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The Energy Intensity of Economic Sectors in MINT Countries: Implications for Sustainable Development

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ABSTRACT

This paper analysed the status of energy intensity of economic sectors (agriculture, industry, commercial, residential) in MINT (Mexico, Indonesia, Nigeria, Turkey) countries and its implications for sustainable development. We utilised descriptive statistics as well as the Logarithmic Mean Divisia Index (LMDI) decomposition analysis to examine energy and efficiency trends, from 1980-2013, in MINT countries. Empirical results indicate inefficient energy use in the residential and industrial sectors of Nigeria and Indonesia. The analysis also indicates that income/output growth (activity effect) contributed to an increase in sectoral energy consumption of MINT countries. It also revealed that while structural effects contributed to a reduction in energy consumption in virtually all the sectors in Turkey and Mexico, it contributed to an increase in energy consumption of the residential, industrial and commercial sectors of Indonesia and Nigeria in virtually all the periods. These results suggest that a policy framework that emphasizes the utilization of energy efficient technologies especially electricity infrastructural development aimed at energy service availability, accessibility and affordability will help to trigger desirable economic development and ensure rapid sustainable development of MINT economies.

1. Introduction

MINT, which is a new economic bloc is an acronym that refers to the countries of Mexico, Indonesia, Nigeria and Turkey. Even though they have diverse history, culture and geopolitics, the "MINT" countries - Mexico, Indonesia, Nigeria and Turkey – share some commonality in terms of economic conditions, have big and growing populations with bright prospects and have been recognised as emerging economic giants becoming the centre point of an economic grouping that is now a prominent player in international economic relations (Adeolu 2013, Wright 2014, Fraser 2011, Boesler 2013, Magalhaes, 2013).

The energy sector is very strategic to the speedy development of MINT economies and numerous empirical evidence indicates a very strong connection between energy use and both the level of economic activity and economic growth (Mehrara 2007, Nnaji et al 2011, Shiu and Pun 2004, Ghosh 2002, Nnaji et al 2013, Jumbe, 2004). Energy serves as a key input in the production of goods and services in any nation's key sectors such as the industrial, commercial and public sector, transportation, residential and the agricultural sectors .For instance, EIA(2010) indicates that the industrial sector has the largest share in economic activities and accounts for one-third of the world's total energy consumption .In most economies, it is keenly noted that one of the basic ingredients of sustainable economic development is access to affordable and clean energy. Sustainable development entails the adoption of production and consumption patterns that meet the needs of the present without jeopardizing the goals of future generations (Nnaji, et al, 2010). Energy services are therefore essential elements of all three pillars of sustainable development — economic, social and environmental.

One of the critical development challenges for MINT countries is how best to provide energy services to key sectors to actualise their diverse economic transformations and development programmes. However, evidence all over the world including the MINT countries has shown that energy production and use are undertaken in unsustainable manner and cannot be tolerated in the future because of its devastating effects on the environment. In MINT countries like Nigeria and Indonesia where energy utilization is based on fuel wood, coal and oil deemed to be dirty fuels, where the gap between access to affordable energy and the demand for clean energy is very large, energy efficiency of core economic sectors can accomplish multiple social and economic objectives. In most studies which employed total energy consumption to investigate the energy intensity of the economy of MINT and other developing economies, evidence indicate a change of less than 1% in economic growth of countries and a change of more than 1% in CO_2 emissions as a result of 1% change in energy consumption (Chebby and Boujelbene 2008, Omisakin 2009,Nnaji, et al 2013, Jo-Hee and Seung 2014, Baek and Koo 2009,Soytas et al, 2007). Intuitively, this indicates a case of inefficient energy consumption. Numerous academic papers indicate that energy efficiency is the least-cost way to provide energy services while at the same time reducing the environmental impacts of these services (IWG 2000, Renner 2008,ACEEE 1997, Lovins and Lovins, 1991). It is therefore imperative to ensure that the production and sectoral consumption of energy are efficiently undertaken and mostly based on sustainable technologies which will be tolerated in the future.

Thus, in the context of designing appropriate policies, a clear exposition of the present state of energy intensity and efficiency trends for MINT countries would be of foremost importance. To this extent it becomes important to analyze the energy intensity changes resulting from changes in economic activity, sectoral shifts, and changes in energy efficiency on the other. Adequate information regarding the energy intensity of the economic sectors will help to evaluate the need for policy interventions to improve the role of energy efficiency in MINT countries.

2. Country profiles

Table 1 and figure 1 presents some recent statistics on the MINT countries. A brief review of Table 1 indicates that these emerging economic giants may have some similarities and diversities with respect to their country specific socio-economic status.

Mexico, Indonesia, and Nigeria have populations that exceed 100 million; whereas, Turkey is below it. Indeed, the table indicates that MINT countries are endowed with large populations which may be an investment incentive factor considering the large market that may be created. The countries seem to have striking similarities with respect to their population growth rates as well. The population growth rates of Mexico, Indonesia and Turkey are within the range of 1.2 and 1.3. Only Nigeria seems to have a population growth rate above 2%. A notable characteristic of Table 1 may be that MINT countries appear to have average Nominal Gross Domestic Product (GDP) above US$800 billion, where Mexico is taking the lead with a GDP of US$ 1,144 billion. In terms of Per capita GDP (PCG), Figure 1 indicates that while Indonesia and Nigeria have low rates of PCG, Mexico has the highest rates in recent times, earlier topped by Turkey from 2008 but was overtaken by Mexico in 2013.The figure reveals that among MINT countries, Nigeria has the lowest rates of PCG and Human Development Index (HDI).

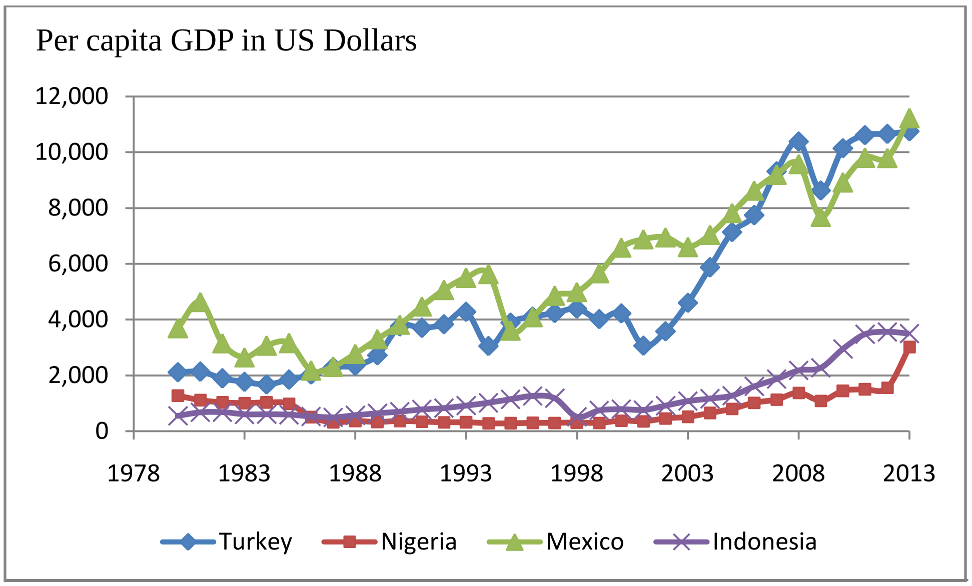
Table 1- Economic and energy profiles of the MINT countries

	Mexico	Indonesia	Nigeria	Turkey
Population, total (2015)	125,385,833	254,454,778	177,475,986	75,932,348
Population growth (annual %) (2013)	1.20	1.29	2.8	1.3
GDP (nominal $) (2015)	1144.3 billion	858.9 billion	490.2 billion	733.6 billion
(Human Development Index) HDI (2014)	0.756	0.684	0.514	0.761
GDP growth (annual %) (Average of 2010-2013)	3.6	6.2	5.6	6.0
Gross capital formation (% of GDP) (2013)	22	34.77	15	21
Net energy imports (% of energy use) (2013)	-23	-89	-117	71
Energy production (kt of oil equivalent) (2011)	228206.8	394572.9	256927.2	31117.4
Energy use per capita (kg of oil equivalent) (2011)	1560	857	721	1539
Electricity use per capita (kWh) (2011)	2092	680	149	2709

Source: World Development Indicators

As depicted in Table 1, the MINT countries appear to have a unique GDP growth which is in the range of 5-6% apart from Mexico which has an annual GDP growth rate of 3.6%. The gross capital formation as a percentage of GDP seems to range from 15% in Nigeria to 34% in Indonesia. Country characteristics also seem to be similar and differ in some areas in terms of the energy statistics. Indonesia, Mexico and Nigeria are net exporters whereas Turkey is net importer of energy. Net energy imports as a percentage of commercial energy used signifies that Nigeria is the highest net exporter with -117%. Both energy production, energy use per capita, and electricity used per capita statistics also imply that the MINT countries may have diverse energy sector properties. Hence, a statistical irregularity captured here may also be reflecting the characteristics of diverse transformations undergone in the different countries. While Nigeria and Indonesia have low rates of both energy use per capita and electricity use per capita, the value of 149 for Nigeria with respect to electricity use per capita is one of the lowest in the world and portends serious electricity crises in Nigeria.

Figure 1 Per capita GDP in MINT Countries, 1980-2013



Source: World Bank statistical data

3. ENERGY CONSUMPTION PATTERN IN MINT COUNTRIES

3.1 Total Final Consumption (TFC) of energy by sectors (1980-2013)

The analysis of energy consumption by sectors revealed that total final consumption of all the sectors in MINT countries as depicted in figure 3.1a has increased by more than 100 percent (122.07%) in the last three decades (1980-2013) with 3.6% annual average growth rate rising from 202340.4 kilotonnes of oil equivalent (ktoe) in 1980 to 449341.5 ktoe in 2013**.** It increased by 34.95% between 1980 and 1990 and by 28.25% between 1991 and 2001 and further increase of 22.71% between 2002 and 2013. The graph indicates that Nigeria and Indonesia witnessed high and increasing energy consumption rates in the range of 42000 to 225000 ktoe; while Turkey and Mexico had energy consumption rates below 70000 ktoe; in the range of 19900 to 62000 ktoe. Individual country's graph indicates that the residential sector witnessed the highest energy consumption rates in most countries followed by the industrial sectors except in Mexico where the Industrial sector had highest consumption rates followed by the residential sector . The agricultural sectors in the countries witnessed very low energy consumption rates.

Figure 3.1a Total Final Consumption of Energy in MINT

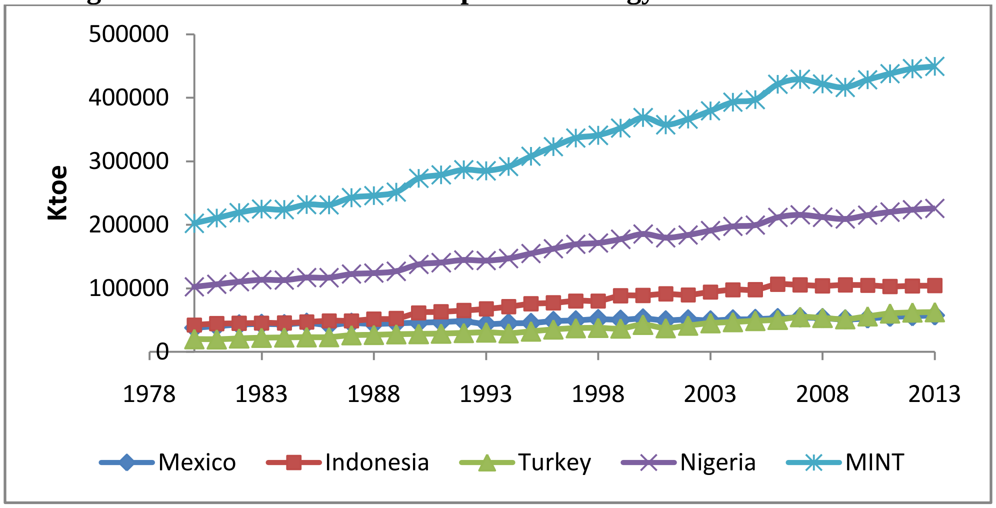


Fig. 3.1b Total Final Consumption of Energy in Mexico

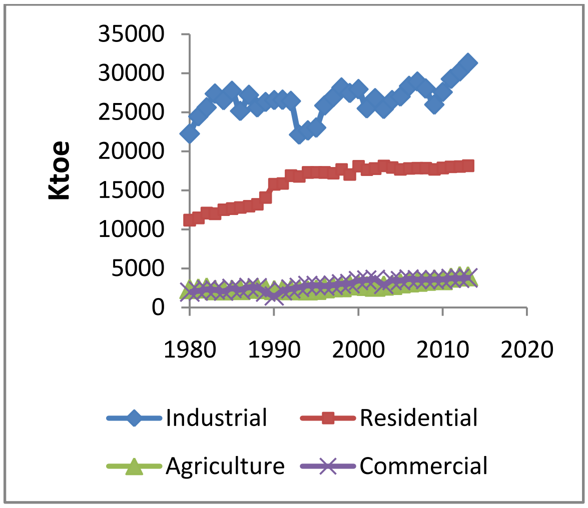


Fig. 3.1c Total Final Consumption of Energy in Indonesia

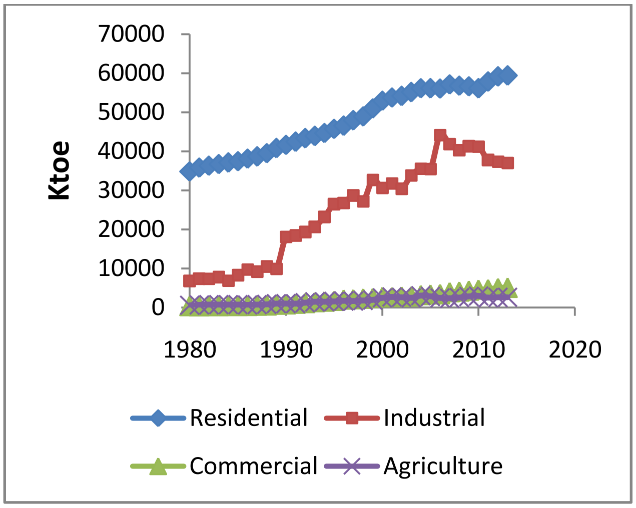


Fig. 3.1d Total Final Consumption of Energy in Nigeria

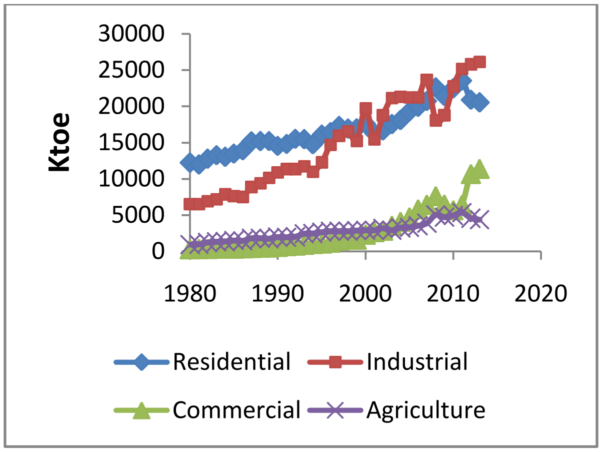
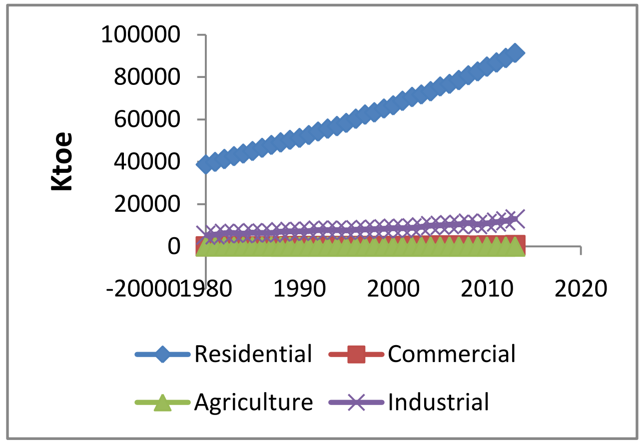


Fig. 3.1e Total Final Consumption of Energy in Turkey



3.2 Total Final Consumption (TFC) by energy types (1980-2013)

The graphs of total final consumption by energy types revealed that oil products and fuel wood (biofuel) despite their inefficient conversion process, dominate the energy mix of most MINT countries except in Mexico which experienced low rates of fuel wood consumption. Despite the fact that electricity is regarded as a clean energy with relatively high level of efficiency, this energy constitute less than 5% of the energy mix, especially in Nigeria; whereas traditional fuel wood was responsible for more than 50% of energy consumption in most MINT countries with far reaching negative implications on the environment and efficiency ratings of the productive systems. However, evidence from the graph indicates that Turkey has been exceptional in witnessing high decreasing levels of wood fuel consumption and high increasing levels of electricity consumption.

Figure 3.2a TFC by energy types in Mexico

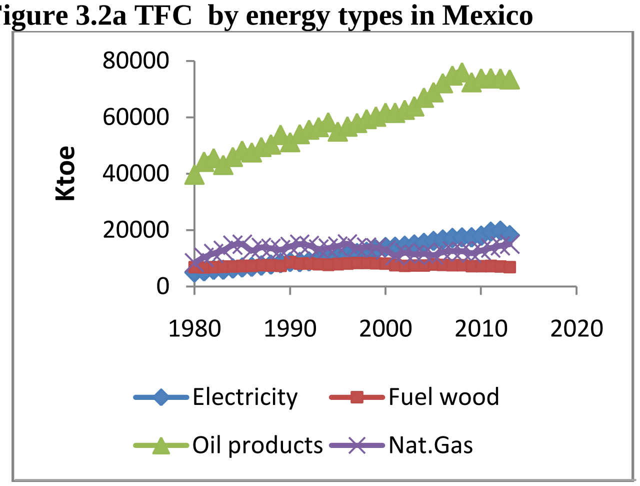


Figure 3.2b TFC by energy types in Indonesia

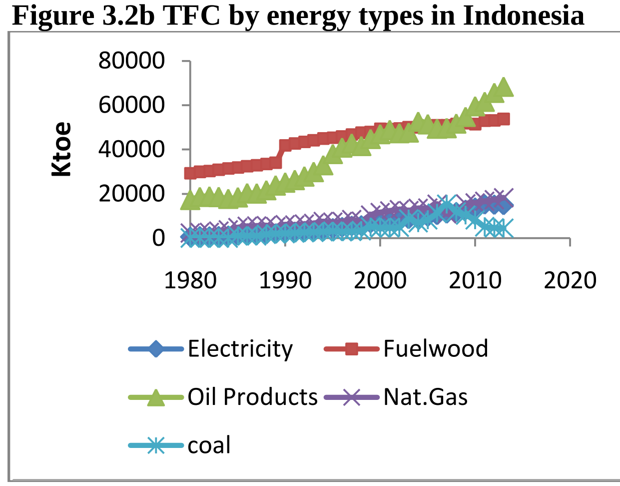


Figure 3.2c TFC by energy types in Nigeria

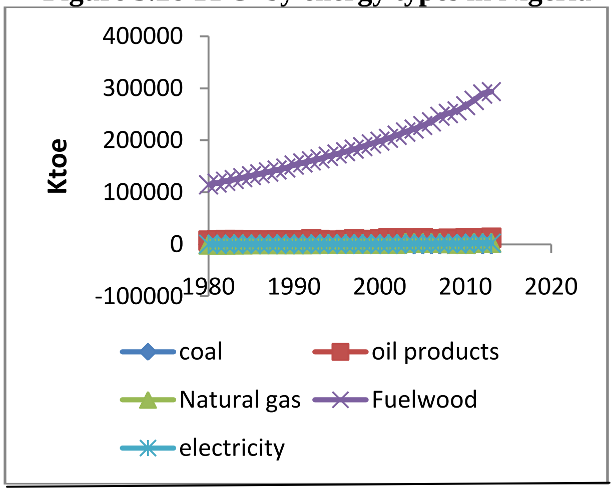
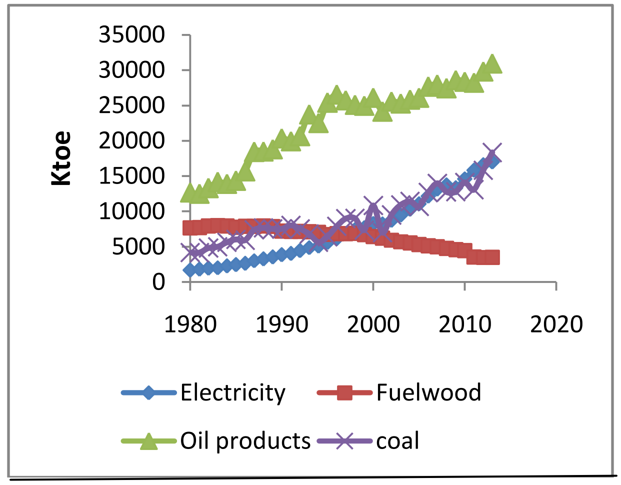


Figure 3.2d TFC by energy types in Turkey



3.2 Overview of energy intensity in MINT countries (1980-2013)

In computing energy intensity, we used the measure (energy/GDP ratio) for the National economy; GDP in million current US $ is used. For the residential sector, value of household consumption is used whereas for value adding sectors (industrial, commercial and agriculture), value-added in current US $ is the denominator used in the study. Using the energy/GDP ratio, the analysis indicates that in MINT countries, national energy intensities have been declining from the period of 1980-2013.Apart from Nigeria with high levels of increasing and decreasing intensity rates, other countries maintained a modest decrease in energy intensity rates. However, from 2003 to 2013, MINT countries maintained a steady decline in energy intensity rates (Figure 3.3a).

Figure 3.3a Energy Intensity in MINT countries

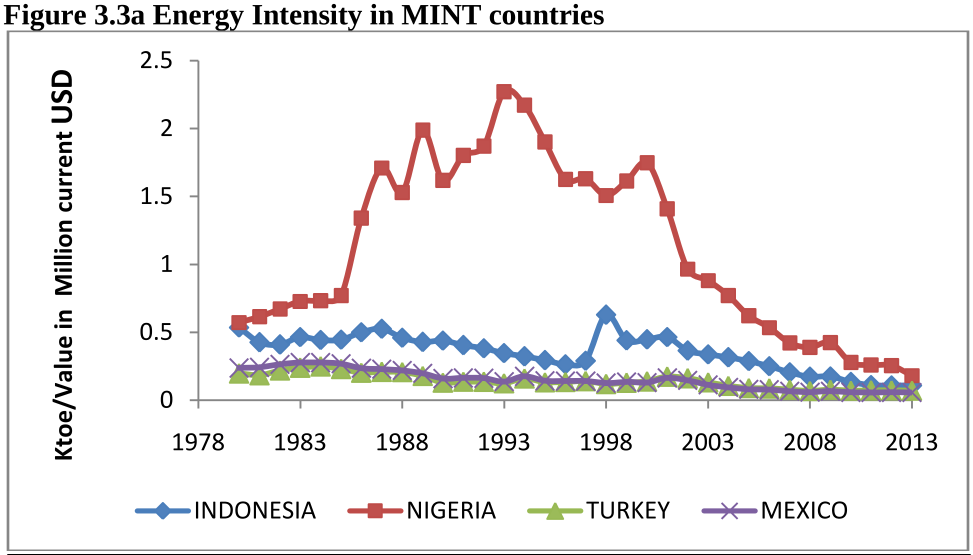


Figure 3.3b Energy Intensity in Mexico

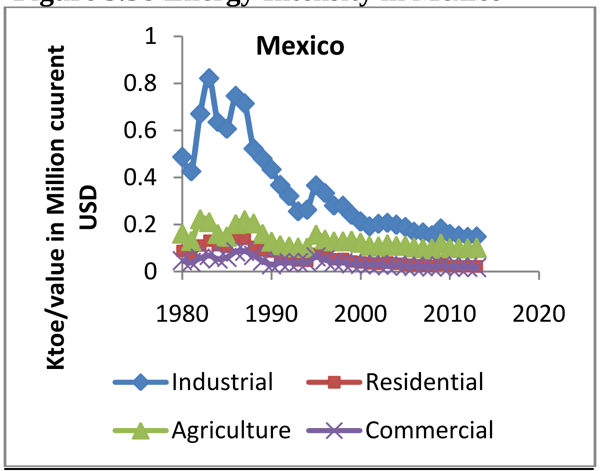


Figure 3.3c Energy Intensity in Indonesia

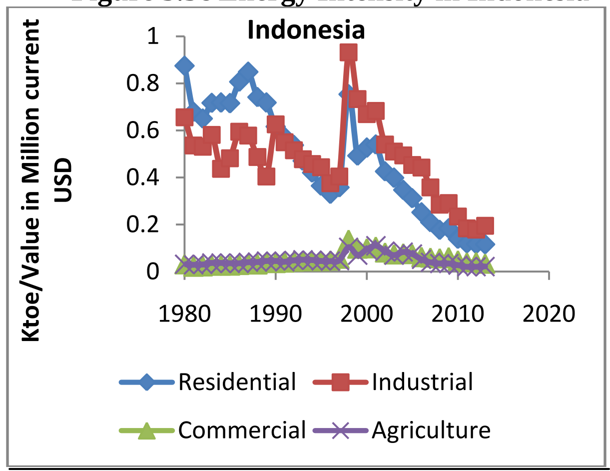


Figure 3.3d Energy Intensity in Nigeria

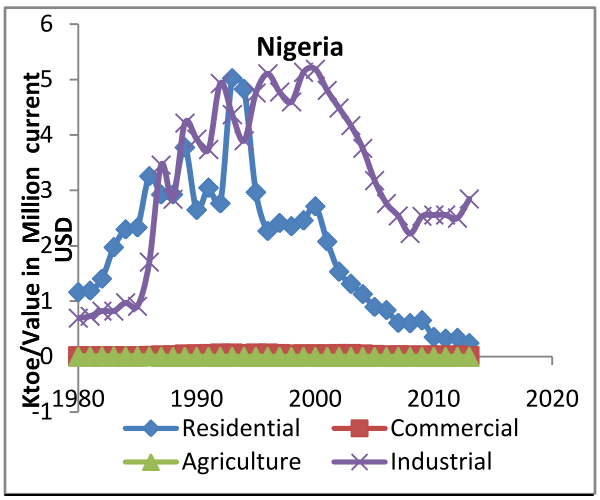
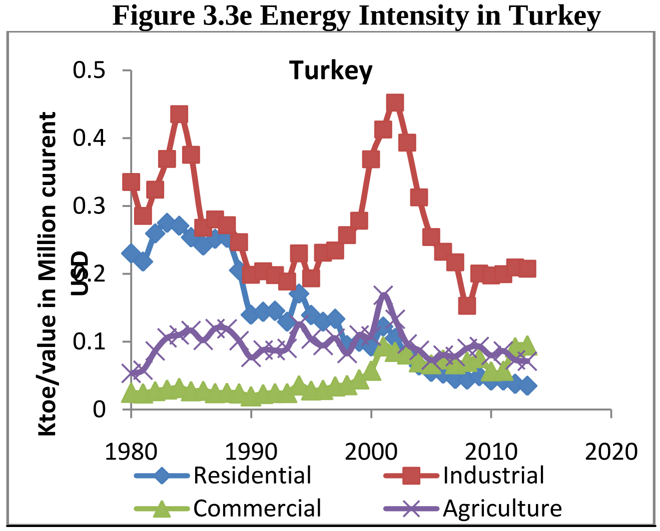


Figure 3.3e Energy Intensity in Turkey



In terms of country-specific intensities, the graphs revealed that the residential and industrial sectors witnessed high energy intensities in most MINT countries. Among MINT countries, Nigeria witnessed highest energy intensities, as high as 5 while Turkey witnessed low energy intensities, recording only 0.45 as highest energy intensity. Mexico and Indonesia had intensities that fluctuate below 1. From late 90's, sectoral energy intensities witnessed inception of reductions in energy intensities with little fluctuations at intervals. However, from 2000 and beyond, virtually all sectoral energy intensities witnessed steady reductions.

Though, this scenario of downward trend in energy intensity may signify energy efficiency; in order to examine the role of energy efficiency in energy consumption, numerous studies have criticized the use of Energy-to-GDP ratios to measure the energy efficiency performance of national economies because of several limitations of using such an indicator ((Schipper et al. 1992; Lermit et. al., 2007, Patterson 1996; Ang and Lee 1994; and IEA 2004). Energy researchers demonstrated that factors other than energy intensity were affecting changes in energy use; mainly the level of aggregate economic activity (activity effect), and the composition of various activities (structure effect). Factorization techniques such as the Logarithmic Mean Divisia Index method were developed to isolate the energy intensity effect in order to give a better estimate of energy efficiency improvements.

4. Data and Methodology

4.1 Data

Data for various countries have been collected from various sources. These data comprise yearly observations over the years 1980–2013, namely:

- Gross Domestic Product by type of expenditure at current prices in US dollars
- GDP by sector by value added in current US dollars. For the residential sector, value-added is replaced by the value of household consumption.
- Total final energy consumption per sector in KTOE (Kilotonne of Oil Equivalent)

Specifically, data have been collected on the industrial, residential, commercial and the agricultural sectors. Energy data are collected from the International Energy Agency while the added value per sector and the GDP data are taken from the United Nations statistical data base.

4.2 Methodology

Logarithmic Mean Divisia Index (LMDI)

The use of LMDI to separate the effects of key components on energy end-use trends over time is well documented in the literature (Chunlan et al., 2008; Bhattacharyya and Ussanarassamee 2005; Reddy and Ray 2010; Lermit and Jollands, 2007, Salta, et al. 2009, Ang, 2004). Evidence from energy analysts such as Ang et al. (2010), Inglesi-lotz and Blignaut (2011) and Liu and Ang (2003) revealed that the LMDI method is recognized as superior in comparative studies involving other decomposition methods. When compared to other widely used methods such as the Laspeyres method, one of the LMDI method's main advantages is that it leaves no residual term, which in other methods can be large and distort the accuracy of results and their interpretation. Two types of decomposition involving LMDI method are additive and multiplicative (Ang, 2005). The additive LMDI approach is easier to use and interpret, and its graphical results and image show effects in a clearer way unlike the multiplicative analysis.

Having highlighted the impressive performance of this methodology, this study shall employ the LMDI to analyze the role of energy efficiency improvements in MINT countries' energy consumption in order to evaluate the need for policy intervention.

In this study, the LMDI method will utilize the additive formulars for decomposing energy use into activity, structural, and energy intensity effects as shown below (Ang, 2005):

The variables are defined as follows:

E_t = total final energy consumed by the industrial, agricultural, service, and residential sectors in year t (ktoe)
$E_{i,t}$ = energy consumption in section i in year t (ktoe)
Q_t = total output from industrial, commercal, agriculture and residential (value of household consumption) sectors (value added in current USD)
$Q_{i,t}$ = output of sector i in year t
S_{it} = output share of sector i in year t ($Q_{i,t}/Q_t$)
$I_{i,t}$ = energy intensity of sector i in year t ($E_{i,t}/Q_{i,t}$)

Total energy consumption can be expressed as follows:

$$E_t = \sum_i Q_t\,(Q_{it}/Q_t)\,(E_{it}/Q_{it}) = \sum_i Q_t\,S_{it}\,I_{it} \qquad (1)$$

Change in total energy consumption between year *0* and year *t:*

$$\Delta E_{tot} = E^t - E^0 = \Delta E_{act} + \Delta E_{i,str} + \Delta E_{int} \quad (2)$$

Where *act (Activity Effect)* denotes change from economic output (changes in GDP), *str (Structural Effect)* denotes structural change and *int (Intensity Effect)* change as a result of energy efficiency effects (energy intensity).

Changes in energy use are calculated for each of the sectors as follows:

$$\Delta E_i = E^t_{i,} - E^0_{i,} = \Delta E_{i,act} + \Delta E_{i,str} + \Delta E_{i,int} \quad (3)$$

This equation according to Ang (2008) is defined as thus:

$$\Delta E_{act} = \sum_i w_{i,t} \ln (Q^t/Q^o) \quad (4)$$

$$\Delta E_{str} = \sum_i w_{i,t} \ln (S^t_i/S^0_i) \quad (5)$$

$$\Delta E_{int} = \sum_i w_{i,t} \ln (I^t_i/I^0_i) \quad (6)$$

$$\Delta E_{tot} = E^t - E^0 = \sum_i w_{i,t} \ln (Q^t S_i I^t_i / Q^0 S^0_i I^0_i) \quad (7)$$

Where w is the logarithmic weighing scheme:

$$w_{i,t} = E^t_i - E^0_i / \ln E^t_i - \ln E^0_i$$

The Activity Effect, measures the change is energy use coming from an increase or decrease in output level or GDP. Energy use falls due to an activity effect if the use of energy increases more slowly than the change in output level or GDP. Energy use falls due to a structural effect if the use of energy increases more slowly than the change in the economic structure. Negative contribution or reduction on total energy use is observed if there is a diversion from energy intensive sectors to less energy intensive sectors. Intensity/Efficiency effect measures changes in energy use coming from technological or efficiency improvements. Energy efficiency improvements imply there will be negative contributions to changes in energy consumption from Intensity/efficiency effect.

4.3 Empirical Results and Discussion

The results of decomposition analysis carried out to examine the priority sectors for policy intervention is presented in Table 2. The analysis shows that Efficiency effect from the residential and industrial sectors have been contributing positively to energy consumption in Nigeria and Indonesia.

Table 2 Sectoral decomposition of Energy Consumption change in MINT countries (1980-2013) (Ktoe; million current prices USD)

COUNTRIES	INDONESIA					TURKEY				
PERIODS	**1980-1986**	**1987-1993**	**1994-2000**	**2001-2007**	**2008-2013**	**1980-1986**	**1987-1993**	**1994-2000**	**2001-2007**	**2008-2013**
AGRICULTURE										
ACTIVITY	128.03	747.9	-197.4	2406.6	1212.3	140.28	1388.27	1418.80	4020.93	536.80
STRUCTURE	-82.52	781.61	-124.52	-193.02	82.23	-370.19	-174.81	-545.91	-481.67	-110.22
EFFICIENCY	65.14	241.23	1256.80	-2566.3	-1236.5	755.98	-585.63	-395.12	-2586.0	-1091.1
INDUSTRY										
ACTIVITY	1699.8	10345.7	-2751.2	35174	18149	839.62	6825.0	7942.5	22964.9	2506.2
STRUCTURE	2093	18515	88.73	-1480.9	-6689.0	1668.4	100.91	-6258.3	-2357.31	-1073.3
EFFICIENCY	792.1	2722.6	10177.0	-2.36	147.30	-1575.1	-4048.6	7051.75	-12384.9	-6676.9
COMMERCIAL										
ACTIVITY	81.25	609.90	-209.35	3145.09	2129.68	43.89	449.25	842.72	5094.30	1076.84
STRUCTURE	22.31	828.90	-239.67	-131.17	1183.31	38.37	-2.08	-308.21	58.47	-88.30
EFFICIENCY	-35.08	288.71	1600.23	1834.49	-2362.1	40.50	3.60	750.62	-1408.57	2756.85
RESIDENTIAL										
ACTIVITY	7592.9	30222.6	-5011.6	53237.9	27265.0	1564.48	10197.2	8566.23	21963.63	2472.30
STRUCTURE	1341.8	40479.6	2435.56	2545.66	-195.40	-481.29	-238.76	-4104.4	839.80	333.08
EFFICIENCY	2.97	2.42	10.80	-0.20	2.67	628.33	-10131	-9815.5	-18380.9	-4896.5
COUNTRIES	**MEXICO**					**NIGERIA**				
PERIODS	**1980-1986**	**1987-1993**	**1994-2000**	**2001-2007**	**2008-2013**	**1980-1986**	**1987-1993**	**1994-2000**	**2001-2007**	**2008-2013**
AGRICULTURE										
ACTIVITY	-832.90	2625.47	680.48	1018.04	542.26	-43.57	-1.01	2.10	7.15	5.16
STRUCTURE	198.57	-1058.86	-534.54	-171.22	-114.75	14.44	0.17	-1.83	-0.04	-1.66
EFFICIENCY	520.79	-1736.81	484.35	-321.79	161.96	27.16	3.62	0.24	-8.54	-6.01
INDUSTRY										
ACTIVITY	-8515.71	27592.75	6830.99	9102.47	4317.45	-2182.8	-734.0	1036.68	6015.45	5832.94
STRUCTURE	1307.98	-7483.33	3840.60	-1802.7	-200.73	-471.47	499.02	1286.28	89.28	1072.81
EFFICIENCY	10142.71	-25173.7	-5381.8	-3860.7	-1241.8	2089.2	227.57	-1764.56	3135.93	614.98
COMMERCIAL										
ACTIVITY	-760.91	2887.38	841.38	1187.55	535.46	-80.13	-191.6	635.25	1942.36	1765.40
STRUCTURE	-192.63	-812.83	592.46	70.77	117.54	6.30	96.83	-385.72	109.79	-95.96
EFFICIENCY	1264.20	-2076.67	-799.43	-1220.5	-417.99	41.44	1686.59	-623.51	-2180.80	-2324.7
RESIDENTIAL										
ACTIVITY	-4307.67	16633.92	4795.83	5948.88	2623.89	-50554	18189.	22441.34	91876.01	55271.9
STRUCTURE	-17.72	3173.73	-1231.0	262.90	-151.72	11858.2	10660.5	-9042.03	2350.19	8378.08
EFFICIENCY	5985.42	-16015.6	-2742.3	-6014.7	-2216.1	30664.9	4298.8	9675.5	88053.83	33860.8

Source: Data from IEA (2015), World Bank database (2015), Calculations by Author. Negative Values imply a decrease in energy consumption

Efficiency effect contributed negatively in all but one period in the countries of Mexico and Turkey.

This positive contribution of efficiency effect in the residential and industrial sectors of Nigeria and Indonesia may imply that most populations in these countries, especially in the rural areas, lack access to modern fuels and greatly rely on fuel wood and other solid fuels with high energy intensity. In Nigeria for example, traditional biomass resources such as wood and charcoal play a central role in fulfilling basic energy needs. Multiple and unpredictable power cuts, which have become a daily occurrence in Nigeria have compelled industrial enterprises to install their own electricity generation , thereby adding considerably to their operating and capital cost which makes it difficult for the industrial sector to produce goods efficiently. In Indonesia, dirty energy resources such as fossil fuel, fuel wood and abundant coal resources are particularly responsible for positive efficiency effect in these sectors. To entrench energy efficiency into Indonesia sectors, the Indonesian government initiated an Industrial Energy Conservation Program under which ONEBA (an energy conservation company) was established. However, its effectiveness is constrained by a number of factors, including a lack of clear institutional objectives and other difficulties (Einar, et al 1996). According to EIA (2014), a major obstacle to the improvement in energy efficiency in Indonesia is that the engineering, architectural, construction, operation and maintenance communities appear to lack both the requisite knowledge of energy efficient technology and the incentives to use the technology.

In Turkey and Mexico, evidence from the analysis on efficiency effect indicates that negative contributions to energy consumption in the residential and industrial sectors dominated in virtually all the periods. These negative contributions of efficiency effect to the energy consumption in Mexico was strongly propelled by the increased share of electricity in industrial energy consumption which has increased very rapidly, exceeding 35 percent from 2009 compared with 13 percent in 1990. The contribution of energy-intensive industries also decreased since 1990, from around 60 percent of industrial consumption to below 49 percent since 2008 (Enerdata, 2015).

In Turkey, negative contributions to energy consumption in the residential and industrial sectors was a consequence of steady reduction in fuel wood consumption since the eighties as well as the increased share of electricity in final energy consumption which surged from 9.5 percent in 1990 to above 20 percent in 2009 and beyond. Indeed, since 2001, electricity consumption has increased at the very rapid pace of 6.3 percent / year, i.e, much faster than final energy consumption (EIA, 2015).

In the area of Activity Effects/Levels, evidence from the analysis indicates that activity effect has been contributing to an increase in sectoral energy consumption of MINT countries. In all the sectors, it contributed positively in virtually all the periods except in the Nigerian agricultural and commercial sectors where negative contributions manifested in the first and second periods probably as a result of low energy utilization in the agricultural sector as well as low energy demand of the pre-90's in the Nigerian commercial sector (Sambo, 2008). The positive contributions are more prominent in the residential, industrial and commercial sectors. This positive contribution implies that as national income and household income increases, more energy consuming services are utilized by households and industrialists in the production process.

With respect to Structural effects, the analysis in table 2 indicates that structural effects contributed to an increase in energy consumption of the residential, industrial and commercial sectors of Indonesia and Nigeria in virtually all the periods. The residential sector is the sector with the highest total sectoral positive contribution, followed by the industrial sector and then, the commercial sector. In Turkey and Mexico, structural effects contributed to a reduction in energy consumption in virtually all the sectors. The implication of this analysis is that, unlike Turkey and Mexico which experienced modest reductions in energy consumption in virtually all the sectors and periods, the structural compositions in Nigeria and Indonesia are dominated by high energy intensive sectors such as the residential and industrial sectors.

4.4 Policy Implications and Conclusion

The main objective of this paper was to examine the status of energy intensity of economic sectors (agriculture, industry, commercial, residential) in MINT (Mexico, Indonesia, Nigeria, Turkey) countries and its implications for sustainable development. To accomplish this goal, we employed descriptive statistics as well as the LMDI decomposition analysis to analyze energy and efficiency trends, from 1980-2013, in MINT countries. Analysis of energy by sector indicates that when compared to Turkey and Mexico, Nigeria and Indonesia witnessed high and increasing energy consumption rates and the residential sector witnessed the highest energy consumption rates in most countries followed by the industrial sectors except in Mexico where the Industrial sector had highest consumption rates followed by the residential sector.

Analysis of energy by fuel types revealed that oil products and fuel wood (biofuel) dominate the energy mix of most MINT countries except in Mexico which experienced low rates of fuel wood consumption. Electricity constitutes less than 5% of the energy mix, especially in Nigeria; whereas traditional fuel wood was responsible for more than 50% of energy consumption. However, Turkey was exceptional in witnessing high decreasing levels of fuel wood consumption and high increasing levels of electricity consumption.

LMDI decomposition results show that efficiency effects from the residential and industrial sectors contributed positively to energy consumption in Nigeria and Indonesia. The analysis indicates that activity effect contributed to an increase in sectoral energy consumption of MINT countries. It also revealed that while structural effects contributed to a reduction in energy consumption in virtually all the sectors in Turkey and Mexico, it contributed to an increase in energy consumption of the residential, industrial and commercial sectors of Indonesia and Nigeria in virtually all the periods.

These empirical results provide useful insight to policy formulation and implementation especially as most of the MINT countries aspire to transform into a fully industrialized economy in the near future. Given that electricity constitutes less than 5% of energy mix and that efficiency effects as well as structural effects contributed positively to energy consumption in virtually all the sectors especially in Nigeria and Indonesia, these scenarios portends serious impediments to the ambition of becoming emerging economic giants. Rapid industrialization requires higher and more efficient consumption of energy products. Inefficiency of energy systems lead to wastages in the processes of extraction, conversion and utilization of energy systems. The consequences of such wastage include environmental degradation, faster depletion of energy resources, and increased cost of energy products and services (EREP, 2012). Apart from improvement in other macroeconomic fundamentals, sustainable energy infrastructure will help to improve income class, ensure rapidly developing modern industrial and service sectors as well as declining poverty rates. A policy framework that emphasizes the utilization of energy efficient technologies especially electricity infrastructural development aimed at energy service availability, accessibility and affordability will help to trigger desirable economic development and ensure rapid sustainable development of MINT economies.

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