# CHAPTER-7

## CONCLUSION

## 7.1 INTRODUCTION

Energy has been essential to India's industrial development. Its use has grown mainly as a result of industrialization, electrification, the creation of infrastructure rapidly, and population growth. Despite the country's ample supply of coal and other renewable energy sources, there is still a significant need for other forms of energy. Energy is in increasing demand as a result of growing industrialization. Approximately 43.6% of the total energy supply is used by it. This is largely attributable to a steady rise in investment made with a goal of self-sufficiency in fundamental and energy-intensive industries. Additionally, it is thought that increasingly energy-intensive industries have resulted in a considerable increase in energy consumption for every rupee of GDP earned. In this scenario, it was necessary to identify any issues with energy use and industry. Examining the patterns of energy usage in the industrial sector and how they affect industrial output is even more crucial. In this regard, issues including industrial energy dependence, industrial energy sources, industrial energy intensities, and industrial value-added have been uncovered with the use of an appropriate statistical inquiry in the current study. Using information from the Annual Survey of Industries, conducted by the Government of India, the relationship has been researched for twenty years, or from 2001 to 2021. The study has targeted 23 different types of manufacturing industries namely, Manufacturing of Basic Metal, Beverages, Chemical and Chemical Products, Coke and Refined Petroleum Products, Computer and Electronic Optical products, Electrical Equipment, Fabricated Metal Products except for Machinery and Equipment, Manufacturing of Food Products, Manufacturing of furniture, Manufacturing of leather related products, Manufacturing of machinery and equipment, Other Non-Metallic Mineral products, Manufacturing of paper and paper products, Pharmaceutical medical, chemical & botanical products, Rubber plastic product, Manufacturing of textiles, Manufacturing of tobacco products, Manufacturing of wearing apparels, Manufacturing of wood and wood products, Other manufacturing, printing and reproduction of media, Publishing Activities, and Crop animal production and Hunting related. Seven chapters—which are listed below—expanded on and addressed the empirical investigation.

### 7.2 CHAPTERISATION

Based on the stated goals, a detailed chapter describing the research demands was included in the study's introduction. The methodology and data source used for the empirical study were described in this chapter. In chapter two, several studies from developed and emerging market economies were reviewed based on the research objectives. Such a process was carried out to pinpoint the gap in the literature and support the current empirical investigation. In the remaining chapters based on the research questions, the empirical analysis was carried out in these chapters.

A thorough explanation of the energy profile, energy scenario, energy demand, employment and energy, trade and energy, energy and the Indian economy, investment and energy, and energy and industrial transformation were all provided in the third chapter. Additionally, a descriptive data analysis was performed on variables such as the number of factories, fixed capital, labor, profit, and gross value added. Their normality was assessed throughout. The summaries of these variables' statistics provided important details on the empirical probability distribution of the research's chosen samples. Additionally, the rate of growth of the aforementioned factors as well as the percentage of energy used by each industry was looked into.

The link between energy input and industrial output was statistically examined in Chapter 4 at aggregate levels. Through a variety of empirical frameworks, including the Panel Unit-Root Test, Johensen's Co-integration Test, and Fixed & Random Effect Models, this relationship was examined as a function of the industrial fuel consumption from basic energy sources, such as coal, electricity, petroleum & other miscellaneous fuels, capital, and labour. A production function framework has also been developed. wherein the industrial net output was considered the output and labour, capital, and energy were taken as inputs. As a result, the function of output and real energy prices has been used to estimate the energy demand function. In addition, the price elasticity of energy demand in the manufacturing sector was worked out. In line with the production function framework, the income share equation has been estimated.

In the fifth chapter, cross-section time-series data analysis was used to evaluate the link between the industrial output and energy input at aggregate and disaggregated levels as a function of total fuel consumption, including coal, electricity, petroleum, and other fuels. Different methods were used, including the Granger Causality Test, the Panel Unit Root Test, the Johensen's Cointegration Test, and the Vector Error Correction Model (VECM). The short-run VECM results revealed short-run causality connecting industrial fuel, electricity, and petroleum consumption to gross industrial value added (GIVA), which translated into rising industrial output and an increase in the short-run demand for energy inputs. In long run, the results of VECM showed that Industrial gross value-added, Industrial coal consumption, and Industrial electricity consumption, had cause-and-effect relationships among the variables. At the disaggregated level, an increase in gross industrial value-added had a positive impact on the demand for coal usage and electricity consumption at a 5% significance level.

Chapter 6 evaluated each industry's fuel efficiency. Among the variables examined were industrial value added (VA), coal consumption (CC), electricity consumption (EC), petroleum consumption (PC), other oil consumption (OC), and consumption of petroleum (PC). The level of specific production units and manufacturing groupings was analyzed separately. Based on the energy data used and gross industrial value added for the various factors mentioned above, the input-output table had been created for each decision-making unit. There is just one output table and four input tables as a result. This input-output table was executed by the Deap-xp2 computer programme. This study employed the DEA-based Malmquist Productivity Index (MPI) to gauge fuel efficiency in the manufacturing sectors of India. The finding indicated that the industrial sector as a whole was heavily dependent on coal. With price changes, fuel usage and fuel substitution invariably changed. Electricity was typically employed in industrial production. However, coal was essential to heavy industries. Fuel usage and industrial gross value added were found to be positively correlated. The need for energy input rose as industrial production expanded. The Granger causality test demonstrated that the relationship between industrial fuel use and gross value added runs in one direction. The Malmquist Productivity Index's energy efficiency test revealed the time frame during which a specific industry's energy performance was higher.

## 7.3 MAJOR FINDINGS

Based on the analysis undertaken in different chapters of this study, the following findings are discernible.

An in-depth understanding of energy and related variables was gained from the study of the Indian energy profile. It was discovered that the need for energy evolved with time. Population growth, fast industrialization, urbanization, an increase in per capita income, a high standard of living, and mass consumer habits were the driving forces. Coal, oil, and solid biomass were the three main fuels that met most of India's energy needs. Coal made up the lion's share of the energy mix among them. Between 2001 and 2021, the demand for coal nearly tripled, accounting for half of the increase in primary energy consumption. About 74 percent of the required coal is produced in India, the remaining requirement is met through imports. Whereas the crude oil dependency on the external sector is about 87 percent. Natural gas dependency is about 56 percent. Since 2000 Indian energy demand accounted for about 10 percent of the world's energy demand.

Additionally, it was discovered that the Indian energy system coexists with abundance and scarcity. For instance, despite having the highest coal reserves in the world, India is the biggest coal importer. ii) Despite being the biggest importer of crude oil, India has developed into the global center for crude oil refining. iii) India is the third-largest emitter of $CO_2$ while having an energy consumption per person that falls short of international requirements. iv) Increasing economic growth powered by coal while decreasing environmental quality. Even though per-capita energy consumption is lower than the global average, the absolute numbers for energy consumption appear to have increased.

It was also observed that there were not many differences in how much each sector depended on a certain fuel. The industrial sector heavily on coal, the transportation sector relied primarily on oil, the building industry mainly on electricity, and the agriculture sector heavily on electricity as well. The second-highest final energy use, at between 36 and 40 percent, is in the industrial sector. Additionally, the Indian energy policy framework has been attempting to move away from fossil fuels like gas, biofuels, and renewables in order to lessen its dependence on them. As a result, solar power installation had greatly increased during the past ten years.

Furthermore, it was determined that fuel usage increased significantly in the year with the low fuel price index. The resultant impact on the industrial gross value added was caused by this. Such relationships confirmed the validity of the law of demand economic theory. Recently, it has been noted that the increase in gross value added was only marginally improved with a lower or constant fuel price index. This suggested that capital expansion was not very strong throughout those periods.

The findings also showed that most industries relied on electricity to produce their goods. A small number of industries, including those that use non-metallic materials (such as cement, chemicals, and paper), are dependent on coal. In contrast to the paper and paper industry, which relies on coal energy on average to the tune of 50%, the non-metallic mineral sector depends on coal energy to the tune of 60% on average. In recent years, electricity has displaced oil in the tobacco industry. For a few years, the textile industry avoided using gas and oil and instead boosted its use of electricity. The industries that produce rubber have also recently expanded their use of electricity while decreasing their use of oil and gas.

The statistical investigation of eleven groups of manufacturing industries revealed that there is a positive relationship between fuel consumption and gross industrial value-added and an inverse relationship between real energy price and fuel demand. The results have been obtained by using different models. Such as the fixed & random models and Allen Partial Elasticity of Substitution. It was found as per the hypothesis that the fixed effect model fits the data better and the result from outcomes are significant. The slope coefficient of the fuel consumed under the fixed effect model indicates that per unit increase in fuel consumption leads to an increase in industrial gross value-added by 0.58814 at a 1% level of significance with the $R^2$ of 0.9802. The slope coefficient of fixed capital drives the industrial gross value-added to change by 0.29315 for every one-unit change in fixed capital. Similarly, the coefficient of labor influences the industrial gross value-added by 0.52091 for every unit change in labor. The statistical representation of the slope coefficient of fuel consumption is large enough to impact the industrial gross value-added. Hence, there has been a substantial influence of energy on industrial gross value added.

In contrast, the energy demand model estimates revealed that the price elasticity of energy demand for manufacturing is about (-) 0.4. which means a one percent change in energy price led to a 0.4 percent decline in fuel demand in the manufacturing sector. However, that of the estimated trans-log production functions of the price elasticity of energy demand was found to be (-) 1.4. which validates the hypothetical statement of an increasing fuel prices affecting negatively the demand for fuel. i.e., one percent increase in the energy price led to a 1.4 percent reduction in fuel consumption overall for the reported eleven industries.

The results obtained after testing the hypothesis, indicated a vivid functional relationship between inputs and outputs. It has been identified that energy consumption and industrial gross value added are positively connected, and a fall in the price of energy leads to more energy demand and energy plays an important role in the industrial output as an input.

Proceeding forward the test of the hypothesis on the interlinkages between energy inputs and industrial value-added for Indian industries at the aggregate and dis-aggregate levels were conducted. In the long run, the results of the Vector Error Correction Model showed that industrial gross value added, industrial coal consumption, and industrial energy consumption had cause-and-effect relationships among the variables in the long run. At the disaggregated level, an increase in gross industrial value-added has a positive impact on the demand for coal usage and electricity consumption at a 5% significance level.

Moreover, the short-run results of the Vector Error Correction Model showed causality running from gross industrial value added to industrial fuel consumption, electricity consumption, and petroleum consumption, which meant expanding industrial production, increased the demand for energy inputs in the short run. Additionally, the Granger causality test revealed the direction of causality running from gross industrial value added to total industrial fuel consumption, gross industrial value added to industrial energy consumption, gross industrial value added to industrial petroleum products, and industrial coal consumption to gross industrial value added. As a result, the inference revealed that the gross industrial value-added was delivered primarily through energy consumption. The industrial sector's energy intake remained as high as 50 percent of the total available commercial energy. Coal & electricity was used as critical component in industrial production both in the short run and long run. Energy-intensive manufacturing such as pulp & paper, basic chemicals, refining, iron & steel, nonferrous metals & nonmetallic mineral seemed to be energy dependent for years to come.

The change in energy consumption productivity for 23 industrial sectors in India had been measured further in terms of energy efficiency using an input-oriented Data Envelopment Model based on the Malmquist Productivity Index was used and presented in the decomposed form: Technical Efficiency Change & Efficient Production Frontier Shift. Technical Efficient Change was employed to measure the technical change, and EPFS was utilized to identify the shift in the efficient production frontier. Both Technical Efficient Change and Efficient Production Frontier showed the value of the Malmquist Productivity Index. Hence the change in productivity was determined by the change in technical efficiency and the shift of the Efficient Production Frontier.

The results indicated that eight manufacturing industries, including the production of basic metals, beverages, chemicals, and chemical products, as well as furniture, clothing, wood products, rubber and plastic, and printing and reproducing media, consumed energy effectively for at least more than six of the two decadal periods. Additionally, it implied that these units are quite close to the benchmarks for energy consumption's efficiency frontier. Coke and refined petroleum products, computer and electronic optical products, electrical equipment, fabricated metal items, and food product manufacturing all showed moderate energy efficiency.

## 7.4 SUGGESTIONS

Based on the empirical analysis and their results in different chapters, the following are the suggestions:

One of the observations showed that increased industrial production, which in turn led to higher energy demand, was the result of increased mass material use. Therefore, a reliable energy supply needs to be improved in order to sustain a sufficient level of industrial activity.

The research also indicated that the major source of energy is from coal and oil, hence industries both in the short run and long run should practice optimization of energy use, avoiding energy loss and storing energy. India also needs to design robust energy policies such as reducing dependency on fossil fuels, particularly petroleum and coal, and moving towards renewable energy sources, including hydrogen. This will make India a manufacturing hub, creating global competitiveness.

The bi-directional causation between energy consumption and industrial gross value-added warrants that the Indian manufacturing sector should use energy efficiently and secure energy as it has a vital role in the production for the stabilization of industrial production.

The price elasticity of demand for energy reveals that a 1 percent rise in energy prices leads to a 1.4 percent fall in the demand for energy which affects 0.58 percent of industrial gross value-added. This calls for measures for fuel price stabilization and, support throughout the production process to maintain sufficient manufacturing output. Hence, the government should invest in the power sector more.

As, many industries are energy inefficient, using energy intensively, gaining energy efficiency should be imperative to account for the reduction in energy use. The scheme of Perform Achieve Trade needed to be expanded further to promote energy efficiency across energy-intensive industries. Apart from these, industries need to understand and identify how and where energy is used more significantly to bring greater efficiency and reduce energy consumption in these industries.

Further, as the heavy industries such as iron-steel, cement and other light industries such as textiles, manufacturing, and food processing enterprises account for the major energy consumption, industries should be encouraged to reuse or recycle material if it causes efficient use of energy, there is also a need to encourage the use of energy-saving technology.

## 7.5 CONTRIBUTION OF THE PRESENT STUDY

The present research study's contribution can be pinned down below.

- The energy scenario of the industrial sector in India has been brought to the fore comprehensively
- Existing literature on energy and industry has been reviewed thoroughly from national and international sources.
- The present study has investigated the energy consumption and industrial gross value added and the energy use per unit of output using annual data on the manufacturing sector from the Annual Survey of Industries.
- In the study, the analysis of 23 clusters of manufacturing industries that constitute the major part of the manufacturing sector had been undertaken.

- The study differs from others as it measures energy use from the deflated value of the cost of energy inputs rather than measuring in physical units.
- A disaggregated analysis has been conducted at the level of individual industrial groups.
- The energy and industrial gross value-added linkages have been statistically brought to light.
- An observation in the direction of identifying the energy-efficient industry has been done.

## 7.6 LIMITATION OF THE STUDY

To examine the functional relationship between energy consumption and industrial value-added and expand to measure energy intensity, the current study has been done with due diligence. However, the study is not free from limitations.

- The study has considered the energy inputs in value terms. Another possibility can be, taking the energy input in tons of oil equivalent.
- Taking energy input in oil equivalent could have captured the energy supply from the captive plant of the manufacturing sector.
- The time series data for the referred period of 2001 to 2021 has not been adjusted for the structural break.
- The current study pertains to only energy consumption and industrial value added in the manufacturing sector whereas it could have been extended to other sectors of the economy as well.

*******

# References


- Abbas, F. and Choudhury. N. (2013). Electricity consumption-economic growth nexus: an aggregated and disaggregated causality analysis in India and Pakistan, *Journal of Policy Modeling*, 35(4), 538-553.
- Abbas, F., & Choudhury, N. (2013). Electricity consumption-economic growth nexus: an aggregated and disaggregated causality analysis in India and Pakistan. *Journal of Policy Modeling*, 35(4), 538-553.
- Abbasi, K. R., et al. (2020). Analysing the role of industrial sector's electricity consumption, prices, and GDP: A modified empirical evidence from Pakistan. *AIMS Energy*, *9*(1), 29–49. https://doi.org/10.3934/ENERGY.2021003.
- Agência Brasil, (2019). Agência Brasil. Retrieved 23 July 2020, from https://agenciabrasil.ebc.com.br/geral/noticia/2019-06/preco-do-gas-e-desemprego-elevam-uso-da-lenha-para-cozinhar-no-brasil.
- Ahmad, B. (2018). Renewable and non-renewable energy consumption- impact on economic growth and CO2 emissions in five emerging market economics, *Environmental Science and Pollution Research*, (25) 35515–35530.
- Asghar, Z. (2008). Energy-Gdp Relationship: A Causal Analysis For The Five Countries Of South Asia. In *Applied Econometrics and International Development* (Vol. 8, Issue 1).
- Behera, J. (2015). Energy consumption and economic growth in India: A reconciliation of Disaggregate Analysis, *Journal of Energy Technologies and Policy*, 5 (6), 15-27.
- Bildirici, Melike E. & Bakirtas, Tahsin, (2014).The relationship among oil, natural gas and coal consumption and economic growth in BRICTS (Brazil, Russian, India, China, Turkey and South Africa) countries, *Energy, Elsevier,* 65(C),134-144.
- Bowden, N., & Payne, J. E. (2009). The causal relationship between US energy consumption and real output: a disaggregated analysis. *Journal of Policy Modeling*, *31*(2), 180-188.
- CEA, (2019). Draft Report on Optimal Generation Capacity Mix for 2029-30. New Delhi: Central Electricity Authority.
- CEA, (2019). Growth of Electricity Sector in India from 1947-2019.New Delhi: CEA. Retrieved from www.cea.nic.in/reports/others/planning/pdm/growth_2019.pdf

- Chen, S.T., Kuo, H.I., & Chen, C.C. (2007). The relationship between GDP and electricity consumption in 10 Asian countries. *Energy Policy*, 35(4), 2611–2621.

- Cheng, B. S., & Lai, T. W. (1997). An investigation of co-integration and causality between energy consumption and economic activity in Taiwan. *Energy economics*, *19*(4), 435-444.

- Chitale, S.D. (1979). Depletion and Locational Advantage in the of mineral extraction programmes, The case research work of coking coal in India, Ph.d Dissertation, *Indian Statistical Institute*, New Delhi.

- Chitale, V. P., & Roy, M. (1975). Energy Crisis in India. *Economic and Scientific Research Foundation*

- Desai, A. V. (1978). India's energy consumption: Composition and trends. *Energy Policy*, *6*(3), 217-230.

- Deshmukh & Parikh.J. S.G, (1992). Policy alternative for Western and Southern Power Systems in India, *Utilities Policy*, 2(3),240-247.

- Devi, R., Singh, V., Dahiya, R. P., & Kumar, A. (2009). Energy consumption pattern of a decentralized community in northern Haryana. *Renewable and Sustainable Energy Reviews*, *13*(1), 194-200.

- Diewert, W. E., Caves, D. W., & Christensen, L. R. (1982). The economic theory of index numbers and the measurement of input, output, and productivity. *Econometrica*, 50(6) 1393–1414.
- Dimitriu, M., & Blessy, M. (2010). Econometric Analysis of Efficiency in The Indian Manufacturing Sector, *Journal for Economic Forecasting*, Institute for Economic Forecasting, 0(1),182-197.

- Donella H. Meadows et al (1972) The limits to growth. *New American Library*,1992.
- El-Sakka., & M.I.T. Ghali, K.H, (2004). Energy and output growth in Canada: A multivariate cointegration analysis. *Energy Economics*, 26(2), 225–238.

- Emmanuel, Z. (2009). Disaggregate Energy consumption and industrial production in South Africa, *Energy policy*, 6, 2214-2220

- Erol, U., & Yu, E. S. H. (1987). Time series analysis of the causal relationships between U.S. energy and employment. *Resources and Energy*, *9*(1), 75–89. https://doi.org/10.1016/0165-0572(87)90024-7.

- Ewing, B. T., Sari, R., & Soytas, U. (2007). Disaggregate energy consumption and industrial output in the United States. *Energy Policy*, *35*(2), 1274–1281. https://doi.org/10.1016/j.enpol.2006.03.012.

- Farrell, M. J. (1957). The measurement of productive efficiency. *Journal of the Royal Statistical Society A*, 120(3) 253– 290.
- Francis, B. M., Moseley, L., & Iyare, S. O. (2007). Energy consumption and projected growth in selected Caribbean countries. *Energy Economics*, *29*(6), 1224-1232.
- Georgescu-Roegen, N. (1986). The entropy law and the economic process in retrospect. *Eastern Economic Journal*, *12*(1), 3-25.
- Georgescu-Roegenm Nicholas, (1975). Energy and economic myths, *Southern Economic Journal*, 41(3), 347-381.
- Ghosh, S. (2002). Electricity consumption and economic growth in India. *Energy Policy*, 30(2),125-129.
- Gokmenoglu, K., Azin, V., & Taspinar, N. (2015). The Relationship between Industrial Production, GDP, Inflation and Oil Price: The Case of Turkey. *Procedia Economics and Finance*, *25*, 497–503. https://doi.org/10.1016/s2212-5671(15)00762-5.
- Golder, B. (2011). Energy intensity of Indian manufacturing firms: effect of energy prices, technology and firm characteristics. *Science, Technology and Society*, *16*(3), 351-372.
- Govindaraju, V.G.R. Chandran, & Chor Foon Tang, (2013). The dynamic links between CO2 emissions, economic growth and coal consumption in china and India. *Applied Energy,* 104(C), 310-318.
- Hondroyiannis, G., Lolos, S., & Papapetrou, E. (2002). Energy consumption and economic growth: Assessing the evidence from Greece. *Energy Economics*, 24(4), 319–336.
- IEA, (2019). Material Efficiency in Clean Energy Transitions. Paris: IEA. Retrieved from www.iea.org/reports/material-efficiency-in-clean-energy-transitions.
- IEA, (2020c). Iron and Steel Technology Roadmap: Towards more sustainable steel making. Paris: IEA. Retrieved from www.iea.org/reports/iron-and-steel-technology-roadmap.
- IEA, (2021). Special Report on World Energy Outlook India 2020-21. France: Directorate of Sustainability, Technology, and Outlooks.
- IEA, (2020). *India Energy Policy Review.* Paris: IEA. Retrieved from www.iea.org/reports/india-2020
- Inaki Arto, (2016). The energy requirements of a developed world. Energy for Sustainable Development.

- Jebali, E., Essid, H., Khraief, N. (2017). The analysis of energy efficiency of the Mediterranean countries: A two-stage double bootstrap DEA approach. *Energy,*134, 991–1000.

- Jena, P. (2009). A study of changing patterns of energy consumption and energy efficiency in the Indian manufacturing sector. https://mpra.ub.uni-muenchen.de/id/eprint/31195.

- Karanfil, & Thomas, J. (2007). Sectoral energy consumption by source and economic growth in Turkey, *Energy Policy*, 345(11),5447-5456.

- Kassim, F., Isik, & Abdurrahman. (2020). Impact of Energy Consumption on Industrial Growth in a Transition Economy: Evidence from Nigeria. https://mpra.ub.uni-muenchen.de/id/eprint/101757

- Kassim, Fatima & Isik, A. (2020). Impact of Energy Consumption on Industrial Growth in a Transition Economy: Evidence from Nigeria. *Munich Personal RePEc Archive,* Online at https://mpra.ub.uni-muenchen.de/101757/ MPRA Paper No. 101757, posted 22 Jul 2020.

- Korsakienė, R., Tvaronavičienė, M., & Smaliukienė, R. (2014). Impact of Energy Prices on Industrial Sector Development and Export: Lithuania in the Context of Baltic States. *Procedia - Social and Behavioral Sciences, 110*, 461–469. https://doi.org/10.1016/j.sbspro.2013.12.890.

- Kraft, J., & Kraft, A. (1978). On the relationship between energy and GNP. *The Journal of Energy and Development*, 3(2),401-403.

- Lee, C.C. (2006). The causality relationship between energy consumption and GDP in G-11 countries revisited. *Energy Policy*, 34(9), 1086–1093.

- Leena Srivastava, R.K. & Pachuari, (1988). Perspectives on energy policy for the household sector, *Energy policy,* 4 ,Tata energy Research Institute.

- Loganathan, N. & Suramaniam, T. (2010). Dynamic Cointegration Link between Energy Consumption and Economic Perfomance: Empirical Evidence from Malaysia, *International Journal of Trade, Economics and Finance,* 261-267.

- Makridou, G., Andriosopoulos, K., Doumpos, M., Zopounidis, C. (2016). Measuring the efficiency of energy-intensive industries across European countries. *Energy Policy*, 88, 573–583.
- Masih, A. M., & Masih, R. (1996). Energy consumption, real income and temporal causality: results from a multi-country study based on cointegration and error-correction modelling techniques. *Energy economics*, *18*(3), 165-183.

- Mehdi. A. & Rafaa. M. (2014). Energy consumption and industrial production: Evidence from Tunisia at both aggregated and disaggregated Levels. *Journal of Knowledge Economics*, (2015) 6:1123–1137.

- Mehra., J & Reddy, S. (2012). Energy Intensity in India and its Impact on GDP, *Journal of Business and Management, 3(4),* 06-12.

- Mohanty, A., & Chaturvedi, D. (2015). Relationship between Electricity Energy Consumption and GDP: Evidence from India. *International Journal of Economics and Finance*, *7*(2). https://doi.org/10.5539/ijef.v7n2p186.

- Monga, G.S., & Sanctis, V.J. (1994). Energy consumption pattern in India, Indias Energy Prospects, *Vikas publications*, New Delhi.

- Moseley, L., & Francis, B.M. (2007). Energy consumption and projected growth in selected Caribbean countries. *Energy Economics*, 29(6), 1224–1232.

- MoSPI, (2019). Annual Survey of Industries 2017-18. Delhi: Ministry of Statistics and Programme Implementation.

- Mousa, B.M., & Bilal, A.A. (2003). Current situation of energy consumption in the Jordanian industry, *Energy conservation and Management*,44(9), 1501-1510.

- Nain, M. Z., Ahmad, W., & Kamaiah, B. (2017). Economic growth, energy consumption and CO2 emissions in India: a disaggregated causal analysis. *International Journal of Sustainable Energy*, *36*(8), 807-824.

- Nan, F., & Yang Li, (2011). Relationship between Energy Consumption and Economic Growth: Empirical study Based on Data on Hebei Province from 1980-2008, *System Engineering Procedia1*, 117-123.

- Nandakumar, V.T., Devasia.M.D., & Thomachan, K.T. (2017). Interaction between Energy Consumption and Economic growth in India. *International Journal of Research*-Granthaalayah, 5(4), 62-71.

- Narayan, P. K., & Smyth, R. (2007). Are shocks to energy consumption permanent or temporary? Evidence from 182 countries. *Energy policy*, *35*(1), 333-341.

- Narayanan, & Sahu, S. (2009). Determinants of Energy Intensity: A Preliminary Investigation of Indian Manufacturing, *MPRA*, Paper 16606.

- OEA DPIIT, (2020). Index of Core Industries. New Delhi: Office of the Economic Advisor, Department for Promotion of Industry and Internal Trade, Ministry of Commerce and Industry, Government of India.

- Oh, W., & Lee, K. (2004). Causal relationship between energy consumption and GDP revisited: the case of Korea 1970–1999. *Energy economics*, *26*(1), 51-59.

- Pachauri, R.K. (1977). Energy & Economic Development In India. *Praeger Publishers*, New York, 1977.

- Parikh, J. K., & Kulshreshtha, M. (2002). Study of efficiency and productivity growth in opencast and underground coal mining in India: a DEA analysis. *Energy Economics*, 24(5)439–453.

- Parikh, J. K., & Parikh, K. S. (1977). Mobilization and impacts of bio-gas technologies. *Energy*, *2*(4), 441-455.

- Paul, S., Bhattacharya, R.N. (2004). Causality between energy consumption and economic growth in India: A note on conflicting results. *Energy Economic,* 26(6), 977–983.

- Payne, J.E. Bowden, N., (2010), sectoral analysis of the causal relationship between renewable and nonrenewable energy consumption and real output in the US. Energy Sources, *Economics, Planning, and Policy,* 5(4), 400–408.

- Pindyck,. R.S. (1979). The structure of world energy demand. *Energy Policy*, 8(2), 178-179.

- Power sector at a glance all India, (2019). Ministry of Power, Government of India. Available at https://powermin.nic.in/en/content/power-sector-glanceall-India.

- R. M. Roegen, (1974), Intergenerational equity and exhaustible resources. *Review of Economic Studies, 41(5),* 29–45.

- Raju, K. N. (2007). *Industrial Energy Conservation Techniques:(concepts, Applications and Case Studies)*. Atlantic Publishers & Dist. www.atlanticbook.com,

- Ramakrishna, G. & Rena, R. (2013). An empirical analysis of energy consumption and economic growth in India: are they casually related? *STUDIA OECONOMICA*, 58(2), 22-40. http://hdl.handle.net/10566/1070.

- Ramazan Zari et al, (2007). Disaggregate energy consumption and industrial output in the united states, *Energy policy*, 35(2), 1274-1281.

- Ray, S. (2011). Measuring energy intensity in selected manufacturing industries in India. *Journal of Energy Technologies and Policy, 1 (1),* 31-45.

- Reddy, B.S., & Ray, B.K. (2008). Understanding industrial energy use: Physical energy intensity changes in Indian manufacturing sector",*Indira Gandhi Institute of Development Research, Mumbai*. http://www.igidr.ac.in/pdf/publication.
- Rena, G., & Ramakrishna, R. (2013). An empirical analysis of energy consumption and economic growth in India: are they casually related? *Study of Economica*, 58(2), 22-40.
- Roegen, R. M. (1974). Intergenerational equity and exhaustible resources. *Review of Economic Studies 41: Symposium on the Economics of Exhaustible Resources*, 29–46.
- Sajal, G. (2002). Electricity consumption and economic growth in India. *Energy Policy* 30, 125-129.
- Samhouri, M. (2009). Electricity consumption in the industrial sector of Jordan: Application of multivariate Linear Regression and Adaptive Neuro-Fuzzy techniques, *Jordan journal of mechanical and industrial engineering*, 3, 69-76.
- Sankaran, A., Kumar, S., K, A., & Das, M. (2019). Estimating the causal relationship between electricity consumption and industrial output: ARDL bounds and Toda-Yamamoto approaches for ten late industrialized countries. *Heliyon*, *5*(6). https://doi.org/10.1016/j.heliyon.2019.e01904.
- Sari,R. & Soytas, U.,(2003). Energy consumption and GDP: causality relationship in G-7 and emerging markets. *Energy Economics*, 25(1), 33–37.
- Seema, N, Thai-Ha Le, Badri, N. R., & Nadia, D. (2019). Petroleum consumption and economic growth relationship: Evidence from the Indian states, *Asia-Pacific Sustainable Development Journal*, *Energy*, 26(1), 134-144.
- Singh K. and Vashishta (2020). Does any relationship between energy consumption and economic growth exist in India? A Var-Model analysis, *OPEC Energy Reviews*, 44(3), 334-347.
- Singh, K., & Vashishtha, S. (2020). A Performance Analysis of Power Distribution Utilities of Haryana. *Asian Basic and Applied Research Journal*, *2*(1), 13-19. Retrieved from https://globalpresshub.com/index.php/ABAARJ/article/view/833.
- Tas, F., Ustuner, Z., Can, G., Eralp, Y., Camlica, H., Basaran, M., ... & Topuz, E. (2005). The prevalence and determinants of the use of complementary and alternative medicine in adult Turkish cancer patients. *Acta Oncologica*, *44*(2), 161-167.
- TERI. (The Energy Research Institute, 2018).
- The Club of Rome on energy studies.

- Tirwaria. A. K., Leena Mary. E., and Nair. S. R. (2021). Electricity consumption and economic growth at the state and sectoral level in India: Evidence using heterogeneous panel data methods, *Energy Economics,* 94(C), 105064. In earlier file it is Tiwari

- Tsani, S. Z. (2010). Energy consumption and economic growth: A causality analysis for Greece. *Energy Economics*, *32*(3), 582-590.

- Tyner, & Wallace E, (1978). Energy Resources and Economic Development in India. *Allied Publishers,* Delhi, 1978

- Vidyarthi, H. (2013). Energy consumption, carbon emissions and economic growth in India, *World Journal of Science, Technology and Sustainable Development,* 10(4), 278-287. https://doi.org/10.1108/WJSTSD-07-2013-0024.

- Vikas Khare, (2013). Status of solar wind renewable energy in India Renewable and Sustainable Energy Reviews.

- Wang, L.W., Le, K.D., Nguyen, T.D. (2019). Assessment of the Energy Efficiency Improvement of Twenty-Five Countries: A DEA Approach. *Energies*, 12, 1535.

- Worrell, E., Laitner, J. A., Ruth, M., & Finman, H. (2003). Productivity benefits of industrial energy efficiency measures. *Energy*, *28*(11), 1081-1098.

- Xishuang Han, Xiaolong Xue, JiaojuGe, Hengqin Wu, & Chang Su. (2014). Measuring the productivity of Energy Consumption of Major Industries in China: A DEA- Based Method. Journal of Mathematical Problems in Engineering, *Hindawi Publishing Corporation,* 4,1-12.

- Y.U., Lee, A. R. Glasure, (1998). Co-integration, error correction, and the relationship between G.D.P. and energy: the case of South Korea and Singapore. *Resource and Energy Economics* 20(1), 17–25.

- Yu, E.S.H. Erol, U., (1987a). Time series analysis of the causal relationships between US energy and employment. *Resources and Energy,* 9(1), 75–89.

- Zamani, M. (2007). Energy consumption and economic activities in Iran. *Energy Economics,* 29 (6), 1135-1140.

- Zhou, Z., Xu, G., Wang, C., & Wu, J. (2019). Modeling undesirable output with a DEA approach based on an exponential transformation: An application to measure the energy efficiency of Chinese industry. *Journal of Cleaner Production*, *236*, 117717.


*********