KPU International Journal of Engineering & Technology
Volume 4, Issue2, Sep. 2024
e-ISSN:2790-0819, p-ISSN:2790-0800

Date Received: 2023-09-19
Date Accepted: 2024-08-24
Date Published: 2024-09-30

The relationship between energy emission, Air pollution, and Growth of population in developing countries: comparative study of China, India, Iran, and Indonesia

OBAIDULLAH OBAIDI[1*] & MOHAMMAD YAMA SAADAT[2]

[1]Assistant professor, Energy Engineering Department, Kabul University, Kabul, Afghanistan.
Email: mohammadyamasaadat@gmail.com, Tel: +93783564293

[2]Assistant professor, Chemical & Industrial Engineering Department, Kabul Polytechnic University, Kabul, Afghanistan. Email: yaserobaidi2018@gmail.com, Tel: +93748029050

Abstract

*Most d**eve**loping countries are facing energy deficiency nowadays, and that pressure makes them accelerate energy generation in different fields to fulfill the demand and increase the energy supply. these developing countries depend on Non-renewable resources which produce huge amounts of greenhouse gases into the atmosphere and pollute the environment. In this paper we have studied how population growth presses the energy supply and increases energy production, these processes increase the pollution level of a country. The population growth in most developing countries is the main cause of pollution and the main reason for the shortage in energy supply. This study aims to understand the relationship between energy emission, Demand, pollution, and the horrible consequences of burning fossils. In the paper, we have illustrated the data of developing countries, which shows, that most of the developing countries have been in the top 10 (TES) countries for decades, which indicates much consumption of energy. The tables show that most developed countries are still depending on non-renewable sources of energy and burning more fossil fuels as compared to developed countries. If the policymakers go with the existing plans the pollution level from energy sectors in developing countries is expected to rise.*

Keywords: Energy Emissions, CO_2, Economic Growth, Air pollution, Energy Supply, Developing Countries.

* Corresponding Author

1. Introduction

Energy is one of the main constituents of life; all human beings depend on the existence of energy for their daily activities. Energy is a necessity for life and human development, economic growth, and life quality. Unfortunately, from industrial revelation till yet most of the energy is provided by the burning of fossil fuels. Which is exactly horrible, the dramatic change in the global temperature and emission of greenhouse gases are the main consequences of it. The population growth and industrial production intensity in the future will increase the burning of fossil fuels. Especially in low-income countries as they are inattentive to the horrific consequences of using non-renewable energy. [1, 2, 3] the majority of the young generation is accompanied by mobile phones, laptops, and other social media, and they could not even imagine life without these things, but the sad reality is that all electronic device is provided with different chemicals that not only produce the pollution in production time but also pollute the environment after usage and even more of them are long-lasting in the environment which increases the level of pollution. The producer tries to produce more and compete in the market, however, they need more energy to keep the high level of production, the way they produce and prepare their energy for production is harmful to the earth's planet. The pollution enters from high-income countries to low-income, and middle-income countries through different ways, trading goods, and foreign direct investment (FDI). [4, 5, 6, 7]

According to the new policies of developing countries, energy consumption will increase so quickly. The International Energy Agency (IEA) has estimated a rapid growth of energy demand in India and Africa in the upcoming years. Southeast Asia especially India and China are aiming to increase the energy supply level by 89% by 2040. [8,9]

2. Energy consumption, supply, and emission in developing countries

The economic growth in developing countries will lead them to the top of the list of energy consumers. In the next years, the world's leading consumers will be the countries that focus more on production and industrialization. 58.1% of world energy consumption belonged to developing countries in 2015; the consumption was around 7.64×10^{9} tons of oil equivalent. Whereas, in the year 2005 the energy consumption was around $2.38\times^{9}$ tons equivalent, which shows a huge level of increase in the developing countries and their intensity toward energy consumption. [10, 11]

Non-OECD countries have shown a constant increase in energy consumption. Up to 62% of total consumption has been accounted for in these countries in 2018. [12] Developing countries are accused of more consumption compared to developed countries; even though they have doubled and tripled the consumption rate. [13] China is the leading consumer of the world's Total energy supply (TES). has accounted for more than 22% of total World TES. While the United States has accounted for only 16% of total world TES. [14]

United States, China, Japan, India, and Russia, these five countries have accounted for more than half of the total world TES together. China, the United States, India, Japan, Germany, and Canada have appeared all the time in the list of top ten energy consumers. The three Europe countries united Kingdome. France and Italy are the countries once in

the year 1971 they were also on the list of top ten consumers of world TES, but now they have been replaced by Asian and Middle Eastern countries (Brazil, Korea, Iran). [16]
CO_2 is one of the greenhouse gasses that attracted the attention of policymakers in greenhouse gas reduction. Almost 77% of total emissions from greenhouse gases are accounted for by CO_2. Recently Asian countries developed strategies to reduce acidification by controlling and reducing SO_2 emissions. More concentration goes to enhancing technology to control the emissions. [15]

Table 1. TES top ten countries from 1991-2018. [16]

NO	Country	TES (Mtoe)	Share in the world TES	
			1971	2018
1	People's Republic of China	3196	7.1%	22.4%
2	United State	2231	28.8%	15.6%
3	India	919	2.8%	6.4%
4	Russian Federation	759	N/A	5.3%
5	Japan	426	4.8%	3%
6	Germany	302	5.5%	2.1%
7	Canada	298	2.6%	2.1%
8	Brazil	287	1.3%	2%
9	Korea	282	0.3%	2%
10	Islamic Republic of Iran	266	0.3%	1.9%
11	France	246	2.9%	1.7%
12	Indonesia	231	0.6%	1.6%
World		14282	100%	100%

In 2018, the total world energy production was 14421 (Mtoe) which has increased 3.2% as compared to 2017. Which is mostly driven by fossil fuels (Natural Gas +5%, Coal +3.3%, Oil +2%) The total from fossil fuels was 370 (Mtoe), and the total of renewable (60 Mtoe) and nuclear 19 (Mtoe) as compared to fossil fuel it is so negligible. The Fossil Fuels covered more than 81% of total world energy production.

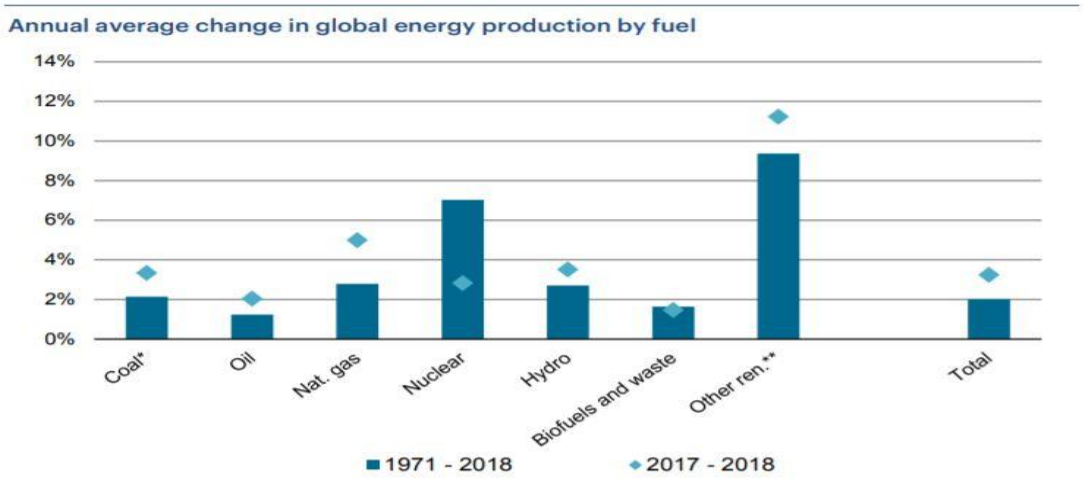


Fig. 1. Annual average of changes in the global energy production. [16]

In 2018 China produced around 48% of the world's total coal, the United States and France 46% of all nuclear. Saudi Arabia, the Russian Federation, United States have consumed 40% of crude oil together, and the US and Russia have also consumed 40% of Natural Gas.

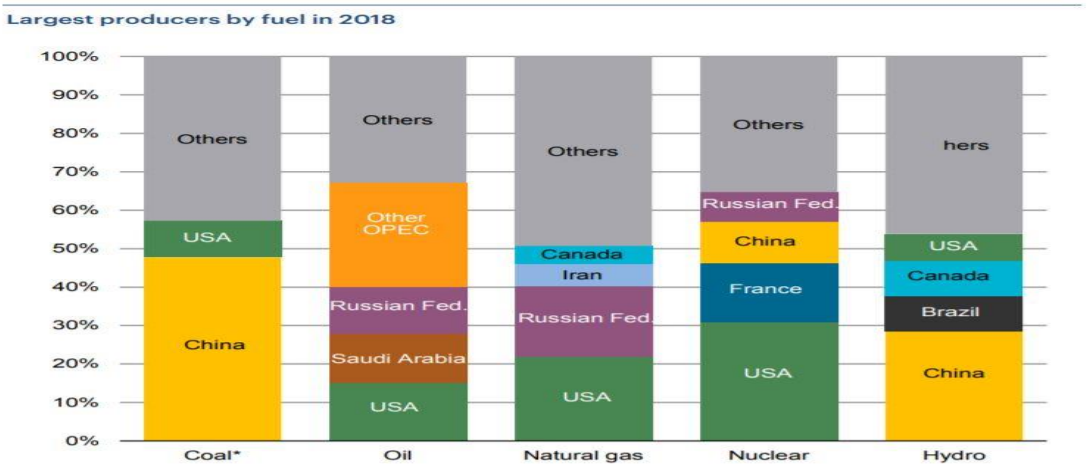


Fig. 2. Illustrate the world's leading energy producer based on Fossil Fuels. [16]

Fig. 3. And Fig. 4. Show the variation in energy supply between the years 1971 to 2018, the world total energy supply (TES) has increased 2.6 times. Which was 5519 (Mtoe) and has been increased to 14282 (Mtoe).

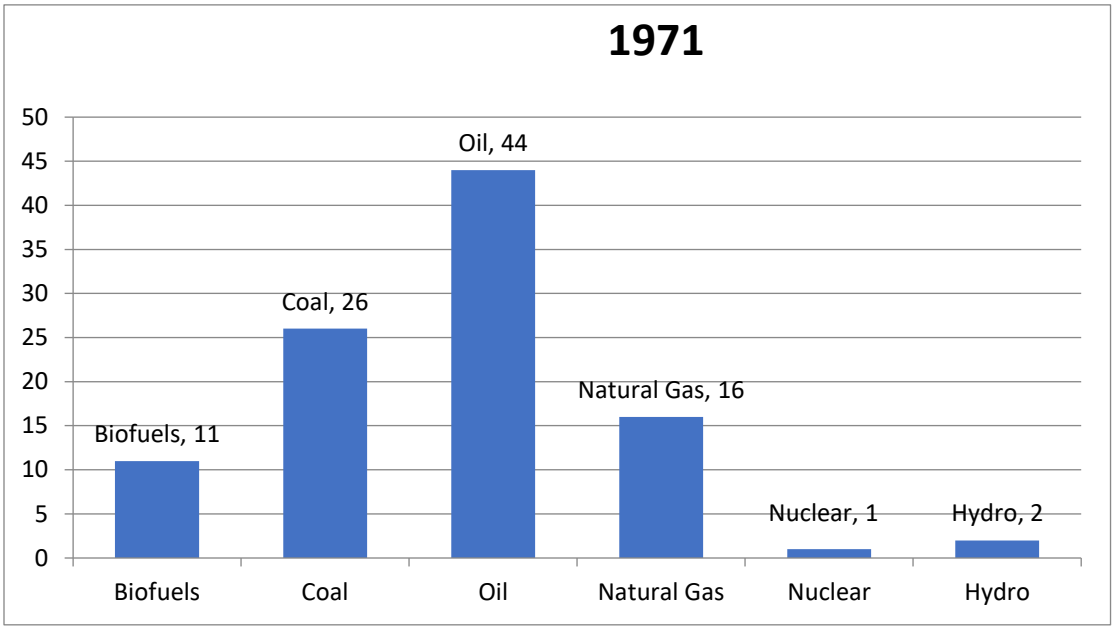


Fig. 3. Total percentage of energy supply by fuel in 1971. [16]

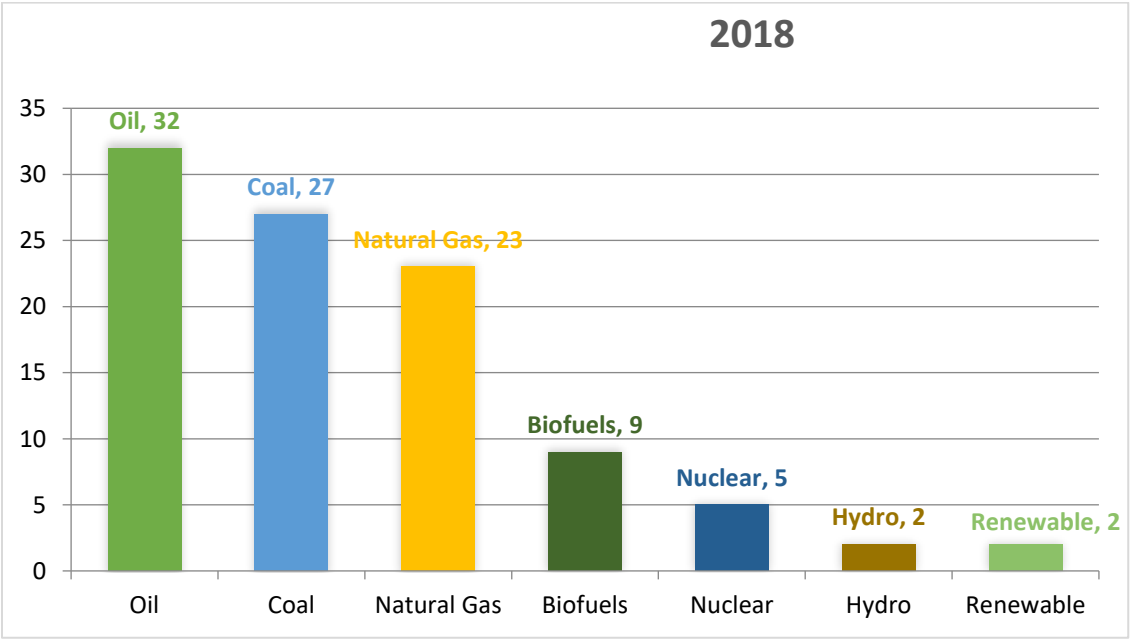


Fig. 4. Total percentage of energy supply by fuel in 2018. [16]

Fig. 5. And Fig. 6. Show the variation between the regions from 1971 to 2018. The OECD's countries have decreased from 61% in 1971 to 38% in the year 2018. Whereas, Non-OECD Asian countries have shown demand increases, which shows that they have raised the level from 13% to 36%.

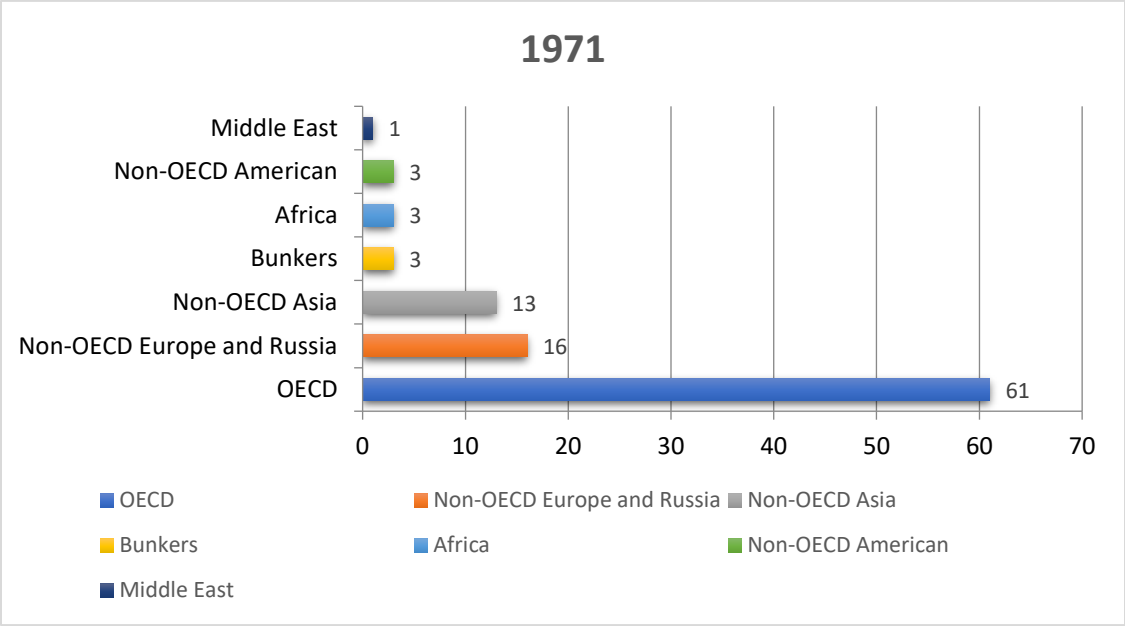


Fig. 5. Total energy supply by region in 1971. [16]

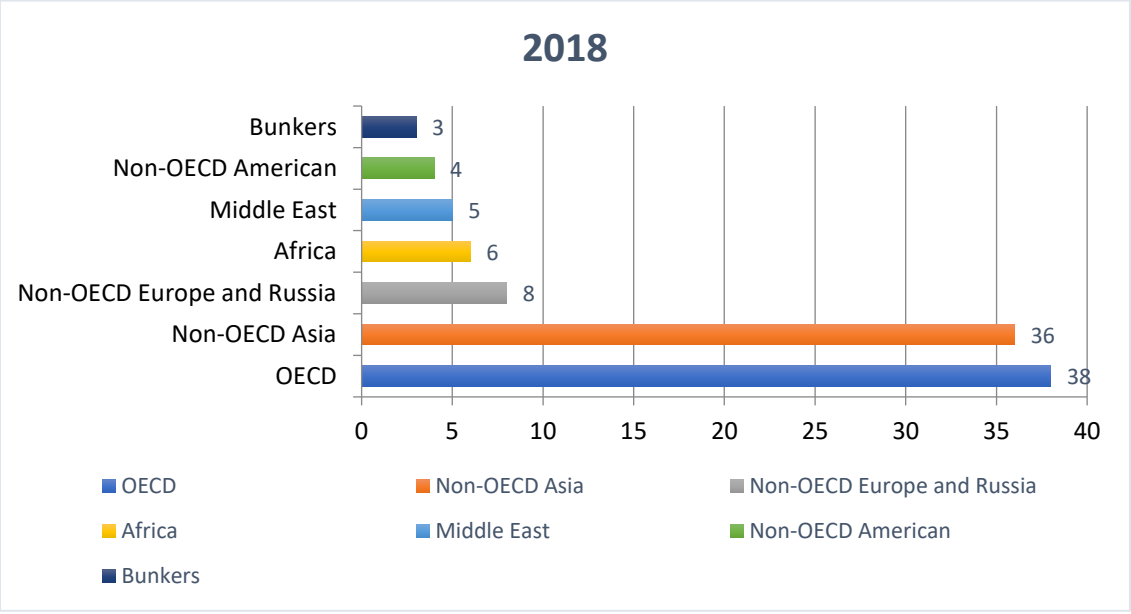


Fig. 6. Total energy supply by region in 2018. [16]

3. Literature review

Climate change and Global warming are two reputed and substantial subjects that have been selected by many scholars in the last decades owing to their impacts on the whole planet. CO Greenhouse gasses always become the most responsible for climate change and global warming. [17,18]

The nigh relationship between GHG emissions and global warming has been manifested by many relevant scholars, most countries are obligated to reduce their GHG and CO_2 emissions and energy consumption to mitigate serious climate change and global warming. [19,20,21]

Grossman, G. M., & Krueger, showed in their paper “Environmental impacts of a North American Free Trade Agreement” (1991), that economic growth has a direct impact on air pollution. They claim that electricity generation and transportation are two of the leading air pollutants sources. [1] Hall, C., Tharakan, P., Hallock, J., Cleveland, C., and Jefferson, M., have studied in their paper “Hydrocarbons and the evolution of human culture” that energy generation is very important in human life for economic, social, and environmental development. [2] Pasten, Cesar, and Juan Carlos Santamarina. Their paper "Energy and Quality of Life" evaluated that energy is one of the important factors for improving life quality. They have mentioned in their paper that economic growth and industrialization are the main causes of dramatic changes. The more we maximize the quality of life the more we maximize the consumption of energy [4].

Energy is required to improve and sustain the purpose all humankind needs for energy in their life. With the growth of population and rapid economic growth, the consumption rate has also increased in both developing and developed countries. Further, improvements in economic, industrial, and life quality will increase the energy demand. Especially the pressure could be more on sustaining energy from non-renewable resources which are less expensive as compared to renewable energy for developing countries. Wu, Ya, Qianwen Zhu, and Bangzhu Zhu have studied the relationship between energy consumption and economic growth in developing countries in the paper "Comparisons of decoupling trends of global economic growth and energy consumption between developed and developing countries" as they showed in their paper the rapid economic growth in the developing countries are pressurizing the energy sector for production of more energy in less time with low cost, which they provide from fossil fuels. [8]

Faith Birol & Maria Argiri have estimated that energy demand will increase by 65% and the emission of CO_2 will rise to 70% between 1995-2020, if all the developing and developed countries go with the same policies in the energy sector, and do not bring changes. 75% of that increase will belong to developing countries, especially China. [22]

Adnan Kasman & Yavuz Selman Duman in their paper analyzed the relationship between CO_2 emission, economic growth, energy consumption, trade, and urbanization in new EU members and candidate countries. The emission of CO_2 from energy consumption in developing countries from industry fields has increased since the 1990s as compared to industrialized countries. [23]

Ehsan Rasoulinezhad & Behnaz Saboori have analyzed the linkage between economic growth, CO_2 emission, and renewable and non-renewable energy consumption. The consequences of rapid economic growth and industrialization, are the dramatic climate change and global warming by CO_2 and greenhouse gas emissions. [24]

M. Salari, and Roxana J. Javid, in their study “The nexus between CO_2 emissions, energy consumption, and economic growth in the US” concentrate on three major factors CO_2 emissions, energy consumption, and economic growth. They used the annual data from

1997-2016 for 50 states to analyze the relationship between these three factors for the US. [25]

4. Data and Methodology: CHN-IND-IRN-IDN is a comparative study between these countries

The world is facing new challenges, and two major of these challenges are economic growth and environmental conservation. Which have created many problems for the earth, among these two the environment comes in front of developing countries always. The two famed worldwide headlines climate change, and global warming are among the consequences of economic growth and carelessness toward the environment in developing countries. [26,27,28]
impact of economic growth on the rise of greenhouse gases in developing countries China, India, Iran, and Indonesia is illustrated by their economic growth, energy consumption, implementation of renewable energy, and estimated CO2 emissions from 1991-2015.

Table 2. Economic growth from 1991-2015. [29]

	1991-2015	2000-2015	2010-2015
CHINA	9.99 %	9.65 %	7.87 %
INDIA	6.77 %	7.18 %	6.74 %
IRAN	2.40 %	2.51 %	-2.64 %
INDONESIA	4.72 %	5.53 %	5.51 %

Table 3. Energy consumption from 1991-2015. [29]

	1991-2015	2000-2015	2010-2015
CHINA	6.17 %	7.61 %	3.92 %
INDIA	5.24 %	5.45 %	5.30 %
IRAN	4.97 %	5.00 %	3.24 %
INDONESIA	5.34 %	4.57 %	5.62 %

Table 4. Changes in renewable energy supply from 1991-2015. [29]

	1991-2015	2000-2015	2010-2015
CHINA	4.18 %	4.97 %	7.89 %
INDIA	-1.11 %	0.54 %	0.91 %
IRAN	-0.70 %	5.82 %	10.25 %
INDONESIA	0.52 %	-0.61 %	-5.59 %

The impacts of greenhouse gases on climate change are not only a problem in developing countries but also a global problem. But the developing countries are more accused of using non-renewable energy which causes more climatic problems. According to the studies developing countries are more focused on non-renewable energy resources as compared to renewable energy the consumption of non-renewable energy accelerates economic growth. Contrariwise, the usage of renewable energy brings fragility to the process of economic growth. Though, fossil fuels are leading (GHG) producers in the atmosphere, and most have been linked to climatic problems by developing countries by usage of non-renewable energy resources. [30,31]

Table 5. Estimated CO_2 emissions from 1991-2015. [29]

	1991-2015	2000-2015	2010-2015
CHINA	71.8 %	48.6 %	79.6 %
INDIA	117.7 %	122.3 %	110.6 %
IRAN	65.5 %	72.4 %	43.6 %
INDONESIA	112.2 %	113.8 %	117.4 %

the combustion of coal produces more CO_2 as compared to other fossil fuel combustion, according to Fig. 7. China alone has produced more than 47% of the world's total CO_2 emission from coal combustion, and India has produced more than 9% of the world total CO_2 emission from coal combustion. As compared to developed countries developing countries are seeking rapid economic growth and more energy consumption. For that specified purpose the developing countries need to produce more energy production in a short time, more of that purpose has been chased by the usage of non-renewable energy for rapid economic growth. [12]

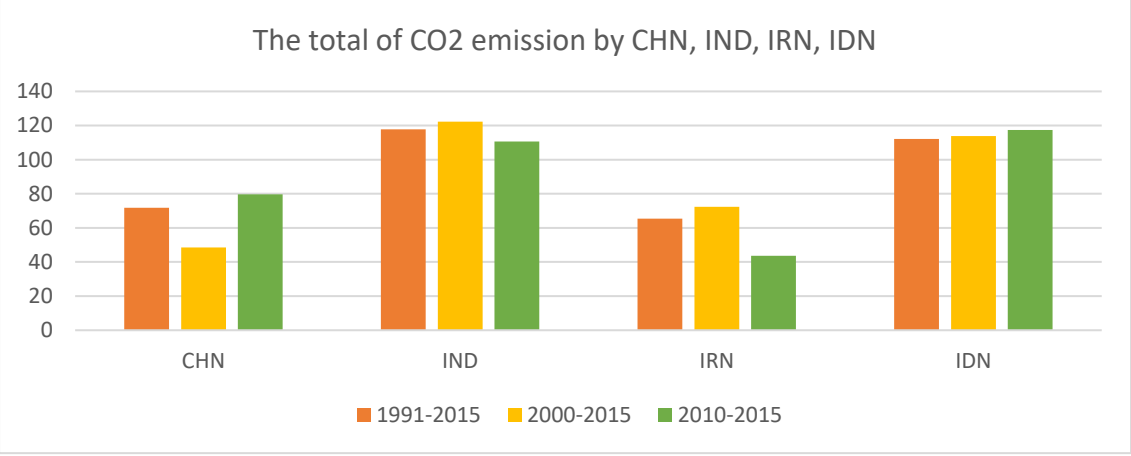


Fig. 7. The total of CO2 emission by CHN, IND, IRN, IDN. [29]

5. Result and Conclusion

In this paper we have studied the relationship between energy consumption, the rising of greenhouse gases, energy emissions, the growth of population, and economic growth in developing countries. We have found the relationship between energy consumption and economic growth in developing countries, as we analyzed the World Bank data for developing countries, in the last decades most developing countries have been in the top 10 in the list of (TES).

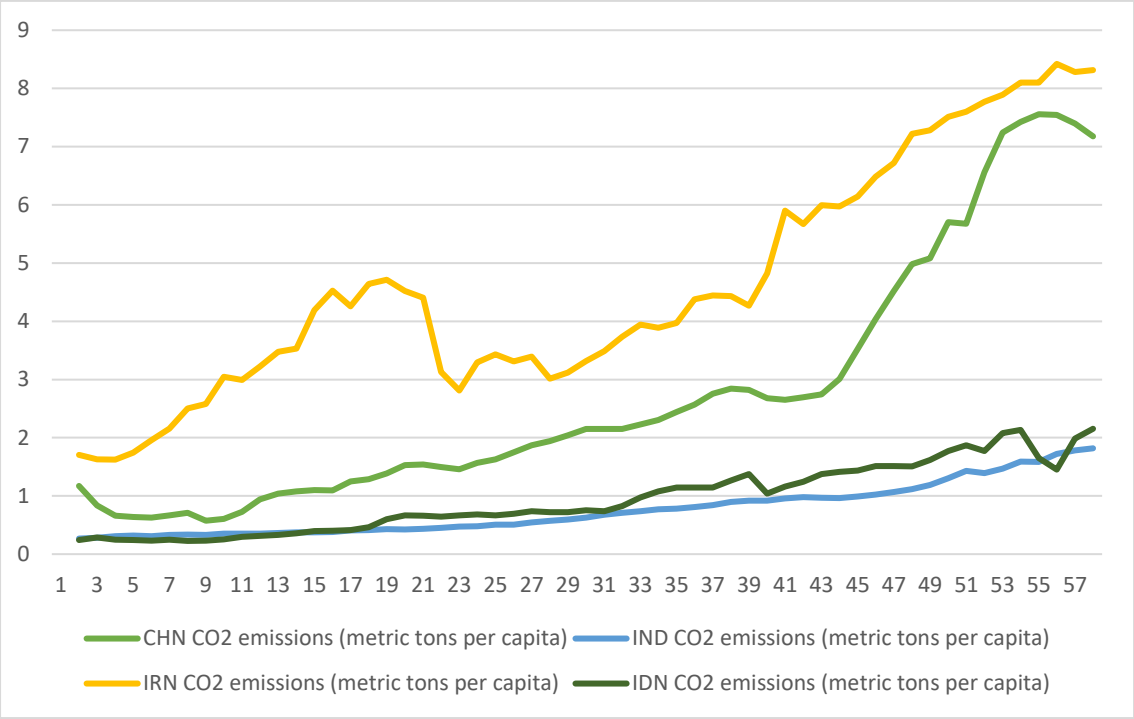


Fig. 8. CO2 emission from 1960-2016. [32,33]

The relationship between energy consumption and economic growth is correlative, economic growth seems impossible without energy generation, and the higher the countries develop their economy the higher they need to produce energy. the way most of the developing countries are trying to develop their economy is different from the developed countries, most of the developing countries are looking for rapid economic growth, where they need to generate more energy, and most of that energy is produced by non-renewable resources as compared to renewable energy the non-renewable is quite low in price for the developing countries.

We find that energy production for developing countries is quite hard from renewable sources as compared to non-renewable resources, also developing countries aim for rapid economic growth in a short time. Such reasons make the developing countries generate more energy from fossil fuels and be careless of the consequences.

The main findings of this study are:

- The usage of fossil fuels in developing countries is still the central debate issue of pollution.
- The level of greenhouse gases is higher in developing countries as compared to developed countries.
- Most of the developing countries have rapid population growth, which forces the countries to generate more energy in a short time and low cost.
- We find that using non-renewable energy for economic growth in the long term brings horrible consequences and it’s not the appropriate way of economic growth.

Renewable energy is the only way to reduce the emission level chase the goal of energy for everyone, and have sustainable economic development. Overall, the study suggests that plan makers in developing countries should bring huge changes in the way of production of energy for economic growth, and invest more in the splitting of renewable resources for economic development. Mitigation of air pollution is one of the global goals that most developed countries are going to chase. But, on the other side, the developing countries are making it difficult, so the only way to chase the goal and bring mitigations to climate change is the cooperation between developed and developing countries. International cooperation will bring significant changes in the field of mitigation. We suggest that developed countries should invest more in developing countries for the development of renewable energy and sustainable economic growth.

References

[1] Aiyegoro, A. A. (1997). A causality analysis of trade flows in the North American free trade agreement. International Advances in Economic Research, 3(2), 227–228. https://doi.org/10.1007/bf02294950.

[2] Hall, C., Tharakan, P., Hallock, J., Cleveland, C., & Jefferson, M. (2003). Hydrocarbons and the evolution of human culture. Nature, 426(6964), 318–322. https://doi.org/10.1038/nature02130.

[3] Perry, A. (2003). Book Review: Climate change 2001: synthesis report. Third assessment report of the Intergovernmental Panel on Climate Change (IPCC); Climate change 2001: the scientific basis; Climate change 2001: impacts, adaptation, and vulnerability; Climate change 2001: mitigation. The Holocene, 13(5), 794. https://doi.org/10.1177/095968360301300516.

[4] Pasten, C., & Santamarina, J. C. (2012). Energy and quality of life. Energy Policy, 49, 468–476. https://doi.org/10.1016/j.enpol.2012.06.051.

[5] Wu, W., Wu, P., Yang, F., Sun, D. L., Zhang, D. X., & Zhou, Y. K. (2018). Assessment of heavy metal pollution and human health risks in urban soils around an electronics manufacturing facility. Science of The Total Environment, 630, 53–61. https://doi.org/10.1016/j.scitotenv.2018.02.183.

[6] Liu, H., Jian, R., Chen, H., Tian, X., Sun, C., Zhu, J., Yang, Z., Sun, J., & Wang, C. (2019). Application of Biodegradable and Biocompatible Nanocomposites in Electronics: Current Status and Future Directions. Nanomaterials, 9(7), 950. https://doi.org/10.3390/nano9070950

[7] Wiedmann, T., & Lenzen, M. (2018). Environmental and social footprints of international trade. Nature Geoscience, 11(5), 314–321. https://doi.org/10.1038/s41561-018-0113-9

[8] Khatib, H. (2012). IEA World Energy Outlook 2011—A comment. Energy Policy, 48, 737–743. https://doi.org/10.1016/j.enpol.2012.06.007.

[9] Full Issue PDF Volume 113, Issue 6. (2016). Energy Engineering, 113(6), 1–81. https://doi.org/10.1080/01998595.2016.11772063.

[10] World Production Gas, Natural Gas Liquids, Coal and Lignite, Electricity, Primary Energy. (2016). Oil & Energy Trends: Annual Statistical Review, 37(1), 25–40. https://doi.org/10.1111/oets.69.

[11] Wu, Y., Zhu, Q., & Zhu, B. (2018). Comparisons of decoupling trends of global economic growth and energy consumption between developed and developing countries. Energy Policy, 116, 30–38. https://doi.org/10.1016/j.enpol.2018.01.047.

[12] An Analysis of the Environmental Kuznets Curve for Carbon Dioxide Emissions: Evidence for OECD and Non-OECD Countries. (2015). European Journal of Sustainable Development, 4(3). https://doi.org/10.14207/ejsd.2015.v4n3p33

[13] Zhang, X., Zhang, H., & Yuan, J. (2019). Economic growth, energy consumption, and carbon emission nexus: fresh evidence from developing countries. Environmental Science and Pollution Research, 26(25), 26367–26380. https://doi.org/10.1007/s11356-019-05878-5

[14] Crompton, P., & Wu, Y. (2005). Energy consumption in China: past trends and future directions. Energy Economics, 27(1), 195–208. https://doi.org/10.1016/j.eneco.2004.10.006

[15] Wijaya Tjoek, P., & Wu, P. I. (2018). Exploring the environmental Kuznets curve for CO2 and SO2 for Southeast Asia in the 21st century context. Environmental Economics, 9(1), 7–21. https://doi.org/10.21511/ee.09(1).2018.01.

[16] Statistics report World Energy Balances. (2020). IEA. https://www.iea.org/data-and-statistics/data-products

[17] Esso, L.J., Keho, Y., 2016. Energy consumption, economic growth and carbon emissions: Cointegration and causality evidence from selected African countries. Energy 114, 492–497. http://dx.doi.org/10.1016/j.energy.2016.08.010.

[18] Soytas, U., Sari, R., 2009. Energy consumption, economic growth, and carbon emissions: Challenges faced by an EU candidate member. Ecol. Econ. 68, 1667–1675. http://dx.doi.org/10.1016/j.ecolecon.2007.06.014.

[19] Akella, A., Saini, R., & Sharma, M. (2009). Social, economical and environmental impacts of renewable energy systems. Renewable Energy, 34(2), 390–396. https://doi.org/10.1016/j.renene.2008.05.002.

[20] Azapagic, A. (2004). Developing a framework for sustainable development indicators for the mining and minerals industry. Journal of Cleaner Production, 12(6), 639–662. https://doi.org/10.1016/s0959-6526(03)00075-1.

[21] BARRETT, S., & GRADDY, K. (2000). Freedom, growth, and the environment. Environment and Development Economics, 5(4), 433–456. https://doi.org/10.1017/s1355770x00000267.

[22] Birol, F., & Argiri, M. (1999). World energy prospects to 2020. Energy, 24(11), 905–918. https://doi.org/10.1016/s0360-5442(99)00045-6.

[23] Kasman, A., & Duman, Y. S. (2015). CO2 emissions, economic growth, energy consumption, trade and urbanization in new EU member and candidate countries: A panel data analysis. Economic Modelling, 44, 97–103. https://doi.org/10.1016/j.econmod.2014.10.022.

[24] Rasoulinezhad, E., & Saboori, B. (2018). Panel estimation for renewable and non-renewable energy consumption, economic growth, CO2 emissions, the composite trade intensity, and financial openness of the commonwealth of independent states. Environmental Science and Pollution Research, 25(18), 17354–17370. https://doi.org/10.1007/s11356-018-1827-3.

[25] Salari, M., Javid, R. J., & Noghanibehambari, H. (2021). The nexus between CO2 emissions, energy consumption, and economic growth in the U.S. *Economic Analysis and Policy*, *69*, 182–194. https://doi.org/10.1016/j.eap.2020.12.007.

[26] Alvarado, R., & Toledo, E. (2016). Environmental degradation and economic growth: evidence for a developing country. Environment, Development and Sustainability, 19(4), 1205–1218. https://doi.org/10.1007/s10668-016-9790-y

[27] Azam, M. (2016). Does environmental degradation shackle economic growth? A panel data investigation on 11 Asian countries. Renewable and Sustainable Energy Reviews, 65, 175–182. https://doi.org/10.1016/j.rser.2016.06.087

[28] Wolde-Rufael, Y., & Idowu, S. (2017). Income distribution and CO2 emission: A comparative analysis for China and India. Renewable and Sustainable Energy Reviews, 74, 1336–1345. https://doi.org/10.1016/j.rser.2016.11.149.

[29] bp global. (2016). Statistical Review of World Energy | Energy economics | Home. https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html

[30] Konisky, D. M., Hughes, L., & Kaylor, C. H. (2015). Extreme weather events and climate change concern. Climatic Change, 134(4), 533–547. https://doi.org/10.1007/s10584-015-1555-3

[31] Handayani, R. D., & Putra, P. D. (2019). Student Cognition in the Context of a Climate System: Global Warming and Greenhouse Effect. Momentum: Physics Education Journal, 69–77. https://doi.org/10.21067/mpej.v3i2.3739

[32] CO2 emissions (metric tons per capita) - India | Data. (n.d.). World Bank. Retrieved June 19, 2021, from https://data.worldbank.org/indicator/EN.ATM.CO2E.PC?end=2016&locations=IN&start=1960&view=chart.

[33] CO2 emissions (metric tons per capita) - China | Data. (n.d.). CO2 Emissions (Metric Tons per Capita) - China | Data. Retrieved June 19, 2021, from https://data.worldbank.org/indicator/EN.ATM.CO2E.PC?end=2016&locations=CN&start=1960&view=chart.

Authors Profile



Assistant Professor Muhammad Yama Saadat son of Ghulam Sarwar, was born in 1994 in Maidan Wardag Province, he had been graduated from Kabul Polytechnic University with honors (Cader) in 2018. Then he was recruited as a scientific staff in Kabul Polytechnic University, after that, Mohammad Yama Saadat completed his master's degree in the Department of Petrochemical & Gas Industrial Engineering, Faculty of Chemical Industrial Engineering at Kabul Polytechnic University in 2023. Muhammad Yama has two textbooks, each book was written on research methods and laboratory experiments, and he also has 5 scientific research articles published in domestic and foreign magazines. Also, Mohammad Yama Saadat has been serving as a teacher of the Faculty of Chemical Industry Engineering since 2019.



Obaidullah Obaidi is an Assistant Professor at Kabul University's Engineering Faculty in the Energy Engineering Department. He specializes in biomass, biofuels, renewable energy, and environmental engineering. Obaidi earned his Bachelor's degree in Chemical Engineering in 2018 and completed his Master's degree in Energy and Environmental Engineering from Galgotias University, India, in 2021. His dedication to advancing energy solutions in Afghanistan is reflected in his ongoing efforts to mentor students and drive innovation in renewable energy.