

An Analysis of Energy

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Abstract—This document is a report of the data analysis on energy generation, consumption practices and the pattern they create with poverty.

Index Terms—energy, renewable energy, poverty, energy consumption, energy generation, MPI, WDI, mortality

I. INTRODUCTION

As all societies do, we depend on energy to produce fundamental needs and to reach certain life standards. But energy is really equally easy to reach for societies under any level of economic condition or generation of the energy in the current global system promotes and exponential growth considering economic growth and well-being. In the scope of this research following questions are being answered.

II. QUESTIONS

A. Main Question

Is Energy inequality exist?

B. Sub-Questions

- How does poverty affects energy accessibility and wealth affects energy consumption habits?
- Does energy produced more and cost less via renewable generation methods in developed countries?
- Does source insufficiency for fundamental needs cause energy inaccessibility and energy inaccessibility generate difficulties to provide of fundamental needs?
- Are any relations between sufficient energy access/generation and breaking point of poverty to wealth?

III. DATASET

A. Used Data and It's Properties

1) *Data*: For the analysis of this project, for 2000-2017 world's renewable and nonrenewable energy generation, world's energy consumption, regional and national MPI (Multi-dimensional Poverty Index) is used. Energy consumption data tables includes energy consumption per continent and per country, renewable energy generation of top 20 country, worlds' renewable energy generation by different modes of generation and finally national and regional MPI score of regions on the world with higher deprivation levels.

The reason 2000-2017 time period is chosen, it is because before 2000 records are unstable and obscure for certain regions, and after 2017 is the energy generation data tables' last updates are occurred.

2) *Data Properties*: MPI identifies multiple deprivations of humans in health, education, standards of living as looking at child mortality, nutrition, years of schooling. MPI (Multidimensional Poverty Index) is a score that is used to measure the poverty level of a country and its' sub-regions. MPI consist three part, health(1/3) under health nutrition(1/6) and child mortality(1/6), education(1/3) under education years of schooling(1/6) and school attendance(1/6) and living standards(1/3) under living standards cooking fuel, sanitation, drinking water, electricity, housing, assets (each 1/8). In case a region is not poor MPI of that region comes out 0, means this region %0 poor. In the 6 it is seen all recorded countries are maximum %60 poor.

WDI (World Development Index) is a statistic table which holds the values of development standards of countries by year. For this analysis child mortality rate is chosen as control value due to its' strong link to poverty.

For the analysis 3 data tables are cleaned and relevant columns merged regarding countries. Time period chosen is 2015 for WDI and Energy Statistics table, 2017 for MPI Statistic Summary of the merged table:

```
> summary(merge2)
  country      Mortality-5 per1000 electricity_generation
Length:160    Min.   : 1.900      Min.   : 0.028
Class :character 1st Qu.: 6.775      1st Qu.: 1.864
Mode :character  Median :16.950      Median :12.024
                Mean   :32.660      Mean   :308.276
                3rd Qu.:47.950      3rd Qu.: 64.314
                Max.   :156.900      Max.   :23313.937

  MPI.Urban      Intensity.of.Deprivation.Urban
Min.   :0.00000  Min.   :33.30
1st Qu.:0.00750  1st Qu.:37.20
Median :0.03900  Median :41.50
Mean   :0.08171  Mean   :41.76
3rd Qu.:0.12850  3rd Qu.:45.75
Max.   :0.45900  Max.   :55.70
NA's   :77       NA's   :77
> ''|
```

per_capita_electricity	renewables_electricity	energy_per_capita
Min. : 15.19	Min. : 0.000	Min. : 98.98
1st Qu.: 397.29	1st Qu.: 0.210	1st Qu.: 3260.33
Median : 1766.12	Median : 2.436	Median : 13474.96
Mean : 3757.09	Mean : 72.933	Mean : 26203.86
3rd Qu.: 4625.12	3rd Qu.: 14.587	3rd Qu.: 30887.68
Max. : 56235.64	Max. : 5506.484	Max. : 221633.70

Fig. 1. Used Data Table Summary

IV. PRE-ANALYSIS - AN OVERLOOK OF OVERALL DATA

A. Energy Consumption

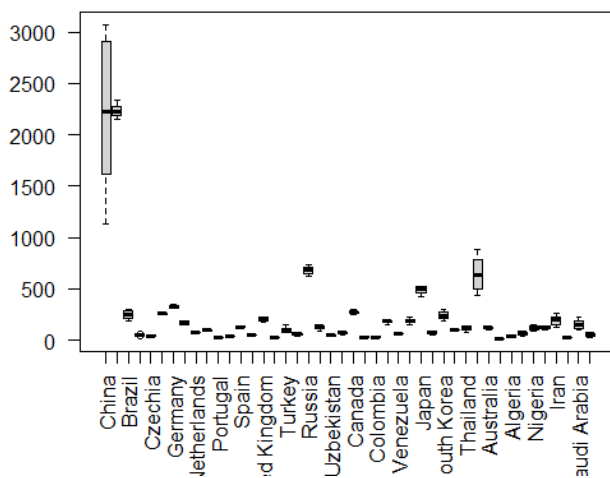


Fig. 2. 2000-2017 Energy Consumption per Country (TWh).

At the 2 china has the most unstable distribution 2000 to 2017 European countries are stable and a narrow distribution.

B. Energy Generation

In this section generated energy is analysed by its' type, by years and generator countries

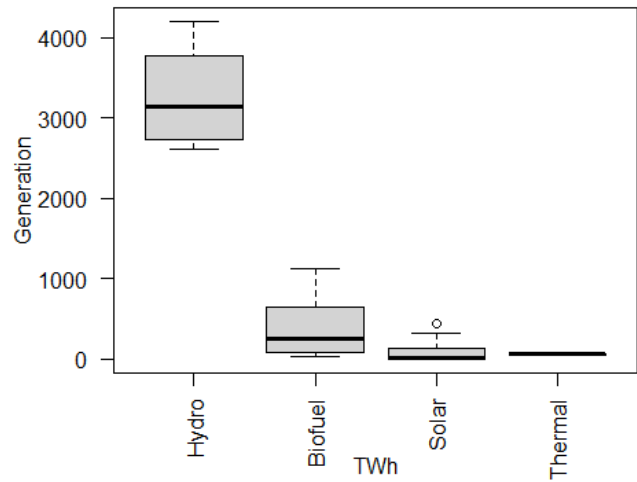


Fig. 3. Box Plot of 2000-2017 Generated Renewable Energy as Mode (TWh).

(TWh) Renewable Generation 2000-2017 Total

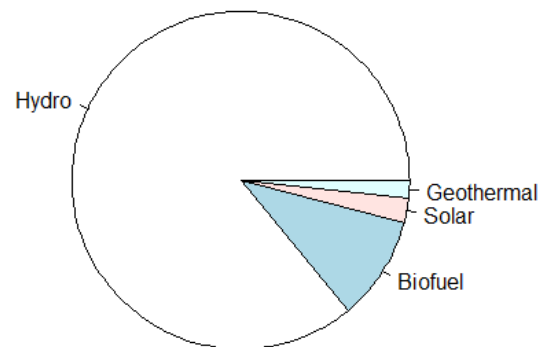


Fig. 4. Pie Chart of Overall Ratios of Generated Renewable Energy Between 2000-2017

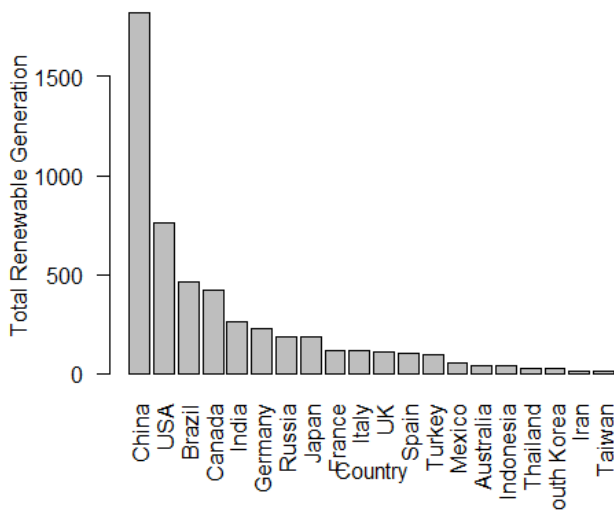


Fig. 5. Bar Plot of 2017 Generated Renewable by Top 20 Renewable Energy Generator Country (TWh).

C. Poverty

In this section national MPI and WDI data are analysed and observed.

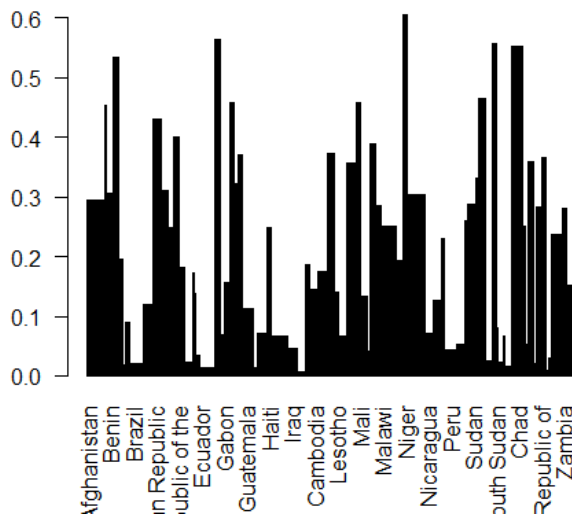


Fig. 6. Bar Plot of MPI score of the Recorded Countries

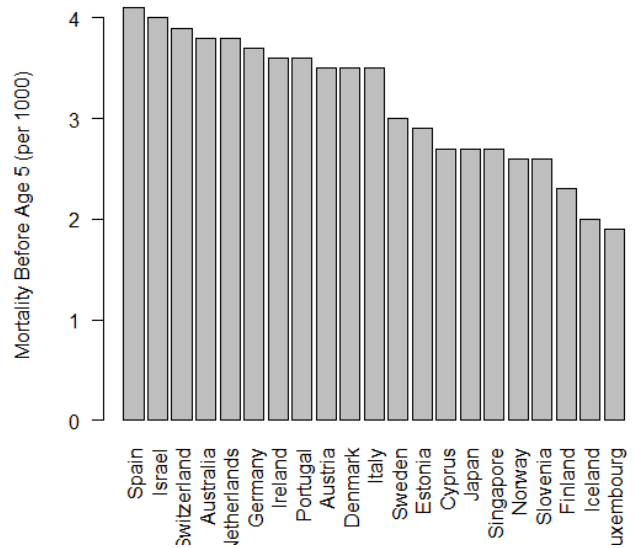


Fig. 7. Bar Plot of Child Mortality Under Age 5 per 1000 -Best 20 Score Out of 160-

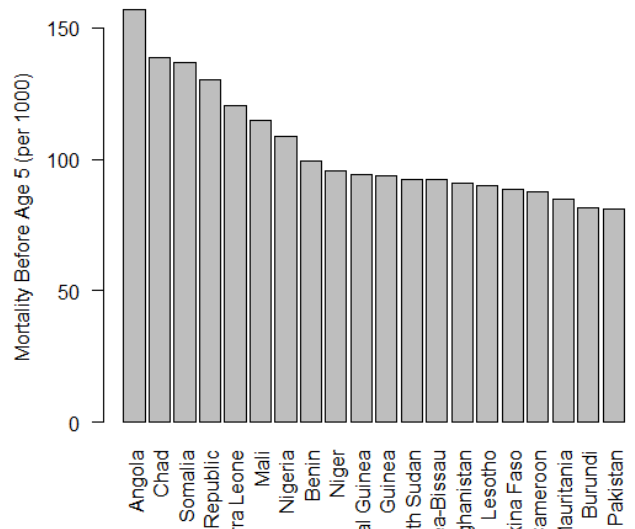


Fig. 8. Bar Plot of Child Mortality Under Age 5 per 1000 -Worst 20 Score Out of 160-

In 7 and 8 lowest and highest 20 scores are showcased among 160 recorded country, under child mortality category for showing extreme values that are difficult to observe on plot charts.

V. ANALYSIS

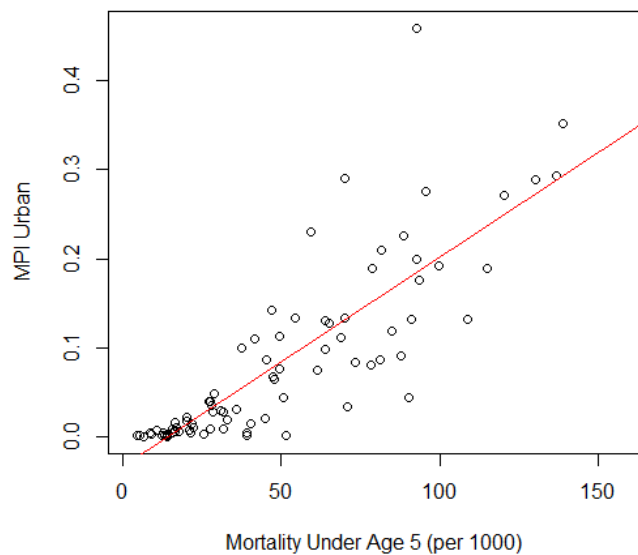


Fig. 9. Plot of Mortality ~ MPI Urban

```
data: merge2$`Mortality-5 per1000` and merge2$MPI.Urban
t = 13.586, df = 81, p-value < 2.2e-16
alternative hypothesis: true correlation is not equal to 0
95 percent confidence interval:
 0.7534713 0.8894316
sample estimates:
      cor
0.8336753
```

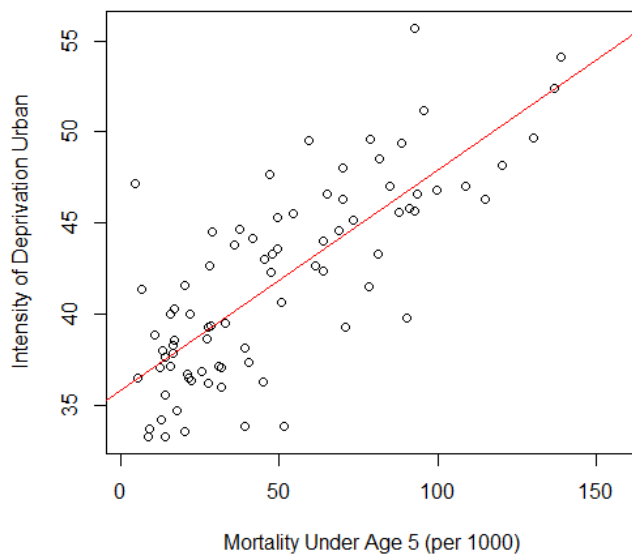


Fig. 10. Plot of Mortality ~ Deprivation Intensity Urban

```
data: merge2$`Mortality-5 per1000` and merge2$Intensity.of.Deprivation.Urban
t = 11.001, df = 81, p-value < 2.2e-16
alternative hypothesis: true correlation is not equal to 0
95 percent confidence interval:
 0.6701714 0.8480916
sample estimates:
      cor
0.7739824
```

In 9 and 10 it is seen that child mortality and poverty are directly proportional. In this scope for further analysis child mortality is used as control variable due to its' wider range as value.

Energy Cons per Capita Countries -Mortality Decreasing Order-

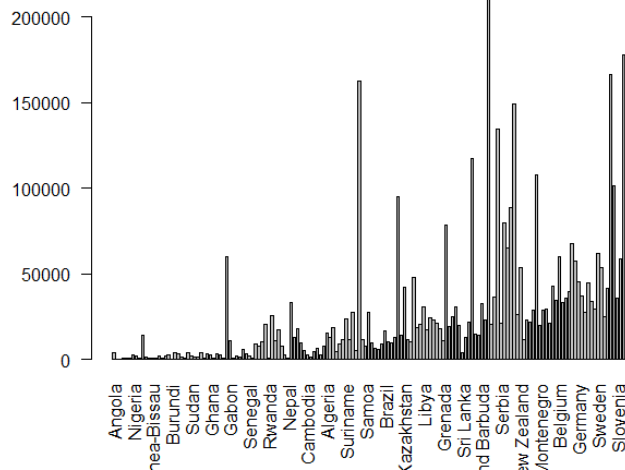


Fig. 11. Bar Plot of Energy Consumption Per-Capita in Child Mortality Decreasing Order Table

An overlook on relation between energy consumption per-capita on the table that is sorted in decreasing order by child mortality column. It is seen that a slight increase on energy access happens towards lower mortality rates; although extreme records.

```
data: merge2$`Mortality-5 per1000` and merge2$per_capita_electricity
t = -5.6864, df = 158, p-value = 6.113e-08
alternative hypothesis: true correlation is not equal to 0
95 percent confidence interval:
-0.5332315 -0.2745752
sample estimates:
cor
-0.4121742
```

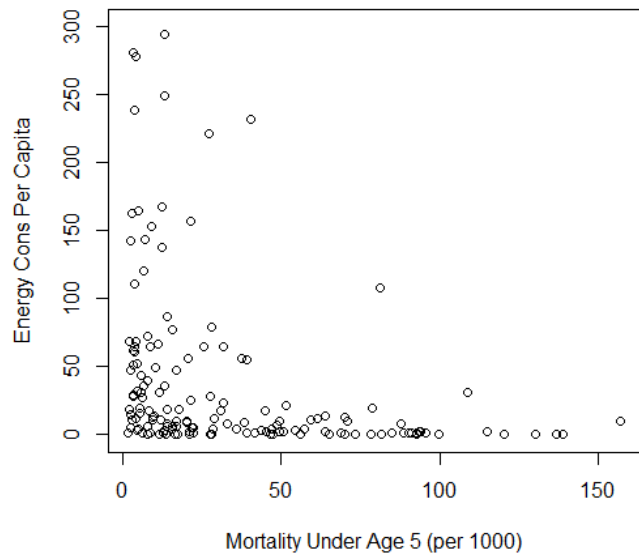


Fig. 13. Plot of Child Mortality ~ Per-Capita Energy Consumption

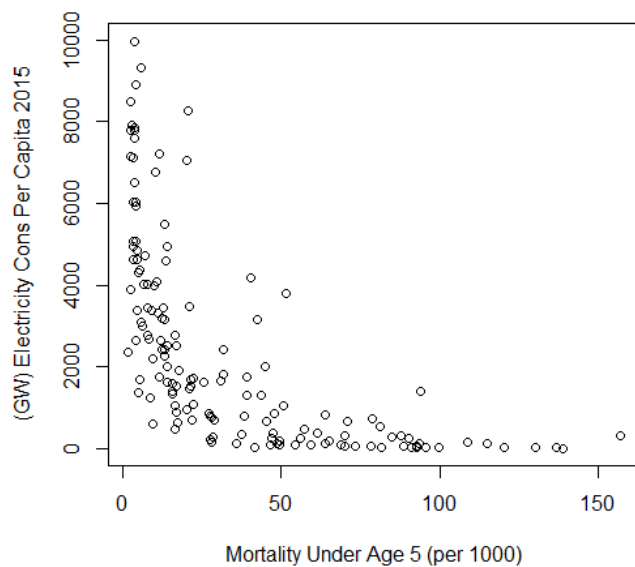


Fig. 12. Plot of Child Mortality ~ Per-Capita Electricity Consumption

```
data: merge2$`Mortality-5 per1000` and merge2$energy_per_capita
t = -6.2657, df = 158, p-value = 3.374e-09
alternative hypothesis: true correlation is not equal to 0
95 percent confidence interval:
-0.5623539 -0.3126004
sample estimates:
cor
-0.4461211
```

VI. RESULTS

This analysis which is made on 160 country is shown there is a strong connection between energy access and poverty. As it is seen 12 and 13, both energy (BTU) and electricity (GWatt) which sourced from petroleum, dry natural gas, coal, net nuclear, renewable, is inaccessible where child mortality rates peaks at. Consequently the link between poverty and energy is shown by data.

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