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The success of the backward integration policy in the Nigerian cement sector

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Abstract: The consumption of cement in Nigeria has increased to 18.5 million metric tonnes per annum (MMTPA) due to rapid urbanization and industrialization. Despite the huge demand for cement in Nigeria, domestic production was unable to meet the demand; hence the country relied on importation of cement to meet domestic construction needs. In 2002, the government adopted and implemented the backward integration policy (BIP), which requires cement import licenses be allocated only to importers who show proof of building factories for local cement manufacturing in Nigeria. Incentives under the policy include waiver of VAT and custom duty for importation of cement production equipment. The aim of this paper is to access the effect of the policy on the cement sector in Nigeria ten years after implementation. Following the implementation of the BIP, all the moribund existing government owned cement plants were privatized, while the private sector installed additional production and bagging capacities. Results showed that before BIP, Nigeria had an installed capacity of 4.03 MMTPA, but producing only 2 MMTPA. But 10 years after the implementation of the BIP, the country now produces 28 MMTPA with a total installed production capacity of 45 MMTPA and bagging capacity of 27.7 MMTPA, while additional 14 cement production plants of various capacities are under construction. Now that Nigeria has become self-sufficient in cement production, with domestic production exceeding the country's need, additional policies that would address the new challenges of the cement sector particularly cement glut is required.

Keywords: Industrial Policy, Limestone, Solid Mineral, Vision 20: 2020

1. Introduction

Cement is an important construction material produced and used virtually throughout the world. Cement is a versatile material used in most civil construction works including buildings, foundations, roads, bridges, airports, sea ports, irrigation, dams etc. the production and utilization of cements appears to be related to the current state of development of a country. China is the largest producer of cement in the world followed by India and USA. Global cement production has grown steadily from less than 200 million tonnes in 1950 to more than 2.5 billion tonnes in 2006 [1] with China producing 44%, while Africa accounts for only 4% of global production [2]. IEA ETSAP [1] reported that in 2006, Asia accounted for 70% of the world cement production with the following breakdown; China (47.4%), India (6.2%), Japan (2.7%) while the rest of the world including Africa accounted for 13.2%. In 2008, the world cement production has reached 2.8 billion tonnes, with the following percentage production from the leading countries China (48.94%), India (6.23%), USA (3.08%), Japan (2.21%), South Korea (1.90%), Russia (1.89%), Brazil (1.83%) and Turkey (1.81%) [3, 4] Wang and Han [3] reported that global cement demand has increased in the last 20 years from 1.04 to 2.84 billion tonnes mostly due to rapid growth from newly industrialized nations such as China, Brazil, India and Turkey. IEA ETSAP [1] similarly reported that current growth in global cement production is largely driven by rising production in emerging economics and developing countries particularly in Asia.

While the consumption of cement is dropping in the leading consumer nations such as China, Brazil and Russia, the demand of cement in Nigeria is rising. The consumption of cement in Nigeria is driven by increased urbanization and industrialization, irrigation projects, roads, water supply and distribution projects, railways, and the establishment of new universities [5]. Despite the huge

demand for cement in Nigeria, domestic production was unable to meet the demand. This caused price hike of cement in Nigeria. In 2002, the government adopted the backward integration policy (BIP), which requires cement import licenses be allocated only to importers who show proof of building factories for local cement manufacturing in Nigeria. Incentives under the policy include waiver of VAT and custom duty for importation of cement production equipment. The aim of this paper is to access the effect of the policy on the cement sector in Nigeria ten years after the implementation of the policy. The study also provided the opportunity of appraise the Nigerian cement manufacturing sector.

2. Nigeria's Vision 20:2020

Nigeria is committed to achieving vision 20:2020, which states that the country planned to be among the 20th most industrialized nation by year 2020. The cement industry is strategic for the realization of this vision. The Nigerian cement demand was estimated as 20 million metric tonnes per annum (MMTPA). The policy is aimed at creating enabling environment to expand the cement sector to meet the national demand. The country hopes to attract investors that will transform Nigeria into a continental hub for cement manufacturing. The country aims to achieve 100% domestic production and supply of Nigeria's demand and 15% supply of regional demand. Expansion of the Nigerian cement sector is expected to generate 200,000 direct jobs and over one million indirect jobs arising from distribution, haulage, supply and sundry support services [6].

3. Methodology

Extensive literature review was carried out including cement companies brochures, newspaper reports and scientific literatures. Data were also obtained from government statistics. Cement factories were also visited.

4. Overview of Cement Production in Nigeria

Cement manufacturing in Nigeria is similar to what obtains in other parts of the world (Fig. 1). Cement production value chain involves five basic processes; extraction (quarrying) and processing of minerals; pyroprocessing to produce clinker; blending and grinding of clinker with gypsum to produce cement; storage, packaging and delivery of cement [7]. The raw materials used for cement manufacturing, mostly limestone; clay and gypsum are extracted in quarries. Typically, about 1.65 tonnes of limestone and 0.4 tonnes of clay are needed to produce 1 tonne of cement [8]. Ali [9] reported that the production of 1 tonnes of Portland cement require about 1.5 – 1.6 tonnes of raw materials including 1.2 – 1.3 tonnes of limestone, 0.3 – 0.4 tonnes of clay and 0.05 – 0.06 tonnes of gypsum. The raw materials (limestone, clay, and sands) are crushed grinded and blended into a fine powder before entering a preheater and calciner from where they are transferred into rotary kiln for pyro processing (clinkerization) where energy is applied to heat up the materials to 1400 - 1480ºC to convert the raw materials into clinker. Cement manufacturing is an energy-intensive process due to the high temperatures required in the kilns for clinkerization. The clinker is cooled and blended with gypsum to form cement [5, 10]. About 90% of the raw materials for the production of cement is limestone. Nigeria has abundant limestone deposits in several states (Table 1), with few developed for cement production.

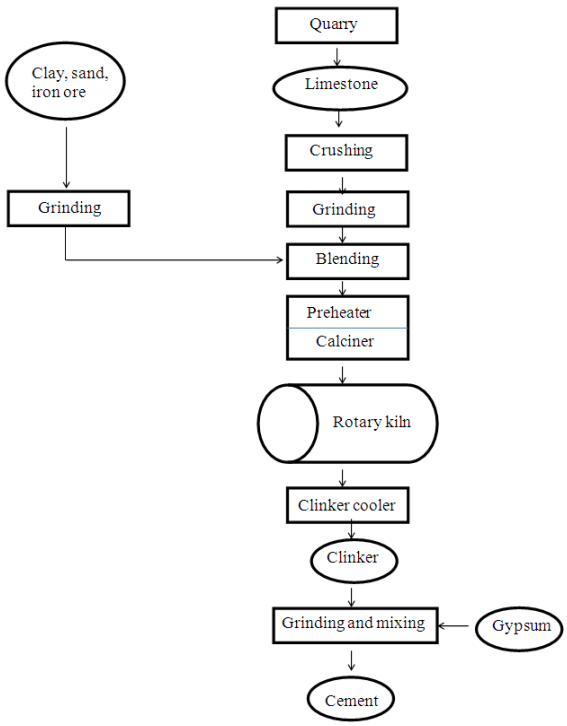

Fig 1. *Generalized process for cement production*

Table 1. *Limestone reserves in Nigeria and their development.*

Nigerian State	Location	Estimated reserves (million tonnes)	Cement factory operating the reserves
	Nkanu	110	
Enugu	Odomoke	54	
	Ngbo	2	
	Ewekoro	35	Lafarge WAPCO
Ogun	Shagamu	10	Lafarge WAPCO
	Ibeshe	NYQ	Dangote Cement Co
Cross River	Mfamosing	30	Calabar Cement Co, UNICEM, Dangote Cement Co

Nigerian State	Location	Estimated reserves (million tonnes)	Cement factory operating the reserves
Benue	Ikot Ana, odukpani, Obubra, Ugep, Calabar, Ago, Ibami	NYQ	Benue Cement Co (Dangote Cement Co)
	Ogbologuta	10.16	
	Igunmale	110	
	Yandev	70	
	Itobe, Adiga, Tokura	NYQ	
Sokoto	Kalambalna	101.6	Cement Co of Northern Nigeria
Gombe	Gombe Ashaka	NYQ	Ashaka Cement Co (Lafarge)
Bauchi	Pindiga, Kanawa	NYQ	
Imo	Umu-Obon, Okigwe	101	
Edo	Akoko-Edo, Owan, Etsako	10	Edo Cement Factory (BUA), AVA
Ebonyi	Nkalagu	174	Nigercem (Ibeto)
	Afikpo, Ntezi, Ikwo	NYQ	Ibeto
Abia	Ohafia, Arochukwu	NYQ	

Source: Modified from RMRDC 2001
NYQ = not yet quantified

Gypsiferous shales are reported from the upper Cretaceous Dukamaje Formation and the Paleocene Dange Formation in the Sokoto area. The 1.46-million tonne gypsum deposit at Wurno in Sokoto State is currently being mined by small-scale miners to supply the Sokoto cement plant. Other gypsum prospects are reported from Nafada/Bajoga in Gombe State, at Fika in Yobe State, and at Guyuk/Gwalura in Adamawa State [11].

The first cement plant installed in Nigeria was Niger Cement at Nkalagu in 1957 South East Nigeria. At independence in 1960, West African Portland Cement (WAPCO) was commissioned in South West Nigeria, while in 1967 Cement Company of northern Nigeria was commissioned. Other cement plants were installed in the 1970s (Table 2), all by the government. Cement plants grew from 5 to 8 plants in 1970 and local production rose from 1.4 to 2.8 and peaked at 3.6 MMT in 1986 and by 2000 only 4 cement plants were operational with cumulative output of 2.2 MMTPA [6]. In 1986, domestic production of cement was 81.40%, while importation accounted for the rest 18.60%, but by 2002, domestic production declined to 23.53% while importation increased to 74.47% (Table 3).

In 2002, the Federal Government introduced the backward integration policy (BIP) and the import substitution policy in the cement manufacturing sector. Projections were made on domestic cement production and consumption with importation supplying the shortfall (Table 4). From other data presented by FGN [6] it was projected that by 2011 – 2013, the domestic production of cement could reach 27.6 MMTPA, thus exceeding the national demand of 21.7 MMTPA. During the period 2002 – 2004, the government privatized all the government owned cement plants including WAPCO (Ewekoro), WAPCO (Shagamu), NigerCem (Nkalagu), Cement Company of Northern Nigeria, Benue Cement Company, Ashaka Cement Company, Edo Cement Company (Table 2).

Table 2. *Cement production plants in Nigeria (domestic production).*

	Plant	Owners	PH*	Capacity before BIP, MMT	Capacity after BIP, MMT	Total capacity, MMT/A	Year started operations	In built power plant capacity, MW	Employment effects (no. of workers)
1	Obajana Cement Company, Obajana	Dangote	N		10.25 (3.25)**	13.5	2006	135 GT	
2	Benue Cement Company PLC, Gboko	Dangote	P	0.4	4 (3)**	7.4	1975/2004	52	
3	Ibese Cement Plant	Dangote	N		6	6	2012		7000 (direct & indirect)
4	Calabar Cement Plant	Dangote	N		6	6	2012		
5	WAPCO Nigeria PLC – Ewekoro 1	Lafarge	P	0.2	-	0.2	1960/2003		
6	WAPCO Nigeria PLC, Ewekoro 2	Lafarge	-	-	2.5	2.5	2011	90	1000
7	WAPCO Nigeria PLC, Shagamu	Lafarge	P	0.6	0.9	1.5	1978		
8	Ashaka Cement Nigeria PLC, Ashaka	Lafarge	P	0.85		0.85	1979		
9	Cement Company of Northern Nigeria (CCNN), Sokoto	Bua	P	0.5		0.5	1967		
10	United Cement Company (UNICEM), Calabar	Flour Mills of Nigeria	PO, N	0.5	2.5	3.0	2009		

	Plant	Owners	PH*	Capacity before BIP, MMT	Capacity after BIP, MMT	Total capacity, MMT/A	Year started operations	In built power plant capacity, MW	Employment effects (no. of workers)
11	Purechem Industries Limited	Purechem Industries Limited	N		0.15	0.15	2006		
12	Nigerian Cement Company (NIGERCEM), Nkalagu	Ibeto	P	0.631		0.631	1957		
13	Edo Cement company	BUA	P, N	0.35	(2.5)**	2.85			
	TOTAL			4.031	34.80	45.081			

*PH = Privatization History (P = previously owned by the government but privatized; PO= privately owned; N =new plants established after BIP)
MMT = million metric tonnes ** Additional capacity under construction

Table 3. *Cement production profile 1986 – 2008.*

Year	Import (Mmt)	Domestic production (Mmt)	Total supply (Mmt)	Market share Import (%)	Domestic production (%)
1986	800,000.00	3,500,000.00	4,300,000.00	18.60	81.40
1987	700,000.00	3,400,000.00	4,100,000.00	17.07	82.93
1988	688,341.00	3,400,000.00	4,088,341.00	16.84	83.16
1989	543,621.00	2,950,000.00	3,493,621.00	15.56	84.44
1990	905,595.00	3,030,000.00	3,935,595.00	23.01	76.99
1991	1,693,200.00	2,924,072.00	4,617,272.00	36.67	63.33
1992	1,985,655.00	2,797,202.00	4,782,857.00	41.52	58.48
1993	2,085,826.00	2,622,218.00	4,708,044.00	44.30	55.70
1994	859,886.00	2,619,908.00	3,479,794.00	24.71	75.29
1995	1,091,232.00	2,610,752.00	3,701,984.00	29.48	70.52
1996	1,060,300.00	2,530,998.00	3,591,298.00	29.52	70.48
1997	1,304,582.00	2,517,413.00	3,821,995.00	34.13	65.87
1998	1,992,588.00	2,206,355.00	4,198,943.00	47.45	52.55
1999	3,112,685.00	2,472,099.00	5,584,784.00	55.74	44.26
2000	3,336,134.00	2,285,506.00	5,621,640.00	59.34	40.66
2001	5,937,000.00	2,168,000.00	8,105,000.00	73.25	26.75
2002	6,041,000.00	2,071,000.00	8,112,000.00	74.47	25.53
2003	6,437,000.00	1,981,000.00	8,418,000.00	76.47	23.53
2004	5,920,000.00	2,337,000.00	8,257,000.00	71.70	28.30
2005	6,629,000.00	2,849,000.00	9,478,000.00	69.94	30.06
2006	6,753,000.00	3,219,722.00	9,972,722.00	67.71	32.29
2007	6,327,000.00	4,642,668.00	10,969,668.00	57.68	42.32
2008	6,977,000.00	6,425,880.00	13,402,880.00	52.06	47.94

Source: FGN (2009)

Table 4. *Nigeria cement industry projections, MMT/A.*

Year	Domestic Consumption	Domestic Production	Shortfall/ Excess capacity
2008	10.000	7.00	-3.00
2009	10.500	7.70	-2.80
2010	11.025	8.47	-2.56
2011	11.578	9.32	-2.26
2012	12.160	10.25	-1.91
2013	12.768	11.28	-1.49
2014	13.410	12.41	-1.00
2015	14.080	13.65	-0.43
2016	14.784	15.02	0.24
2017	15.520	16.52	1.00
2018	16.296	18.17	1.87
2019	17.110	19.99	2.88
2020	17.970	22.00	4.03

Source: FGN (2009)

As a result of implementation of the BIP, all the moribund government owned cement plants were privatized and revived. This is one sector where the privatization of government owned companies resulted in the revitalization of the sector, unlike the iron and steel sector that could not be revived despite privatization [13]. Additional cement production capacity was embarked upon by indigenous companies and multinationals, both for cement production plants (Table 2), and bagging plants/cement importation terminals (Table 5). There was renewed massive investment in the sector (Fig. 2). According to the Cement Manufacturers Association of Nigeria (CMAN), between 2002 and 2012, a total of $ 6 billion was invested by local manufacturers, while ongoing expansion and new plants is estimated to cost another $ 3.5 billion [14]. These injected investments boost the nation's economy even at a time when many companies are pulling

out of Nigeria because of the increased security challenges.

Table 5. *Cement bagging plants in Nigeria (importation).*

	Bagging Plants/companies	Owners	Capacity MMT	Operational since
1	Lagos Cement Terminal			
2	Port Harcourt Cement Terminal			
3	Onne cement terminal	Dangote	12.86	
4	Aliko Inland cement terminal			
5	Continental Cement terminal			
6	Ibeto Cement Company		1.5	
7	Eastern Bulkcem Company Limited	Ibeto	1.5	
8	Atlas Cement Company – Floating Terminal	Lafarge	0.5	1981
9	Quacem Limited/Topcem Cement Company		0.5	
10	Essettee Nigeria Limited, Oron		-	Non operational
11	Gateway Portland Cement		0.999	
12	WestCom Technologies & Energy Services		0.9	2009
13	International Cement Company		0.55	
14	Bua International Limited – Floating Terminal (Lagos & PH)		4.2	
15	Management Enterprises Limited		1.2	Non operational
16	Flour Mills Nigeria PLC (Apapa Bulk Terminal*)		3	
	TOTAL CAPACITY		27.709	

*Handles bulk products including cement and other products such as wheat

Fig 2. *A cement plant (pre-heater plant) under construction in Nigeria.*

The implementation of the BIP has resulted in the emergence of local and regional players in cement manufacturing in Africa. Dangote Cement Company (an indigenous company) has surpassed Lafarge (a multinational company) as the largest cement producer in Nigeria and Africa. Dangote has emerged as the largest cement producing company in Nigeria and indeed the whole of Africa. Dangote aims to reach capacity of 60 MMTPA by 2015, 55% of this is intended for domestic consumption while the rest 45% will be exported to other African countries [15]. Dangote has 4 major cement plants distributed cross Nigeria with a combined capacity of 26.2 MMTPA. The plants include Obajana Cement Plc, Benue Cement Company, Dangote Cement Works Ltd, Ibese and Calabar Cement Plant. The Obajana Cement Plant is the single largest cement plant in sub Saharan Africa with a capacity of 10.2 MMTPA (with additional capacity of 3.25 MMTPA planned). The vertical roller mills of the plant is designed for energy saving and efficient grinding of raw material and clinker. The plant is equipped with gas pipeline of approximately 90 km length for the supply of natural gas from Ajaokuta to Obajana. Gas is consumed at the plant at the rate of 96,000 m^3/hour. The power generation capacity of the plant is 135MW.

Dangote operates 5 cement terminals in Nigeria through which it currently imports cement including Lagos Cement Terminal, Port Harcourt Cement Terminal, Onne cement terminal, Aliko Inland cement terminal, Continental Cement terminal. The combined capacity of these terminals is 12.86 MMTPA. These operations will progressively be replaced and converted into export terminals as new production capacity comes online in Nigeria.

Dangote has also built production plants in some other African countries including Senegal (1.5 MMTPA), Zambia (1.5 MMTPA), Tanzania (1.5 MMTPA), South Africa (2.2 MMTPA), Congo Brazzaville (1.5 MMTPA), Ethiopia (1.5 million MTpa), Cameroun (1.5 MMTPA). Dangote has also installed terminals i.e. bagging plants in some African countries that lack limestones such as Ghana (3.0 MMTPA), Sierra Leone (0.5 MMTPA), Ivory Coast (1.0 MMTPA), and Liberia (0.5 MMTPA) (http://dangote.com/ourbrands/cement.aspx#nig, downloaded 15 January 2013)

The ten years of BIP have resulted in increasing the domestic installed capacity of 2 million tonnes in 2002 to 28 million tonnes in 2012, while creating direct and indirect employment for about two million people. The BIP had also saved the country about N 210 billion per year ($ 1 = N 160 as at December 2012) [16, 17, 18] The construction of additional 2.5 MMTPA Edo cement plant at Ukpella was estimated to cost USD 500 million will take 28 months to complete while providing 4000 skilled jobs and 20,000 indirect jobs. Two new cement plants in India, KCP plant and Jaypee Group with project costs of RS 350 crore and RS 1600 crore having 1.2 and 3 MMTPA capacity will respectively employ about 2000 and 7000 people (World Cement, 2011). Dangotes's Ibese Cement Plant created 2000 direct and indirect jobs while the new Lafarge WAPCO Ewekoro plant could generate over 1000 jobs. The employment effect of cement manufacturing is therefore huge.

Domestic cement production was 2 MMTPA in 2002, 2.5 MMT in 2004, 10.5 MMT in 2010 and 28 MMT in 2012. By 2012, CMAN declared that Nigeria has now attained

self-sufficiency in cement production. CMAN reported that domestic production rose from 2 MMTPA in 2002 to 13MMTPA in 2011 and by October 2012 has produced 17 MMTPA [19]. CMAN also reported that the country is producing 22.5 MMTPA while cement consumption is 18.5 MMTPA [20]. There are fears when the new cement product plants (Table 6) comes on stream, glut could arise. Also, despite meeting and exceeding the domestic demand of cement, importation of the commodity into Nigeria continued. Some newspaper reported cement glut in Nigeria [14, 21, 23] About 2500 permanent and casual workers of Benue Cement Company have been temporarily laid off pending when the business climate improves [24]. However, it is on record that Nigeria is the third world largest importer of clinker after Russia and USA [25]. There are indications that China, Spain, Turkey are dumping subsidized cheap cement in Nigeria [26]. There are reports indicating that the whole issue of glut is a spurious claim just to create artificial scarcity for political and economic reasons [27].

Table 6. *Emerging cement production and bagging plants in Nigeria.*

	Owners	Project completion date	Current status	Capacity, MMTPA
1	AVA Cement		EPC	0.44
2	Otedola Cement			
3	Madewell Cement			
4	Zane Cement Company			
5	NICA Limited			
6	Reagan Renaissance			
7	Minaj Holdings			
	Ibeto Cement, Effium, Ebonyi State	2016	EPC	5.0
	Quacem Nig Ltd		L	
	Gateway Portland Cement			
	Weston Tech & Engineering Services		L	
	International Cement Co., Lagos		L	
	Bua (Kogi and Ebonyi)		F	
	Essettee Nig Ltd		F	

EPC = Engineering Procurement and Construction
F = Feasibility L= land acquisition

Despite the purported glut in cement, the price of the product is still high in Nigeria, indicating that glut may not be the only challenge of the sector. According to Lead Capital Ltd [28] a bag of cement (typically 50 kg) sold for N2200 in May 2008 as against N 625 in 2002. There are reports suggesting that the price of cement (50 kg bag) is highest in Nigeria than anywhere else. The reported listed the price of cement in other countries such as Ghana (N 950), Liberia (<N 1000), Kuwait (<N 600) whereas in China, Turkey, Indonesia and Vietnam the price is less than N 500 [27]. In a recent study, Pan African Capital [5] listed the causes of high cement prices in Nigeria to include; huge supply gap of cement where demand is higher than supply, too many middle men in the supply and distribution of cement, unstable power supply which lead to over dependence on expensive fossil fuel which carries about 50 percent of total cost of production, hoarding of cement by marketers to sustain importation, huge cost of transportation of cement from factory to end-users vis-à-vis poor distribution network of some cement companies, sheer monopoly of production and importation of cement by a few players, high tax burden, unfavorable government policy on production and importation, and high capital involved in setting up more cement factories.

Policy inconsistency is also partly responsible for the challenges in the cement sector. For instance at different times the government had banned and unban cement/clinker importation. In 2007, the government had attempted price control of cement, which was not sustained. In 2007, the BIP suffered setbacks, because companies without any evidence of building cement plant were granted importation licenses, thereby threatening the huge investments by domestic manufacturers [25]. In 2010, the government increased the duty on bulk cement from 5% (since 1999) to 15% and imposed additional levy of 20%, thereby making the total duty on cement to be 35% [27]. All these policy inconsistencies had negative effects on cement prices. On the other hand, the India cement industry witness boost since early 1980s when the country adopted price decontrol policy for the industry. Now the India cement industry has directly employed over 1.35 lakh persons (1 lakh = 100,000) and engaged another 12 lakh persons indirectly [29]. The Indian cement industry is currently the second largest in the world after China, but ahead of USA and Japan [30]. In China, productivity has improved significantly. 1.67 million Cement industry employees produced 595 million tons of cement in 2000, whereas, in 2007, 1.18 million employees produced 13.6 billion tonnes of cement [31]. Report suggests that some powerful cartels are influencing government policies on cement in Nigeria [27]

Other challenges of the cement sector in Nigeria are the low per capita consumption of the product. The per capita consumption of cement in Nigeria is growing steadily from 65 kg in 2005, through 71 kg in 2006 and attaining 90.5 kg in 2008, whereas the global average is 273 kg [25]. In 2007, the per capita consumption of cement in Nigeria is higher than that of Kenya (58.3 kg) but significantly lower than that of Egypt (405 kg), Kuwait (1,224 kg), Qatar (3,358 kg) and Turkey (4,030 kg) [2]. Similarly, in 2005 the per capita consumption of cement in Iran, Iraq, Lebanon, Israel and Libya are 459 kg, 161 kg, 930 kg, 491 kg and 973 kg respectively [32].

Energy related issues emerged as one of the challenges of the Nigeria cement sector. Cement production is an energy intensive process. A large amount of thermal energy is utilized during the pyro-processing of raw materials into clinker, while electrical energy is require for milling the raw materials. Electricity in Nigeria is quite unstable, of

poor quality and only covering about 40 % of the population [33]. Hence, most of the cement mills in the country generate their own electricity from natural gas, coal or low pour fuel oil (LPFO). The prices of all these energy carriers have been unstable over the years in Nigeria. In Nigeria, energy account for 35% of production cost whereas in China it accounts for less than 10%. In Nigeria, LFPO prices have increased from N 25 per liter in 2009 to N 107 as at November 2012, an increase of 331% [14] Because of bad roads and high cost of fuel, transportation account for 20 – 25% of the cost of cement.

Pan Africa Capital [5] reported that for each tonne of cement produced requires 60 – 130 kg of fuel or its equivalent depending on the cement variety and the production process and about 105 kWh of electricity for raw materials and cement milling. In Pakistan, the production of one tonne of clinker requires about 80 – 90 liters of heavy oil or 80 – 100m^3 of natural gas or 150 – 180 kg of coal for thermal energy and an electricity consumption of 100 – 105kWh. It has been variously reported that the cement industry is an energy intensive sector, consuming about 2.9 – 5 MJ/kg of cement produced with a mean of 4 MJ/kg [7, 34, 35]. Most authors reported that energy costs accounts for 30 – 40% of the production cost [3, 36], but IFC [37] reported 40 – 50%. It therefore follows that management of energy could significantly reduce the production costs. Hence, Table 7 summarizes some of the measures that can be taken to improve energy efficiently in the cement sector. Other more detailed measures can be found in the following literatures; [3, 36, 38, 39].

Other measures that could reduce some of the challenges of the cement industry in Nigeria is to implement additional policies that would encourage the increased domestic utilization of cement, exportation of cement to other African nations, while discouraging the manipulation of cement prices by the cartels.

Table 7. *Energy saving strategies in cement production.*

Technology	Applications	References
Waste heat recovery steam generator	Co-generation of electricity from pre-heater and kiln flue gas emissions is environmentally friendly and could generate 30% of electricity needs of the plant	Khurana et al., 2002; Wang and Han, 2012; Radwan, 2012
Fluidized bed cement kiln	Reduces energy consumption by 10 – 12%, though still at pilot stage	EC, 2010; ECRA /CSI, 2009; IEA ETSAP, 2010
Dry process should replace wet process	Wet process requires about 56 – 66% more energy	IEA ETSAP, 2010
Replacement of raw materials with industrial wastes	Energy savings can be attained by replacing traditional cement raw materials with industries wastes such as fly ash furnace slag	IEA ETSAP, 2010
Substitution of fuel with alternative fuel sources	Alternative that have been used to substitute for fuel in cement manufacturing include wood, paper, MSW, plastics, RDF, sludge, saw dust, agro wastes, rubber/tyres, sewage sludge, textiles	IEA ETSAP, 2010
Preheater	Kilns with preheater saves energy. The higher the number of cyclone stages in the preheater more heat is recovered	IEA ETSAP, 2010; Radwan, 2012
Pre calciner	Kiln with preheater and pre calciner are most energy efficient/state of the art tech	IEA ETSAP, 2010; Radwan, 2012
Vertical roller mills (for high mineral additions) and high pressure grinding rolls (for limited mineral additions)	These are the state-of-the art technologies because they have the highest electrical efficiency (50.5 and 44.5 kWh/t of cement respectively	IEA ETSAP, 2010; Cembureau, 1999
The grate cooler for clinker cooling	The grate cooler is more versatile and energy efficient than the rotary (tube) or planetary (satellite) coolers	IEA ETSAP, 2010; Radwan, 2012
Rotatory kiln material selection	The heat loss through the shell of the kiln can be reduced by selecting the type of refractory material having lower thermal conductivity i.e high insulation	Radwan, 2012
By pass gas from kiln inlet	The heat from by-pass gas is used for raw material drying and steam production for power generation	Radwan, 2012
Pre heater exit gas utilization	Pre-heater exit gas can be used for drying and steam production for power generation	Radwan, 2012
New suspension preheaters (NSP)	NSP to replace the shaft kilns for improved energy efficiency and clinker quality	Wang and Han, 2012

5. Conclusions

The consumption of cement in Nigeria has increased to 18.5 million metric tonnes per annum (MMTPA) due to rapid urbanization and industrialization. Nigeria is blessed with abundant limestone, the major ingredient for the production of cement. From 1957 to 1975, the Nigerian government installed 6 cement manufacturing plants. These plants supplied the bulk of the cement needs in the country attaining a peak of 84.44 % in 1989, after which the domestic production dropped to 26.75% in 2001. Despite the huge demand for cement in Nigeria, domestic

production was unable to meet the demand; hence the country relied on importation of cement to meet domestic construction needs. In 2002, the government adopted and implemented the backward integration policy (BIP), which requires cement import licenses be allocated only to importers who show proof of building factories for local cement manufacturing in Nigeria. Incentives under the policy include waiver of VAT and custom duty for importation of cement production equipment. The domestic share of the cement use in Nigeria continue to decline, and the least was recorded in 2003 when domestic production accounted only for 23.55% of cement consumption in the country. However, following the implementation of the BIP, all the moribund existing government owned cement plants were privatized, while the private sector installed additional production and bagging capacities. Before BIP, Nigeria had an installed capacity of 4.03 MMTPA, but producing only 2 MMTPA. But 10 years after the implementation of the BIP, the country now produces 28 MMTPA with a total installed production capacity of 45 MMTPA and bagging capacity of 27.7 MMTPA, while additional 14 cement production plants of various capacities are under construction. Now that Nigeria has become self-sufficient in cement production, with domestic production exceeding the country's need, additional policies that would address the new challenges of the cement sector particularly cement glut is required. Measures that could reduce some of the challenges of the cement industry in Nigeria is to implement additional policies that would encourage the increased domestic utilization of cement, exportation of cement to other African nations, while discouraging the manipulation of cement prices by the cartels.

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