORPGO (%)	UFORPGO (%)	Crfi (%/yr)	VarOM0 (\$/MWh)	HRO 10 ⁶ Btu/MWh
1. Benin <i>Received Dec15, 2000</i>										
Akpakpa	Ben Stat1	31.0	0	0	0	0.04*	0.06*	0.1*	31	1*
Cotonou	Ben Stat2	20.0	0	0	0	0.04*	0.06*	0.1*	20*	1*
<i>AllSmallDiesels</i>	Ben Stat3	7.6	575,400	100	0	0.04*	0.06*	0.1*	22	1*

Table 6 (Continued) Existing ECOWAS Thermal Stations

Station Name	Station Code #	Fuel cost FpO (\$/MWh)	Fuel escalation, fpescO (%/yr)	Decay rate (%/yr)	Min usage Pgmin (MWh/yr)	Forced decommissioning (AT period ty)
1. Benin						
Akpakpa	Ben Stat1	96	1.08	0.03	5000	-
Cotonou	Ben Stat2	77	1.12	0.04	15	-
<i>AllSmallDiesels</i>	Ben Stat3	137.87	1.02*	0.05	15153	-

Table 7 Existing ECOWAS Hydropower Stations

Station Name	Existing hydro station code #	Hoimit (MW)	HOVcost (\$/MW)	Hoexpstep (MW)	HOVmax (MW)	HOLF (MWh/yr)	FORoh (%/yr)	Crfih (%/yr)	VarOMoh (\$/MWh)
1. Benin <i>Received Dec15, 2000</i>									
Nangbeto East	Ben Stat 1	32.5	0	0	0	85 000	0.32	0	8.9

Table 7 (Continued) Existing ECOWAS Hydropower Stations

Station Name	Existing hydro Station #	DecayHO (%/yr)	Reshyd (%)	MinH (MWh/yr)	FdecomH (Period)
1. Benin					
Nangbeto East	Ben Stat 1	0.025	0.08	12 500	-