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The energy security situation of Ghana; A Country Comparative Analysis of 34 other countries worldwide

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Abstract
This study employed the composite energy security index developed (CESI) by B. K. Sovacool (2011) to compare Ghana's energy security situation with those of 34 other countries — ASEAN, USA, EU, Japan, South Korea, China., India, Oceania, and 17 African countries — over a 20-year period. The aim is to determine which metrics of the composite index these countries outperformed Ghana. These metrics were captured under the categories of availability, affordability, technology development and efficiency, environmental sustainability, and regulation and governance. The top five performers were Brunei (273), Japan (260), New Zealand (254), USA (253), and EU (252) while the five worst performers were (from the bottom) Tunisia (123), Libya (124), Algeria (127), Egypt (128), and Morocco (132). Ghana was 17th, with a score of 185. The best-performing African countries were Congo DR (201), Cameroun (201), Angola (200), Tanzania (199), and Zambia (187). Ghana was the sixth best performer amongst the African countries.
Keywords: Energy Security, CESI, environmental sustainability

1.1 Introduction

The concept and definitions of energy security have widened speedily over time. In present day definitions (see Chevalier, 2005; IEA, 2007d; APERC, 2007; CIEP, 2004) four main elements can be identified. The first and most dominant element (included in all definitions) is the availability of energy to an economy. This entails an element of absolute availability or physical existence (fossil resources are essentially finite). Next, there is an element of accessibility due to the large spatial discrepancy between consumption and production of resources. Acquiring access often carries geopolitical implications. Furthermore, there is an element of costs in most interpretations of Security of Supply. Finally, some definitions also include an element of environmental sustainability (e.g., related to the availability of tar sands or bio-energy).

This paper adapts the definition of Brown, MA and BK Sovacool 2011. Energy security, defined as the equitable provision of available, affordable, reliable, efficient, environmentally benign, proactively governed, and socially acceptable energy services to the end users, has grown as a salient policy and political issue of late (BK Sovacool, 2011). Energy use and development varies widely across the continent, with some African countries exporting energy to neighbors or the global market while others lack even basic infrastructures, or systems to acquire energy by. The World Bank has declared 25 of the 54 nations on the continent to be in an energy crisis (World Bank, 2011).

The security of supply and the concentration of energy fuels among countries, the peak oil theories, the rising prices, and energy poverty, to name a few, have all become prominent concerns among policymakers and investors of late, along with energy security's close relationship with sustainable development and economic growth (Sovacool*, 2011). Energy development has not kept pace with rising demand in developing regions, placing a large strain on the continent's existing resources over the first decade of the new century. From 2001 to 2005, GDP for over half of the countries in Sub Saharan Africa rose by over 4.5% annually, while generation capacity grew at a rate of 1.2% (Foster et.al, 2010)

Ghana's energy security challenge is to ensure the supply of adequate and reliable modern forms of energy for economic development in an environmentally benign manner. The installed generation capacity available for grid supply at the end of 2012 was 2,296 megawatts (MW) (Energy Commission, Ghana, 2013). Though many has been our challenges we pick consolation in the fact that we have not perform badly over the years even in the midst of all these challenges.

In this paper, selection of energy security index for the performance measurement was based on a maiden research by Benjamin K. Sovacool in 2011 using 20 indicators. This maiden paper provides the appropriate premise for the definition of energy security as well as for the selection of the appropriate indicators constituting the composite index. Prior to the publication of this paper, no composite indicator had been used to compare the energy security situation of countries due the controversy surrounding the definition and scope of energy security. The composite indicator employed in the maiden study was essentially a consensus on the definition. This is because it was the result of a survey questionnaire administered to 74 energy experts working at 35 institutions in Asia, Europe, and North America. This study scales down the number to 13, with recourse to priority and data availability. Research intensity, though highly rated, was not included in the set of 13 indicators for the composite index due to the data limitation for most of the developing nations.

The composite index used by Sovacool consisted of 20 metrics under the five dimensions. The availability dimension of energy security included four metrics: total primary energy supply per capita, average reserve-to-production ratios, self-sufficiency, and share of national renewable energy supply. Affordability relied on the four metrics of stability of electricity prices, percentage of population with access to the electricity grid, households dependent on traditional fuels, and the retail price of gasoline. Technology development and efficiency was reflected by the four metrics of research intensity, energy intensity, grid efficiency, and energy stockpiles. In terms of environmental sustainability, the four metrics were forest cover, water availability, per-capita energy-related CO_2 emissions, and per-capita SO_2 emissions. Lastly, to reflect regulation and governance, the index employed worldwide governance ratings, energy exports, per-capita energy subsidies, and quality of energy information. These metrics were scaled down to 13 with respect to priority and data availability. This prioritization of the indicators was based on a research by Benjamin K. Sovacool et al. (Sovacool*, 2011).

This study therefore seek to compare Ghana's energy security situation with those of 34 other countries. We seek to compare the performance of Ghana's situation to that of the pest performers in the world and in Africa with the ultimate aim of determining which metrics of the composite index these countries outperformed Ghana. This would among other things direct policy maker to specific areas that require urgent attention in our quest to improving our energy situation as a Country.

The rest of the paper is organized into sections 2.0 to section 4.0. Sections 2.0 gives a brief insight to the methodology for the country comparative analysis, while section 3.0 is dedicated to results and discussion of study findings. The last section 4.0 concludes the study and offer some policy recommendation based on the study findings.

2.0 Methodology

The methodology for the country comparative analysis essentially involved scaling down the number of indicators from 20 to 13 data collection, synthesis, and scoring country performance among the 13 metrics over a 20-year period. This was followed by analysis of the performance of the overall top five performers and top five African performers relative to the performance of Ghana.

Ultimately, the 13 indicators were classified under the thematic areas of availability, affordability, technology development and efficiency, environmental sustainability, and regulation and governance as per the adopted definition of energy security. Tables 6 to 9 (in Appendix A) elaborate this classification. The selected metrics include total primary energy supply per capita, average reserve-to-production ratio for natural gas and oil, self-sufficiency, share of renewable energy in the total primary energy supply, percentage of population with high connections to the electricity grid, retail price of gasoline/petrol, energy intensity, grid inefficiency, forest cover, water availability, per-capita energy-related CO_2 emissions, worldwide governance rating, and quality of energy information. Tables 16 to 25 in Appendix C show the energy security data for the 35 countries.

All the 13 metrics in the index were made unidirectional so that the higher values would correspond with better energy security scores (the idea being that it would be easier to identify common trends). Thus, four of the metrics — retail prices, energy intensity, grid inefficiency, and per-capita CO_2 emissions — were inverted or transformed. Scoring is empirical and relative — empirical in that the scores were based on the real-world performance of the countries observed within a particular metric for a given year, and relative in that the best and worst scores for those countries were taken and used to create a range of scoring points. This was done by converting all the data points to a score between 0 and 100. The scoring range was created by subtracting the minimum value (the worst performer) from the maximum value (the best performer). The negative values were discarded and converted to zero. In the next step, each value was taken, the minimum value was subtracted from it, and the resulting value was divided by the range. The result was a score for each country anywhere from 0 to 100. The absolute score (aggregate of the mean score for each year and metric) was then calculated for each country.

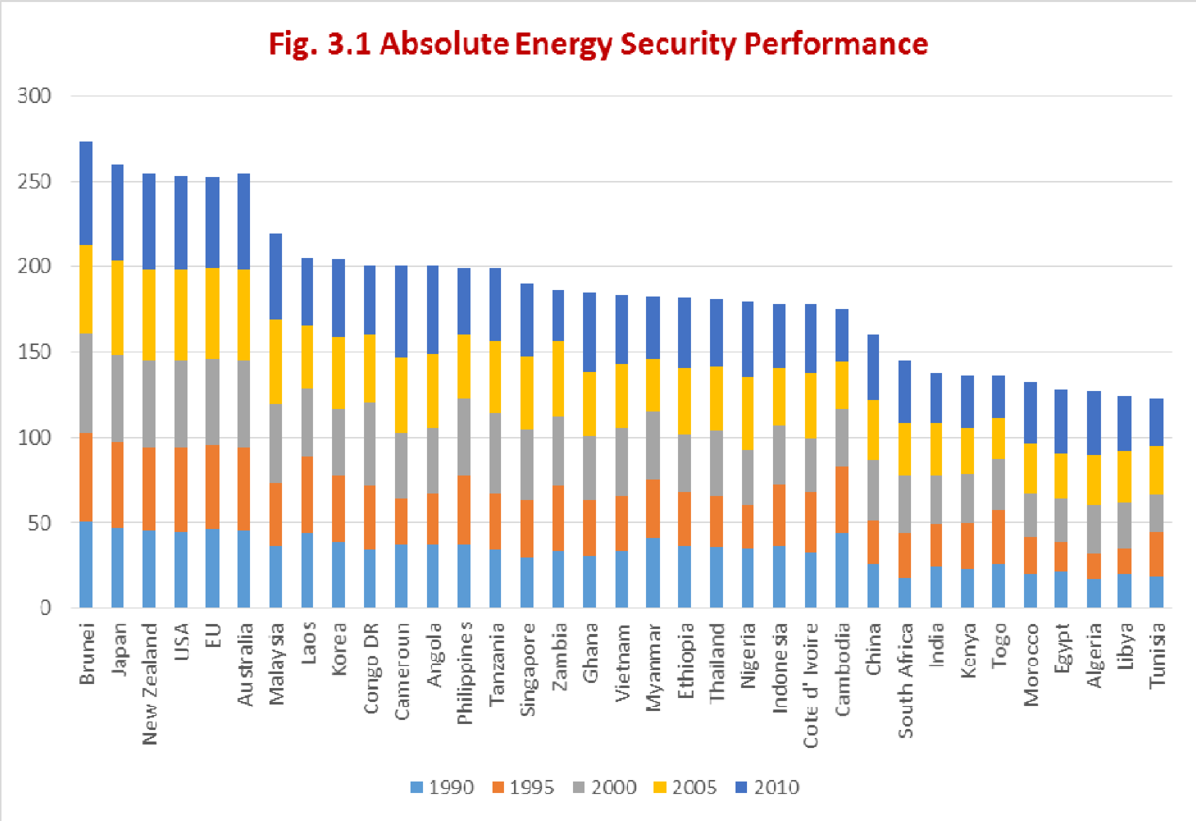
The scoring of the five best overall performers as well as the top five African performers was extensively analyzed alongside that of Ghana. This aspect of the research was to investigate which metrics Ghana needs to improve to be able to improve its energy security situation. The assumption here is that the absolute best performers are the countries that have had very consistent comprehensive energy security policies over the 20-year period and are thus worth emulating.

3.0 Results and Discussion

The analysis of the results of the country comparative analysis was done in two parts: comparative analysis of the performances of the overall five best performers and the best five African performers with the performance of Ghana. The assumption here is that, it is worth pursuing a comprehensive energy security course. This is the very essence of the composite energy security index and also the reason that it is best to learn from the overall best performers.

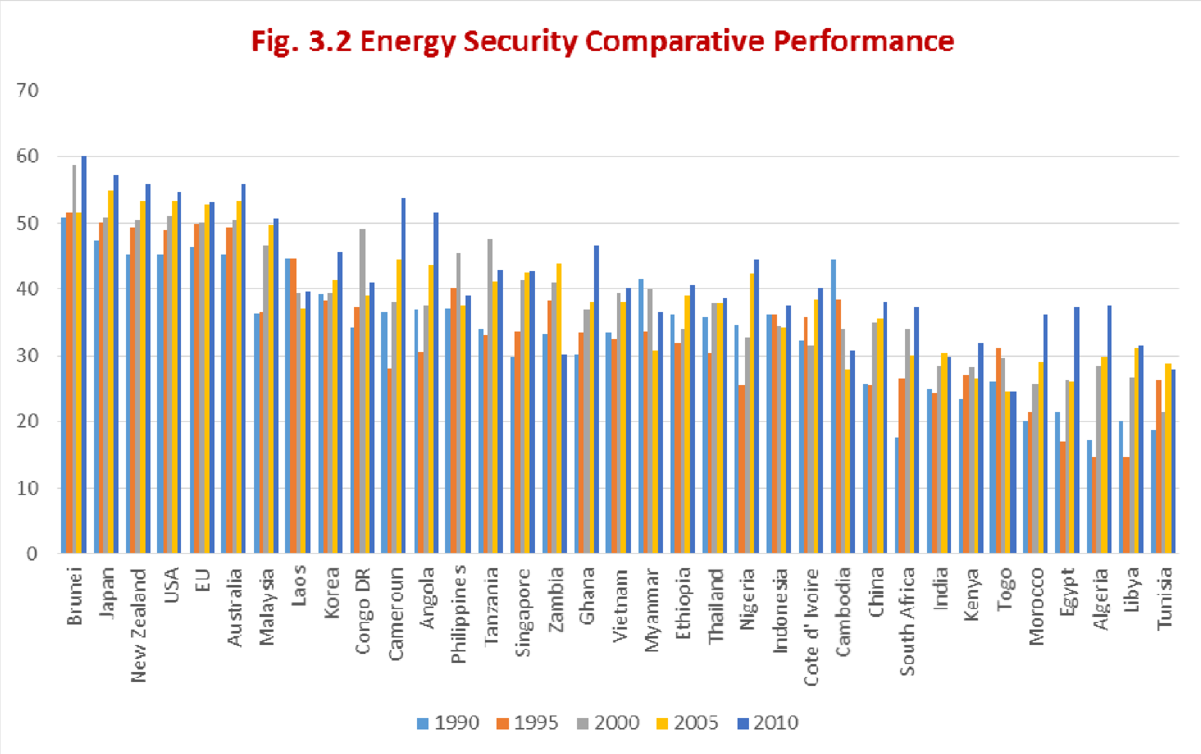
3.1 Absolute Best Performers

Figure 3.1 below, shows the absolute performance (aggregate of the mean score for each year and metric) of all the 35 countries over a 20-year period. The top five performers were Brunei (273), Japan (260), New Zealand (254), USA (253), and EU (252) while the five worst performers were (from the bottom) Tunisia (123), Libya (124), Algeria (127), Egypt (128), and Morocco (132). No country got a perfect score of 500, indicating that even the best performer has room for improvement in some of the metrics. Again, the relativity of the index shows that the energy security levels of countries are interrelated, and as such, a global effort is required to address the challenges posed by such. Ghana placed 17th, with a score of 185.



All the five worst performers – Morocco (132), Egypt (128), Algeria (127), Libya (124), and Tunisia (123) – are oil- and gas-resource-rich North African nations. Brunei, which is also an oil- and gas-resource-rich country, was the best performer. The other top performers all have good quantities of oil and gas resources. These data show that oil and gas resource wealth per se does not guarantee energy security; it should be accompanied by good policies. It is therefore necessary to investigate which policies the top-performing countries implemented over the study period.

Again, 3.2, which shows the comparative performance of the countries over the years, indicates that the top performers sustained their high-level performances over the study period. This presumably indicates the consistent implementation of good policies or possibly effective monitoring and evaluation regimes, which progressively informed better decision-making processes over the study period. As can be seen in Figure 3.2, there were marginal increments in the absolute performances of the top five performers over the five-year intervals, indicating a sustained high performance in most of the metrics. This confirms that these countries sustained high performances in most of the metrics over the study period via the appropriate respective policies.



The comparison of the performance of Ghana in the various metrics with those of the top performers in the year 1990 showed that all the countries performed better in the following metrics: population with high connection to electricity, water availability, forest cover, grid inefficiency, retail prices of unleaded gasoline, average reserve-to-production ratio, and TPES per capita. Figures 3.3 to 3.15 (See Appendix A) show the situation as of 2010. Here, the five countries performed better than Ghana in governance rating, water availability, forest cover, grid inefficiency, grid connection, and TPES per capita. Again, apart from Brunei, all the top five performers fared better than Ghana in terms of energy intensity. Only New Zealand had a better share of renewable energy than Ghana. It is important to note, however, that Ghana's high share of renewable energy in the TPES was from wood fuel, which is used primarily for rural and peri-urban cooking and heating.

3.2 Best African Absolute Performers

This analysis could be considered a more realistic comparison due to the relative comparable features of the African countries in terms of political stability and governance, economic structure, energy policy and security priorities, and resource endowment. The top five African performers were Congo DR (201), Cameroun (201), Angola (200), Tanzania (199), and Zambia (187). Ghana was the sixth best performer amongst the African countries, with a score of 185.

For 1990, the TPES per-capita values were Congo DR 0.32, Cameroun 0.41, Angola 0.55, Tanzania 0.38, Zambia 0.68, and Ghana 0.35, showing that all these countries performed better than Ghana in TPES per capita, apart from Congo DR. Only Angola had a better average reserve-to-production ratio, although the difference was very wide: 61 to 4.54. Cameroun had 3.40 while the other three had 0. The self-sufficiency values were Congo DR 1.02, Cameroun 2.20, Angola 4.87, Tanzania 0.93, Zambia 0.91, and Ghana 1.0, indicating that Ghana did better than only Tanzania and Zambia. The shares of renewable energy figures were Congo DR 84.74, Cameroun 76.70, Angola 73.46, Tanzania 91.73, Zambia 74.29, and Ghana 73.70, showing that all but Angola did better. Only Cameroun (29) had a better grid connection than Ghana (25). The retail prices of unleaded gasoline in Tanzania (42) and Zambia (40) were better than that in Ghana (53). Congo DR had 81 while Cameroun had 68. Ghana's energy intensity (18,247.58) was better than only Zambia's (20708.50). Ghana's grid inefficiency (3.15) was better than those of all the others. Ghana's forest cover and water availability were the least amongst all the countries. Lastly, Ghana performed better than only Angola and Zambia in terms of CO_2 emission per capita.

The performance of Ghana in the various metrics vis-à-vis the Absolute Best Performers and Best African Absolute Performers are summarized in Table 3 above. The blue boxes indicate the metrics in which Ghana performed better than the other countries.

Table 1: Summary of Ghana's Performance against the Best Performers (2010)

Metric	Overall Best Performers	Best African Performers
TPES per capita (toe)	Brunei, Japan, New Zealand, USA, EU	Angola, Tanzania, Zambia
Average RPR for oil and natural gas) (years)		Cameroun
Self-sufficiency (%)	New Zealand	Cameroun, Angola
Share RE TPES (%)		Tanzania, Zambia, Cameroun, DR Congo
Pop with high-quality connections to the grid (%)	Brunei, Japan, New Zealand, USA, EU	
Retail price of 100 L unleaded gasoline (2009, USD, PPP)		Cameroun, Angola
Energy intensity (Btu/yr, 2005, USD, PPP)	Japan, New Zealand, USA, EU	Tanzania, Angola, Cameroun, DR Congo
Grid inefficiency (%)	Brunei, Japan, New Zealand, USA, EU	Tanzania, Angola, Cameroun, DR Congo, Zambia
Forest cover (%)	Brunei, Japan, New Zealand, USA, EU	Tanzania, Angola, Cameroun, DR Congo, Zambia
Water availability	Brunei, Japan, New Zealand, USA, EU	
Per-capita energy-related CO_2 emission (metric tons)		Congo, Tanzania, Zambia
Worldwide governance rating	NA	
Quality of energy information (out of the 12)	Parity	Parity

Figure 3.16-3.28 (See Appendix B) depict the situation as of 2010. Angola (0.64), Tanzania (0.45), and Zambia (0.61) had better TPES per-capita values than Ghana (0.39). Only Cameroun (325.8) had a better average reserve-to-production ratio than Ghana (229.4). Cameroun (1.28) and Angola (8.49) had better self-sufficiency than Ghana (1.01). The share of renewable energy for Congo DR (93.4), Cameroun (63.79), Tanzania (88.59), and Zambia (80.86) were all better than that for Ghana (63.81). Cameroun (12) and Angola (65) had lower prices for unleaded gasoline compared to Ghana (82). Apart from Zambia (14,235.02), all the others had lower energy intensity than Ghana (13,418.05). All the countries also had lower grid inefficiency compared to Ghana (23.57). Ghana again had the smallest forest cover (21.71) but better water availability than all the others. Congo DR (0.05), Tanzania (0.15), and Zambia (0.18) had lower per-capita CO_2 emission than Ghana (0.31). The governance rating in Ghana (55.43), however, was better than those of all the other countries. There was parity in the quality of energy information, apart from Zambia (11).

4.0 Conclusion and Policy Implications

The objective of the country comparative analysis was to determine which countries performed better than Ghana in terms of absolute performance, and then to identify in which indicators they did so. The essence of this exercise was to identify which countries and policies Ghana can learn from, the reason being that good performance is linked to good policies. It is worth noting, however, that different countries have different conditions, and therefore, it is imperative that their respective situations be juxtaposed on that of Ghana to know which country has a similar situation as Ghana to determine which of the policies are doable in the Ghanaian context. This research, however, ends at identifying the country and metric.

From figure 46 we strongly conclude that, "Natural endowment without appropriate policies to improve the other metrics does not guarantee energy security". This is illustrated by the performances of Brunei, Japan, New Zealand, USA, and EU compared to those of Tunisia, Egypt, Algeria, and Libya. All the five worst performers – Morocco (132), Egypt (128), Algeria (127), Libya (124), and Tunisia (123) – are oil- and gas-resource-rich North African nations.

Extensive policy analysis is therefore required to identify the best policy alternatives with respect to the different metrics. One can be tempted to identify all the counties that performed better than Ghana in the individual metrics, but that will defeat the very essence of the composite index, which is to eliminate the limitations of measuring the performances of individual indicators in isolation. The logic here is that a country with a good overall energy security performance must be implementing policies targeting not only individual metrics but also the comprehensive energy security of the country.

Based on the discussion of Table 3, which is a summary of the analysis results, it can be said that Ghana has room for improvement in all the metrics. The better absolute performers in the respective metrics provide the benchmark for policy adoption and adaptation. It will be appropriate to start from the African countries and to progressively consider much higher benchmarks outside Africa.

4.1 Policy Implications

The relative natures of the energy security indices imply that the energy security of countries are interrelated and hence require a global concerted effort. The overall best performers and the best African performers provide a good lead for Ghana in its quest to improve its existing energy security situation.

Again, the fact that there were better performers than Ghana in Africa and beyond indicates that there is room for improvement. In this regard, there is a need to review the overall energy security policy of Ghana, and to incorporate the international best practices therein.

Having said that, it is important to note that different countries have their peculiar conditions and challenges, and as such, it is necessary to investigate these conditions and to juxtapose them on Ghana's situation before adoption and possible adaptation can be recommended. Nonetheless, this aspect would require extensive work and is thus recommended for future studies.

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APPENDIX (A)

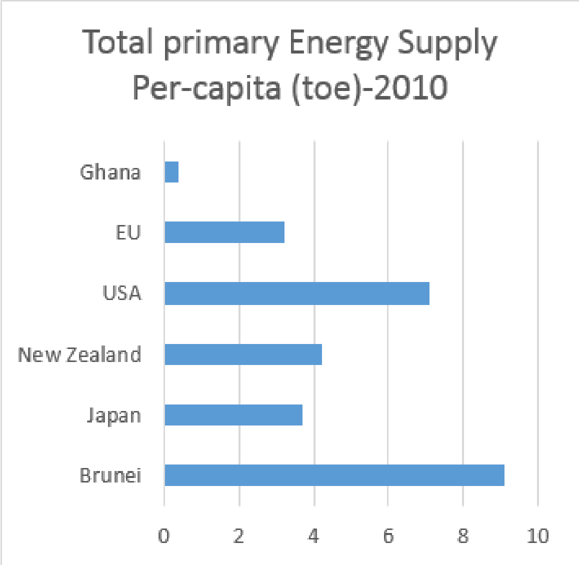
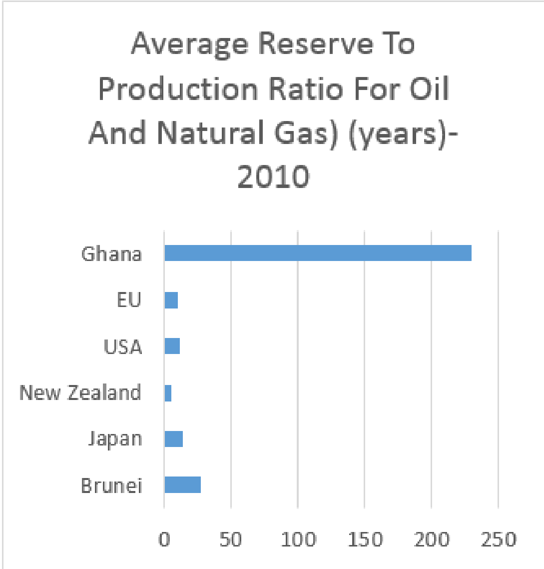


Figure 3.3 Source: Author's own elaboration using data from EIA, WB, IEA, etc.



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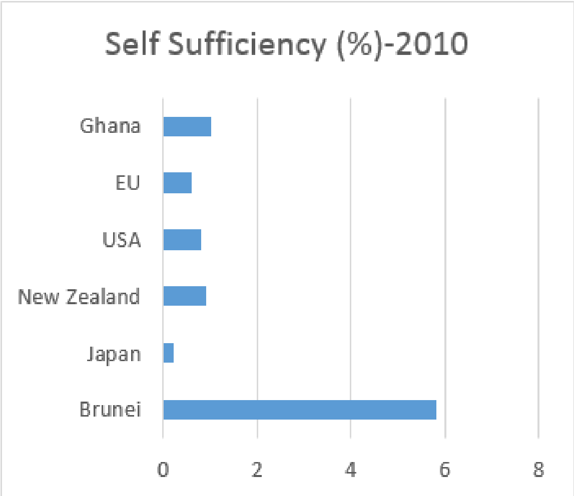

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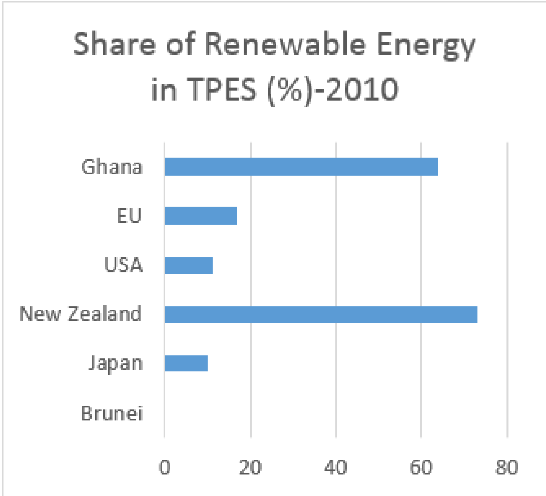

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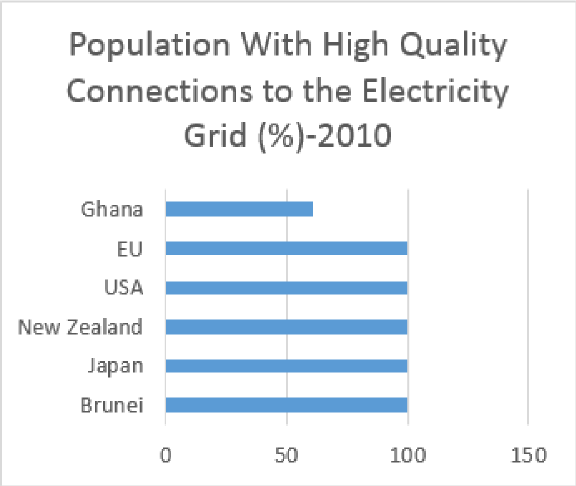

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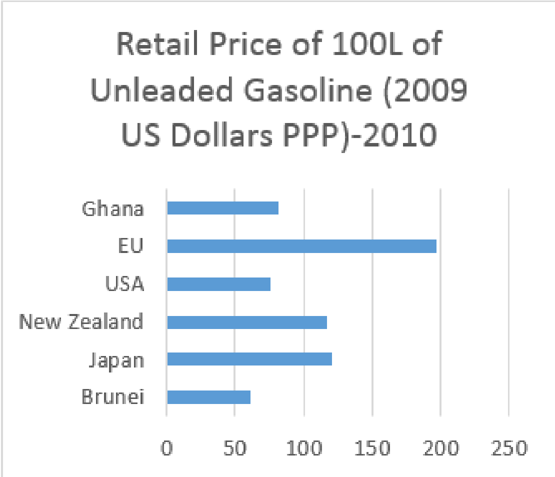

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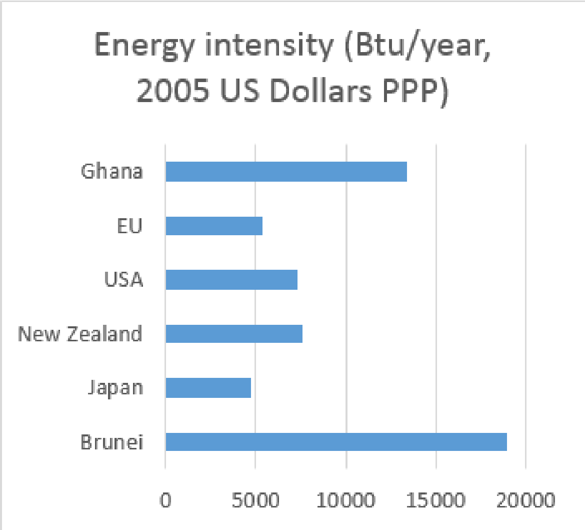

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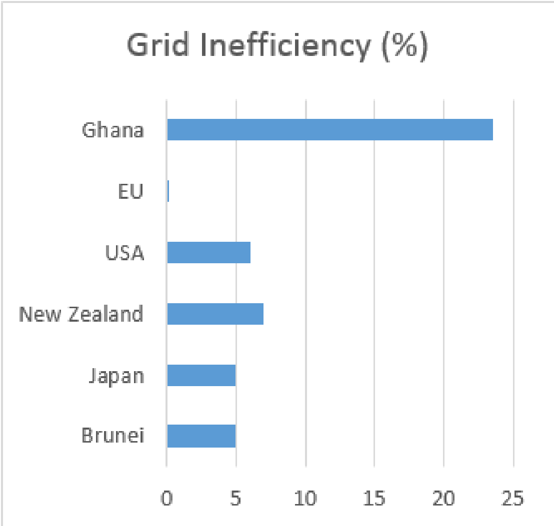

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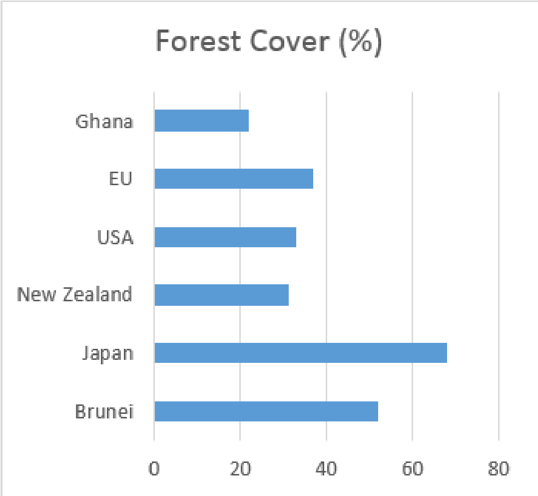

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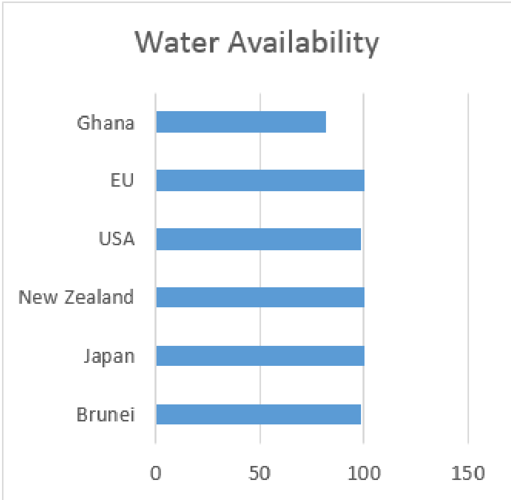

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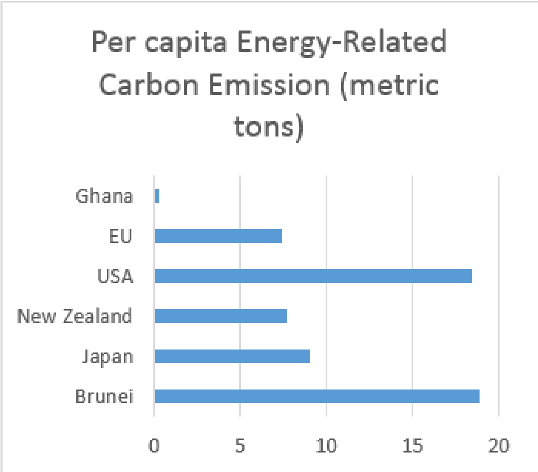

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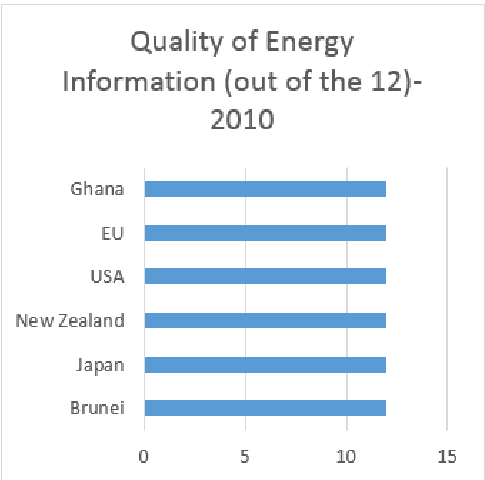

Figure 3.15. Source: Author's own elaboration using data from EIA, WB, IEA, etc.

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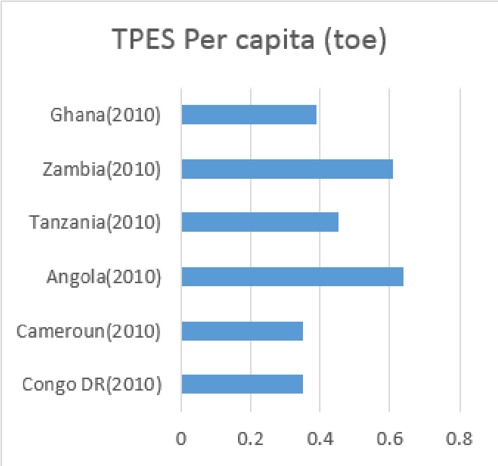
APPENDIX B



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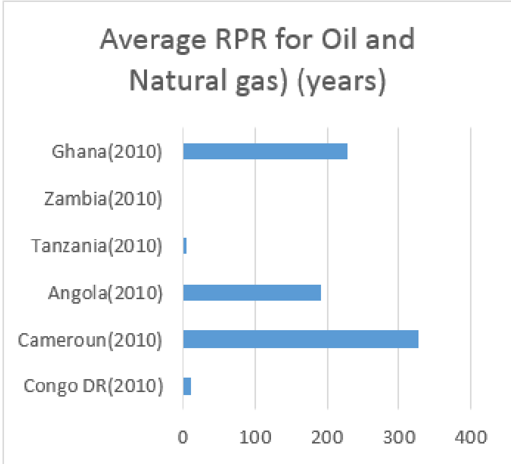

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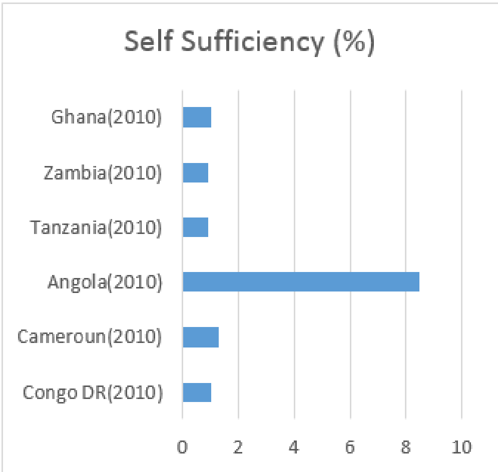

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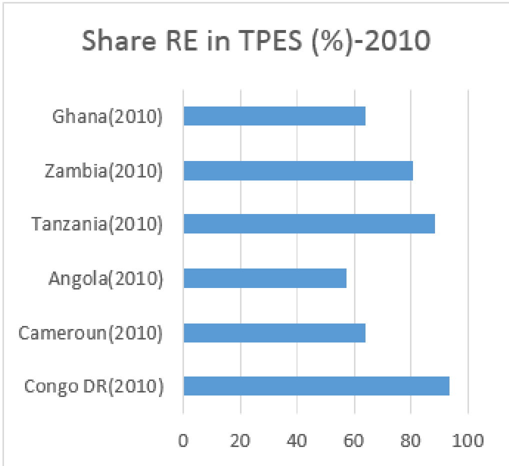

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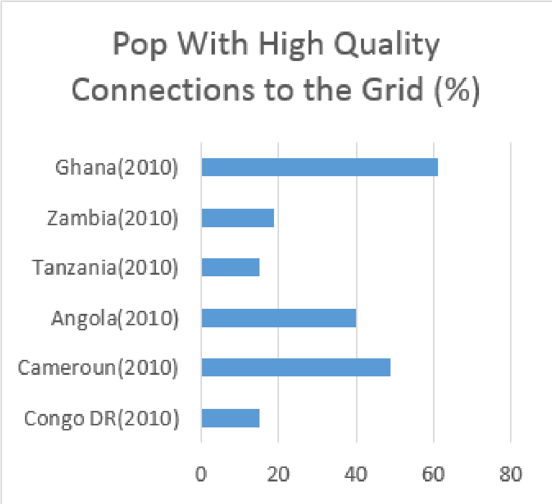

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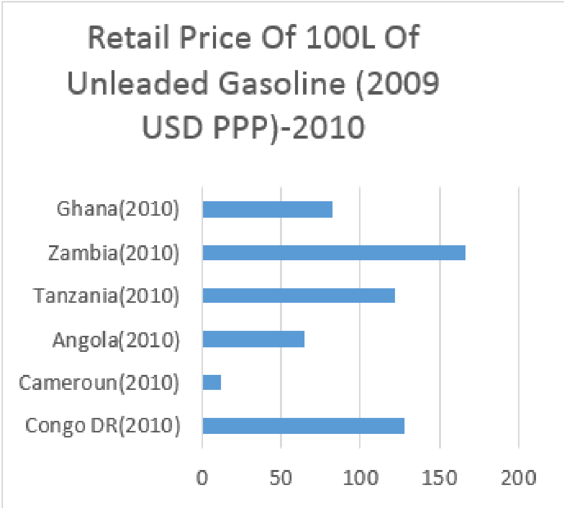

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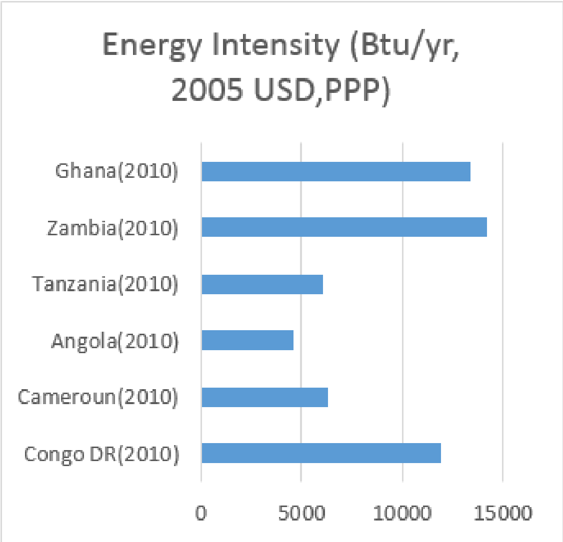

Figure 3.22. Source: Author's own elaboration using data from EIA, WB, IEA, etc.

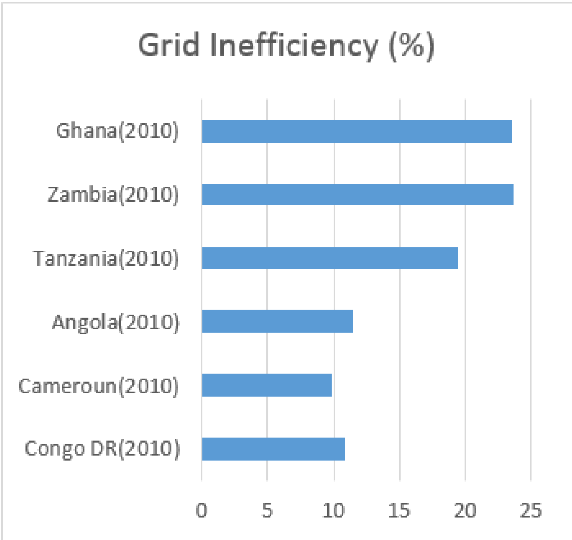

Figure 3.23. Source: Author's own elaboration using data from EIA, WB, IEA, etc.

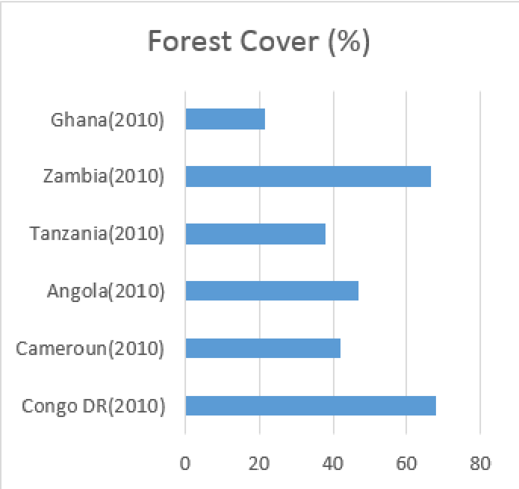

Figure 3.24. Source: Author's own elaboration using data from EIA, WB, IEA, etc.

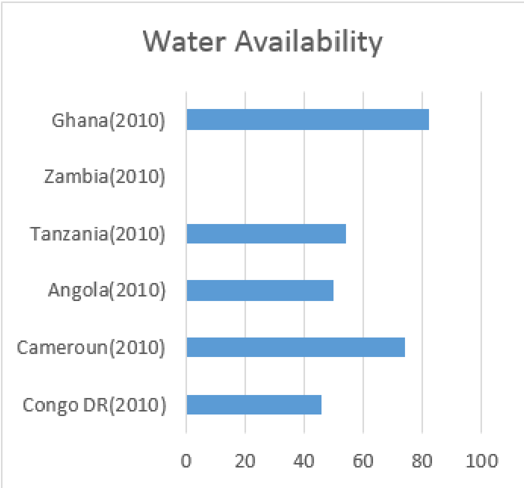

Figure 3.25. Source: Author's own elaboration using data from EIA, WB, IEA, etc.

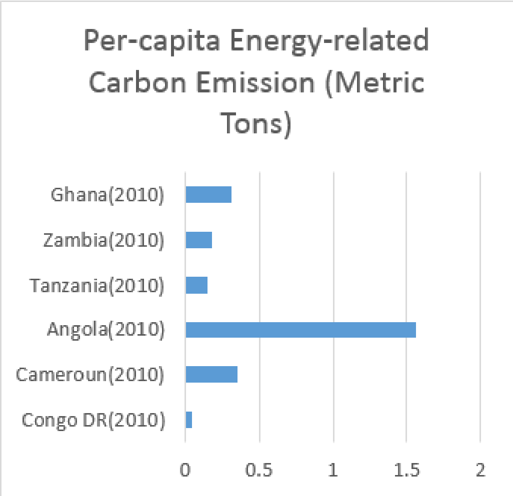

Figure 3.26. Source: Author's own elaboration using data from EIA, WB, IEA, etc.

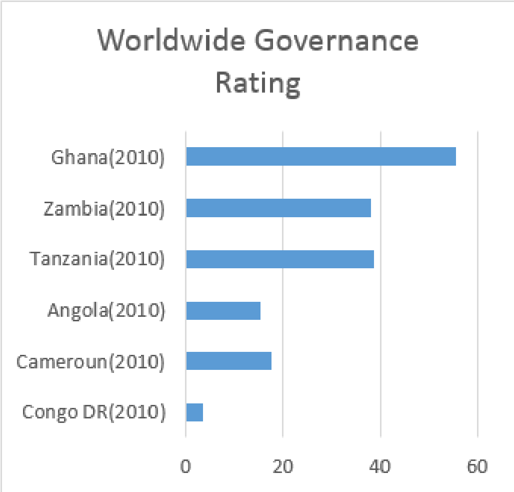

Figure 3.27. Source: Author's own elaboration using data from EIA, WB, IEA, etc.

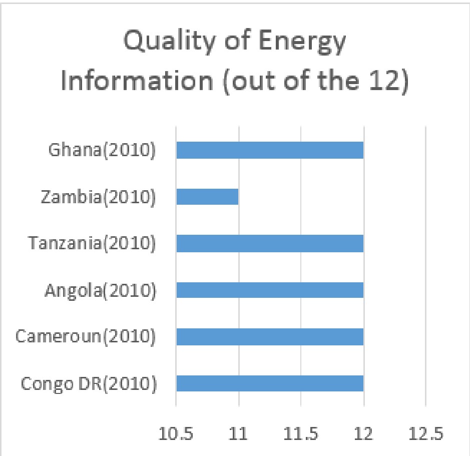

Figure 3.28. Source: Author's own elaboration using data from EIA, WB, IEA, etc.