2.1 Introduction:

Energy has multiple interactions with economy, different sectors, industry, environment, human life and many more. The previous research works on energy have tried to establish energy relations with development, standard of living, measurement of energy efficiency, eco-efficiency, energy relations with sustainable development and energy practices and managements. In the present chapter an attempt has been made to present the status of research done on energy and energy related issues. Having said this, the previous research works have been classified into five broad groups. They are:

- Reviews on Energy Policies and Programmes
- Reviews on Energy Practices, Management, Methods and Energy Security
- Reviews on Energy and Development
- Reviews on Environmental Issues, Eco-efficiency and Sustainability
- Reviews on Energy Efficiency

2.2 Reviews on Energy Policies and Programmes:

Energy practices, methods, management, efficiency, eco-efficiency have largely been influenced by energy policies and programmes of the government, the energy ministries, the energy departments and also by the energy providers. The research works on energy policy issues and energy programmes have been reviewed and presented below:

Howard et al., (2006) reviewed energy intensity trends for major OECD countries. The authors argue that energy efficiency improvement is an important aspect in the global energy sector. The authors stated that if there were no energy efficiency, the OECD countries would have consumed 49 per cent more energy than what was consumed in 1998. They estimated an overall reduction in the amount of energy consumption due to energy efficiency improvement. They studied various energy policies formulated in Japan, the United States of America (U.S.), California and Western Europe. They have also studied various programmes adopted in Japan, the U.S. California and Western Europe. The authors have critically evaluated the efficacy of energy efficiency policies. The authors have found that nine well designed
energy policies reduced primary energy use by 11 per cent in the U.S. The authors, from their studies, found that the implementation of various energy efficiency policies have resulted in energy saving in Japan and some European countries (Howard, Philip, Arthur, Satoshi, & Fridtjof, 2006).

Kathrina et al., (2011) have examined various energy related issues such as climate change, global warming and etc. The authors argue that the rising prices of energy, climate change, global warming and ecological awareness of the people have forced governments and industrial concerns to adopt energy efficiency measures in the manufacturing process. They have found that governments and industrial concerns all over the world are keen to implement measures to increase energy efficiency in the production process. The studies revealed that various problems are involved in the adoption of energy efficiency measures by the industrial concerns. The authors, from their study, found that there is a gap between solution and actual implementation of energy efficiency policies by industries in their production process (Katharina, Matthias, Schonsleben, Marc, & Franc, 2011).

Kanako (2011) has examined 300 policies and about 500 measures. These policies and measures were implemented in International Energy Agency (IEA) countries like Brazil, India, South Africa, etc. The author has explained features and incidence of various policies which were undertaken for increasing energy efficiency. The author has also described the relationship of a measure, with its technical actions in industries. The author has reiterated that energy efficiency measures have the potential to reduce Carbon Dioxide (CO₂). The author argues that the energy efficiency measures are cost effective. The energy efficiency measures benefit the society at large. The study revealed that the adoption of energy efficiency in IEA countries have reduced the energy cost(Kanako, Tanaka, 2011).

Yasir et al., (2013) have examined various programmes undertaken for promoting renewable energy sources in countries such as the US, Germany, France, China, etc. But, the authors have focused on Germany. They found that Germany started enacting laws for the promotion of renewable energy sources after 1990. The Renewable energy act is an important energy act which was enacted in order to promote renewable energy sources in Germany. The act came into existence on 1April, 2000. As per the act, the people in Germany could install photovoltaic
modules and turbines and thereby generate electricity which could be fed into the national power grid. Under the act, the people are entitled for payments for 20 years in Germany. The authors came across a market incentive programmes for promoting solar energy on buildings in Germany. The Government of Germany has exempted large scale solar systems from VAT. They argue that the power generated from the renewable sources increases availability of electricity. They have also found that the power generated from the renewable sources has reduced the price of electricity in Germany. The authors have confirmed that the economic benefits of support programs of renewable energies are more than their costs. The authors have concluded that the programmes adopted for promoting renewable energy sources have avoided about 70 million tons of CO₂ emissions in 2009 (Yasir, Noureddine, & Mohamed, 2013).

Meredith et al., (2015) have made an attempt to provide field evidence on the returns from the energy efficiency investments made in the US. The authors have evaluated Weatherization Assistance Programme (WAP). It was an energy efficiency programme. Under the WAP, more than 7 million low income households have been considered for weatherization assistance since 1976. The authors have collected a sample of 30,000 Michigan households, who were the recipients of WAP. They found that the benefits of energy efficiency programme are substantially less than the investment costs. The findings showed that the investment costs on energy efficiency programs are about 2.5 times than actual savings. They argue that there exists energy efficiency gap. The authors have concluded that the energy efficiency programs benefited the society a lot. The investments on energy efficiency programmes have reduced greenhouse gas and CO₂ (Meredith, Michael, & Catherine, 2015).

Massimo and Lester (2015) made an attempt to measure energy efficiency based on economic foundations. The authors argue that policy makers cannot rely upon energy intensity for the measurement of energy efficiency. They found that the previous studies have not discussed theoretical basis for measuring energy efficiency. The studies have also revealed that the previous works did provide any explanation on parametric empirical approaches for measuring the level of energy efficiency. The authors have tried to measure energy efficiency from an economic perspective (Massimo & Lester, 2015).
Premakumara and Praveen (2016) have tried to analyze energy inclusiveness in the growth process of Karnataka. The authors have used cross section secondary data from 2011 census. The radar has been used for presenting district level data. The dummy variable regression models have also been used. They found that firewood and LPG are the main sources of energy for cooking in rural and urban Karnataka, respectively. The studies also revealed that there are a wide range of disparities in the availability and use of firewood and LPG in rural Karnataka and urban Karnataka, respectively. The use of energy for cooking is not eco-efficient in both rural and urban Karnataka. The authors have suggested that the government should restrict the use of firewood in rural Karnataka. They recommended that the government should promote LPG or biogas in the rural Karnataka. The authors proposed that the governments should also prohibit the use of kerosene in urban Karnataka. The authors have also suggested that the government should take measures for promoting solar energy or LPG for cooking in urban Karnataka (Premakumara; Praveen, Saldanha, 2016).

2.3 Reviews on Energy Practices, Managements, Methods and Energy Security:

It has been found from the larger and broad spectrum of energy studies that different countries have followed different energy practices in production, transfer and consumption of energy. The energy management practices differ from country to country depending on the availability of energy, state of development and other factors. The previous studies on energy show that various methods have been developed by the researchers to capture various energy dimensions. It is also found from the previous studies on energy that different techniques were employed to measure the energy security. In the following section, the research works on energy practices, management, methods and energy security have been reviewed and presented below:

Joachim (2009) carried out a sample survey in commercial and service sector to identify the barriers to energy efficiency in Germany. The author evaluated the relevance of various types of barriers to energy efficiency in sectors and sub sectors in Germany. The study results revealed that there are a large number of barriers to energy efficiency in commercial and service sector in Germany. The author has found various barriers to energy efficiency. They are: lack of information about energy consumption, lack of information about energy efficiency measures, and user or
 investor’s dilemma. The author has also found that large number sectors do have only a few barriers to energy efficiency. The author argues that a number of barriers to energy efficiency exist in German public administration. The author has concluded that organizations have not given priority to barriers to energy efficiency (Joachim, 2009).

Guang-Ming et al., (2010) have made an attempt to measure energy efficiency in Chinese industries. The authors have examined maximum energy potential in 28 regions in China. The results revealed that industries in the east area of China have the best average energy efficiency in 2000-2006. The study has identified two factors responsible for the wastage of a large amount of energy during production process in Chinese industries. They are: (i) The industrial structure heavily relies upon large amount of energy in China, and (ii) The Industrial Energy Efficiency and Pure Technical Efficiency (IEPTE) is very low in China. The authors have proposed various measures and policies to improve regional energy efficiency in China (Guang-Ming, Jun, & Jin-Nan, 2010).

Benjamin and Ishani (2011) have combined literature on energy security into condensable form. The authors have compiled data from literature review. They have also conducted semi-structured research with global energy experts. They used a modified Delphi Method. The Surveys and intensive focused workshops were also conducted by the authors. The authors argue that the energy security is a multi-dimensional concept. The authors opine that energy security comprises of five dimensions. They are: availability, affordability, technological development, sustainability and regulation. Further, the authors have divided the five dimensions into 20 components. The components are related to security of supply and production, dependency, and diversification for availability. The authors have developed 320 simple and 20 complex indicators for the measurement of energy security (Benjamin & Ishani, 2011).

Trianni and Cango (2012) have identified the most important barriers which restricted the adoption of the Best Available Technologies and Practices (BATP) in 128 in Small Scale Enterprises (SMEs) in North Italy. The authors have examined 128 non-energy intensive manufacturing, small and medium sizes industries in north Italy. The study revealed that all SMEs should not be put together for identifying the
barriers to energy efficiency. The authors argue that different SMEs have different barriers to energy efficiency. The barriers to energy efficiency vary from size to size and also from sector to sector. The authors have analyzed the effect of barriers on decision making. The authors have suggested further research in the field of energy for identification of barriers in increasing energy efficiency (Trianni & Cango, 2012).

Seyithan and Numan (2012) have examined energy management practices adopted by industries in Turkey. The authors have listed out various barriers which come in the way of adopting energy management practice in Turkish industries. They carried out questionnaire method on iron and steel, ceramics, and cement industries in Turkey. Their survey revealed that 22 per cent of Turkish industries on whom survey was conducted have not adopted energy management practices. The authors have found out the most important barriers for the energy management practices in Turkish industries. They are: inadequate awareness, lack of financial support for energy management practice, lack of cooperation between industrialists and the government. The authors have suggested various measures for the effective energy management practices in Turkish industries. They are: restructuring and strengthening legal and institutional framework, promotion of energy efficiency, provision of education and training etc (Seyithan & Numan, 2012).

Fernandez et al., (2013) have made an attempt to analyze the growth of real energy efficiency in European Union (EU). The authors have also examined the percent change of real energy efficiency in various countries of EU. They have relied upon a multiplicative energy intensity approach for the analysis. The authors have decomposed change in aggregate energy intensity in 20 countries of the EU. They carried out a comparative analysis of real energy intensity in different sectors of the countries of the EU. They have also applied a new method to monitor the changes in energy intensity. The results revealed that former Communist European countries made sincere efforts to improve energy efficiency. The authors have suggested various ways and means to improve energy efficiency in industrial sector, hotels, restaurants, construction, (Fernandez, Gonzalez, Landaj, & Presno, 2013).

Fernandez and Gonzalez (2015) have examined the influence of changes in sectoral composition on aggregate energy intensity in most European Union (EU) economies. The authors have developed and applied a new approach based on the
Index Decomposition Analysis (IDA) to estimate the contribution of each sector to the percent change in structural factors. The study results revealed that (i) intensity factor is more influential, (ii) structural change has positive influence on energy intensity in Ex-communist countries, and (iii) the industrial sector strongly and negatively contributed to the changes in energy intensity in EU economies, particularly in western countries. The authors have concluded that the adaption of efficient technology, innovation, and policies would accelerate transition processes in communist countries. (Fernandez & Gonzalez, 2015).

Premakumara (2017) has theoretically and empirically estimated energy security in India. The author has confined his studies to India only. The author has defined energy security in highly developed and less developed countries. The author defined energy security in highly developed countries as “a resilient energy system with uninterrupted availability of energy sources at an affordable price”. The author defined energy security in less developed countries as “it is an access to modern energy sources”. The author argues that energy security system varies from country to country depending upon level of economic development and scope of the energy security system. The author has used secondary time series data for analysis. The author has calculated Compound Annual Growth Rate (CAGR) of energy sources. The author has used four dimensions to measure energy security. They are: primary energy mix, status of energy demand, energy dependency and environmental sustainability. The results revealed that the energy security has weakened in India over the period of time. The study results also revealed that energy demand is rising. It is more dependent on imported energy sources in India. It has also been found from the study that India has failed to develop the clean energy sources. Consequently, India failed to mitigate CO₂ emissions to meet Kyoto and Doha agreements. The author has concluded that the clean energy plays a vital and critical role in the sustainable development of India (Premakumara, 2017).

Premakumara and Adil (2017) have examined that how energy consumption would change with the level of income and level of energy efficiency. The authors have used secondary time series data for 48 countries for the period 1987-2015. The structural ANOVA dummy regression models have been used for estimating structural changes. It has been found from the analysis that the structural change has significant impact on the level of per capita income, the level of gross domestic
product, the level of energy consumption, and the level of energy efficiency. The study revealed that as a country moves from lower structure to higher structure, per capita income, gross domestic product, energy consumption, and energy efficiency would increase. They concluded that the structural change and energy efficiency are closely related (Premakumara & Adil, 2017).

2.4 Reviews on Energy and Development:

Most of the early works on energy have tried to establish the relationship of energy with development. The various energy studies have used different methods such as regression analysis, Granger analysis, Co-integration analysis, Input-Output analysis, etc. Most of the previous studies on energy have proved uni-directional, bi-directional, multi-level and stable long-run stable relationship between energy and economic development. The following section presents the previous research works on energy and economic development.

Abul et al., (1997) have made an attempt to examine the Granger causality test. The authors have used the Johansen multiple co-integrations between total energy consumption, real income and price level for the analysis. The application of Johansen co-integration test proved the relationship between energy consumption and price level in East-Asian New Industrialised Countries (NICs), namely, Korea and Taiwan. It has been found from the studies that there is unidirectional causality from price level to energy consumption. The vector error correction models have also been used for the analysis. The authors have also found the direction of Granger causality either Granger exogenity or endogenity of each of the variables. The strength of causality has also been measured. The results indicated that all three variables are integrated and mutually related to each other. The authors have concluded that price change leads to a change in energy consumption. The change in energy consumption brings about a further change in economic growth in highly energy dependent East-Asian NICs – Korea and Taiwan (Abul & Rumi, 1997).

Asafu-Adjaye (2000) has made an attempt to establish the causal relationship between energy consumption and economic growth in Asian countries such as India, Indonesia, Thailand and Phillipines. The author has applied co-integration techniques and vector error corrects models for analysis. The author has examined the causal
relationship between energy use and economic growth. It has been found from the study results that the unidirectional granger causality runs from energy to income in India and Indonesia in the short run. The study also revealed that the bidirectional granger causality runs from energy to income in Thailand and Phillipines. It has also been found that energy, income and prices are mutually related to each other in Phillipines and Thailand. However, the author has failed to explain the causes responsible for the neutrality between energy and income in Thailand and Phillipines in the short run (Asafu-Adjaye, 2000).

Ernst et al., (2003) have made an attempt to estimate the relationship between energy efficiency improvement measures and productivity in industries. The authors have carried out 70 industrial case studies to establish the relationship between energy efficiency measures and productivity in industries in the US. The authors have developed a method of economic assessment of productivity benefits for estimating the relationship between energy efficiency improvement measures and productivity in industries. The productivity benefits arise due to the adoption of energy efficiency measures. The authors argue that investment in energy efficiency technology would enhance level of production in the industries. The authors have also opined that the adoption of energy efficiency measures provides larger opportunities for increasing the volume of production. The authors have evaluated the effect of energy efficiency in an iron and steel industry in the US. The study has proved that energy efficiency technologies are cost effective. The authors argue that the industries could reap the productivity benefits. The authors have suggested further research in the field of energy efficiency technology (Ernst, John, Michael, & Hodayath, 2003).

Song et al., (2008) have established the causal relationship between energy consumption and economic growth. The authors have applied linear and nonlinear Granger causality tests to estimate causal relationship between energy use and economic growth. The authors have used the US and Asian Newly Industrialized Countries (NICs) as samples for the analysis. It has been found from the studies that the neutrality hypothesis holds good for the US, Thailand and South Korea. The study results revealed that unidirectional causality is running from economic growth to energy consumption in Philippines and Singapore. The authors have also found that energy consumption has affected economic growth in Taiwan, Hong-Kong, Malaysia and Indonesia. The authors have proposed further research in the field to prove and
strengthen the relationship between energy consumption and economic growth (Song, Ching-Fu, & Zhen, 2008)

Mounir (2009) has examined the causal relationship between per capita energy consumption and gross domestic product in Tunisia. The author applied the Johansen co-integration models to establish the causal relationship between per capita energy consumption and per capita gross domestic product from 1974 to 2004. The author has also used vector error correction models to find out Granger causality. The results revealed that in the long-run, the bidirectional causality between per capita energy consumption and gross domestic product. It has also been found that the causality runs from energy to gross domestic product in the short run. The author argues that per capita energy consumption and gross domestic product cause short term disturbances. It has also been found that energy and gross domestic product correct short term disturbances in the long-run relationship. The author opines that there is bidirectional causality between the per capita energy consumption and gross domestic product in Tunisia. The author has concluded that energy is an important factor in the growth of gross domestic product (Mounir, 2009).

Mathew and Rukmini (2010) have made an attempt to establish the causal relationship between energy consumption and economic growth in New Zealand. The authors have applied tri-variate demand and multi-variate production models to prove the relationship between energy consumption and economic growth. The study has proved the long-run relationship between energy consumption and economic growth. The authors argue that energy demand is derived demand and it depends on energy prices. The study has also revealed short run causality running from capital to energy consumption. It has also been found from the study that the energy demand is determined by economic activities in New Zealand (Matthew & Rukmini, 2010).

Stern (2010) in article entitled “The Role of Energy in Economic Growth” has made an attempt to explain the role of energy in the process of production. The author argues that the various models in economics do not pay attention to energy. The author stated that scarcity of energy retards economic growth. The author has considered energy as a factor of production. The author has applied unified models of energy and growth. The author has empirically tested the casual relationship between energy and growth. The author has found that production is a function of capital,
labour and energy. The author has also found that the elasticity of substitution between energy and capital is very low (Stern, 2010).

Nicholas and James (2011) have examined the causal relationship between electricity use and economic growth in 88 countries. The authors have divided panel of 88 countries into four groups as per the world development report (WDR). They are: high income countries, upper middle income countries, lower middle income countries and low income countries. The authors have used data over the period of 1999-2006. The authors have applied vector error correction models. It has been found from the study results that (i) The bidirectional causality exists between electricity consumption and economic growth in both the short and long-run in the high and upper middle income countries. (ii) The unidirectional causality runs from electricity consumption to economic growth in the short run in the lower middle income countries. (iii) The bidirectional causality exists between electricity consumption and economic growth in the long-run in the lower middle income countries. (iii) The unidirectional causality runs from electricity consumption to economic growth in the low income countries (Nicholas & James, 2011).

Ali and Koray (2012) have made an effort to analyze Granger causality between GDP and energy in panel of 79 countries. The authors assumed that all panel countries are homogeneous. They used the data for 1980-2007. They also examined Granger causality between GDP and energy in panel countries which are heterogeneous. They examined 4 different types of causal relationships. They are: Homogeneous non-causality, Homogeneous causality, Heterogeneous non-causality, and Heterogeneous causality. The study results revealed that bi-directional causality exists in seven-tenth countries, unidirectional Granger causality exists in one-tenth countries, and no Granger causality in two-tenth countries (Ali & Koray, 2012).

Robina and Mark (2013) have reexamined the causal relationship between per capita energy use and gross domestic product in 30 OECD countries. The authors have analyzed the relationship between energy use and GDP by using Co-integration, Vector Error Correction Models. The study revealed that the bidirectional causal relationship between energy use and GDP in the very short-run. The strong unidirectional causality running from capital formation and GDP to energy use has also been found. The authors have also identified reverse causality between GDP and
energy use in the long-run. They have also applied slightly different model for Engle-Granger two step procedures. The authors have found the causal relationship between per capita energy use and GDP. The authors have concluded that the policies and programmes adopted for reducing the use of energy do not have negative impact on economic development in the very short run. The authors have also concluded that the measures initiated for increasing energy efficiency do not have negative impact on the economic development in the very short run (Robin & Mark, 2013).

Olivier and Majda (2013) have empirically examined correlation between energy consumption and economic growth in 12 oil exporting countries from 1990 to 2010. The authors used econometric techniques to analyze the relationship between energy consumption and economic growth. The results showed that the long-run relationship exists between energy consumption and economic growth. The Vector Error Correction Model proved unidirectional causality from energy consumption to economic growth in the short-run. The reserve causality from economic growth to energy consumption in the long-run has also been found (Olivier & Majda, 2013).

Wang et al., (2013) have analyzed scenario based energy efficiency based productivity in China. The authors have applied non-radial directional distance function for estimating energy efficiency and productivity. They have included CO₂ emissions as an undesirable output. They used three production scenarios for the analysis. They are: energy conservation (EC), energy conservation and emission reduction (ECER), and energy conservation, emission reduction and economic growth (ECERE). The study results revealed that energy efficiency and productivity vary under different production scenarios. The authors have summarized that the technological change has resulted in many fold increase in productivity in China. The energy efficiency improvement has also increased productivity in China (Wang, Zhou, & Zhou, 2013).

Gregory et al., (2013) have conducted a study in the energy sector in Malawi. The authors have stated that the energy sector in Malawi is in deserted condition. The energy sector did not contribute much to the economic development of Malawi. The energy supply in the country is highly inefficient and not reliable. The majority of people in Malawi live in country side and depended on firewood for cooking. Malawi is rich in renewable energy sources. But, it has not made much progress in developing
renewable energy sources. The various factors such as, poverty, wrong approach, lack of political will, etc. have retarded the growth of energy sector in Malawi. It has been found from the study that less than 1 per cent of rural population has access to electricity in Malawi. It has also been found from the studies that electricity is mainly generated from diesel and gas. The authors have concluded that energy sector has not significantly contributed for the development of Malawian economy (Gregory, Liu, & Wuyuan, 2014).

Hargreaves (2013) has examined the relationships between sustainable economic growth, population growth and energy consumption. The author has used decomposition method to explain the energy relations with sustainable development. The author has explained how to achieve the goal of sustainability. It has been found from the study results that energy resources are chiefly and readily available in Australia. The study has found that chief and ready availability of energy has accelerated the growth of the Australian economy. It has also been found that initiation of various reforms in the energy sector has contributed for the growth of Australian economy. It has been found from the study that Australia is heavily dependent on fossil fuels. The per capita greenhouse emission of fossil fuels in Australia is the highest in the world. The author has suggested alternative energy policies to mitigate the highest greenhouse emission of fossil fuels. The study also found that the demand for energy increased with the growth of population in Australia. The author proposes integration of population and energy policies for sustainable growth of Australian economy (Hargreaves, 2013).

Wilson and Cosmas (2013) have made an attempt to analyze energy efficiency in Zimbabwean Industries. The authors have defined energy efficiency as economic use of energy sources. They have introduced the concept of energy audit to measure energy efficiency. They reiterated that the consumption of more energy by the society has detrimental effects. The study revealed that the acute shortage of power has affected all sectors in Zimbabwe. The authors have proposed various measures to achieve energy efficiency. The authors have recommended various measures for energy efficiency. They are: demand side management, load management, time of day pricing, energy conservation and cogeneration of energy. The authors have concluded that use of energy efficient energy products would result in energy savings (Wilson & Cosmas, 2013).
Al-Rashed and Leon (2015) have made an effort to estimate energy efficiency in OPEC countries. The authors have used period wise energy coefficients for the analysis. The study results revealed that energy coefficients had varied behaviour among the member countries of OPEC. It has been found from the study results that energy coefficients moved towards unity in the 1990s but energy coefficients settled under 1 in the 2000s. The authors have concluded that as OPEC countries grow and diversify, future demand for electricity use in household, public and commercial sectors would increase (Al-Rashed & Leon, 2015).

Dmitriy et al., (2015) have analyzed that energy efficiency and energy conservation in Russian industries. The authors have used a matrix equation for calculating and examining energy efficiency in Russian industries. The matrix equation diversifies economic system. They have also analyzed the effect of energy efficiency with consumers and industries with application of a matrix equation. The authors have argued that existence and functioning of an economy depends upon the consumption of energy. They have described the role of energy in an economy. The authors have also argued that availability of energy sources vary from country to country. The study results revealed that amount of energy consumption in the economy is determined by amount of energy consumed by the industries and enterprises(Dmitriy, Evgeny, & Valery, 2015).

Praveen and Premakumara (2017) in their study extended the argument which was made in the previous studies, i.e., there is a long-run relationship between energy and economic development. The authors have estimated the relationship between consumption of electricity and industrial income in India. They used time series data from 1972 to 2015. They applied the Johansen co-integration models for co-integration analysis. The Phillips-Perron test was also conducted to check the stationarity of data. The authors have used 5 parameters for the analysis. They are: industrial income, electricity generation, electricity availability, total consumption of electricity and industrial consumption of electricity. The results revealed that industrial income has long-run stable relationship with electricity availability, electricity generation and total electricity consumption. It has also been found that industrial electricity consumption has long-run stable relationship with the industrial income. The application of vector error correction models have proved that short run
disturbances were corrected and long-run relationships were also restored between the variables (Praveen & Premakumara, 2017).

Anitha and Premakumara (2014) have made an attempt to analyze the relationship between energy consumption in industries and GDP in India. The authors have applied the Johansen Co-integration techniques for examining the relationship between GDP and energy consumption in India. It has been found from the analysis that there is long-run stable relationship between consumption of electricity by industries and GDP in India. It has also been proved in the analysis that electricity plays a vital role in the industrial income in India. The authors have concluded that an uninterrupted supply of electricity to industries would generate more GDP in India (Anitha & Premakumara, 2014).

Premakumara (2015) has analyzed the long-run relationship between energy and economic development for selected countries of Asia. The author has used time series data from 1981 to 2010. The Johansen co-integration technique has been applied for the analysis. The study results revealed that there is long-run stable relationship between energy supply and GDP in India. It has also been found from the analysis that there is long-run stable relationship energy per capita consumption and per capita income in India. The study has proved long-run relationship between energy supply and GDP exists in Korea. The analysis has established long-run stable relationship between per capita income, energy supply and per capita energy consumption in Japan. The study has also found that energy production does not have long-run relationship with economic development in India and Japan. The study results also revealed that there is no long-run relationship between energy supply and economic development in Korea. The author has proposed the redesign of energy policies for the better economic development of Asia (Premakumara, 2015).

Praveen and Premakumara (2017) have made an effort to estimate the long-run relationship between the use of petrol in industries and industrial development in India. The authors have also analyzed environmental implications of use of petrol in industries in India. They have applied the Johansen co-integration models, vector error correction models for the analysis. They used four parameters such as, industrial income, oil availability and industrial petrol consumption and industrial petrol efficiency. The co-integration test for industrial income and oil availability revealed
that both the industrial income and oil availability are co-integrating with each other. The vector error correction model revealed that the industrial income is correcting short-term disturbances in the long-run relationship with oil availability and restores long-run relationship. The co-integration test has failed to prove long-run stable relationship between the industrial income and industrial petrol consumption. The authors have constructed impact models for estimating impact of use of petrol and industrial petrol efficiency on the industrial income. The impact model revealed that the industrial petrol efficiency is on the rise. The authors have concluded that the continuous rise in industrial petrol efficiency reduces negative impact on the environment (Praveen; Premakumara, 2017).

Ravishankar and Premakumara (2017) have made an attempt to establish the long-run relationship between energy use in agriculture and agricultural development in India. The authors have used long-run time series for the analysis. The Johansen Co-integration techniques have also been employed to establish long-term stable relationship between energy use in agriculture and agricultural development. The results revealed that agricultural income has long-run relationship with electricity generation, availability, and total consumption of electricity in India. The study revealed that short term disturbances have been corrected in one time period. The authors have also found that electricity plays a vital role in the determinant of agricultural income in India. The authors have proposed for integrating the electricity policy with agricultural policy for development of both the sectors in India (Ravishankar & Premakumara, 2017).

Mallaiah and Narasimha (2017) have analyzed the relationship between renewable energy and economic development in India. The authors have used Johansen Co-integration techniques and Fully Modified Ordinary Least Square (FMOLS) for the analysis. The study results revealed that there is an inverse relationship between renewable energy consumption and economic growth. It has been found from the calculation of long-run output elasticities that inputs such as, labour and capital play a vital role in the process of economic development. The authors have argued that investment on renewable energy not only reduces dependence on fossil fuels but also mitigates CO₂ emission. The authors have proposed that the policy makers should ensure sustainable development by implementing appropriate energy policies (Mallaiah & Narasimha, 2017).
2.5 Reviews on Environmental Issues, Eco-efficiency and Sustainability:

Energy and environment are related. It is clean energy which ensures sustainable development. Environmental concerns have largely been discussed in the academic world in recent years. Energy should not only be efficient, it should also be eco-efficient to have sustainable green growth. In this context, the following reviews have been presented related to energy, eco-efficiency, sustainability and green growth.

Hertwich (2005) has examined the impact of the rebound effect from the industrial ecology perspective. The author states that measures taken to protect the environment have many unintended effects on the society. The rebound effect encompasses both behaviour and the system responses to cost reductions of energy services due to energy efficiency measures. The author argues that changed behaviour may offset the environmental gain. The author concludes that the rebound effect is not properly focused and it has to be extended to cover co-benefits, negative side benefits and spillover benefits (Edgar, 2005).

Worrell et al., (2005) state that the largest refining capacity is in the US. The US possesses less than a quarter of all crude oil in the world. The cost on energy is a major factor for the US petroleum refineries. The US petroleum refineries spend 50 per cent of cost on energy consumption. The study has revealed that the US petroleum refineries have ample opportunities to reduce cost on energy consumption without sacrificing the quality of the product. The petroleum refineries in the US can contact ‘Energy Star’ for providing additional energy management tools. The authors suggested that further research in the field is needed for the assessment of feasibility of implementation of selected technologies at individual plants (Worrell, Ernst, Galitsky, & Christina, 2005).

Robert et al., (2007) have analyzed the role of energy in economic development and argued that energy efficiency leads to economic growth, and energy efficiency reduces greenhouse gas emissions. The authors argue that policy recommendations for increasing energy cost by imposing carbon tax for attaining sustainability are ineffective and have adverse impact on economic growth. The authors have also argued that the strategy for reducing greenhouse gas and achieving
technology driven economic growth does not require a drastic new technology, but rather improved technology or more precisely better deregulation of the electric power sector (Robert, Hal, & Tom, 2007).

Nick et al., (2009) have applied computable general equilibrium model of Scotland to identify the theoretical conditions under which rebound and backfire effects would occur. The authors have found that general energy efficiency in Scottish production sector has initially resulted in rebound effect which eventually turned into backfire effect. The production sector in Scotland uses more energy on account of energy efficiency gain. The ratio of GDP to CO₂ emissions declined in the Scottish production sector. The study revealed that the economic factors responsible for rebound effect. The authors argue that energy efficiency reduces the energy price which in turn would lead to income effect which ultimately increases the demand for energy. The authors have recommended coordinated portfolio of energy policies for environmental improvements (Nick, Peter, Kim, & Karen, 2009).

Ernst et al., (2009) have stated that industrial sector causes 37 percent of global greenhouse gas emissions, out of which 80 percent is due to energy use in the industries. The authors argue that the adoption of energy efficiency technologies and policies play an important role in mitigating industrial greenhouse gas emissions up to 2030. They estimated that the energy intensive industries such as iron and steel, chemical and fertilizers, cement, pulp and paper, petroleum refining industries, etc. are largely responsible for global greenhouse gas emission and CO₂ (Ernst, Lenny, Joyashree, Lynn, & Jochen, 2009).

Shuangzhen and Xiaochum (2012) have elaborately proposed various ways and means for energy efficiency improvement and sustainable development in cement industries in China. The authors argue that cement industry is one of the five most energy intensive industries in the world. The cement production is responsible for 5 per cent human made CO₂ emission. They suggested for replacement of Shaft Kilns by New Suspension Pre-heaters (NSP), as they are energy efficient. They also recommended the adoption of Organic Rankine Cycle (ORC) and KalineCycle (KC) for Waste Heat Recovery (WHR). They proposed that coal fly ash could replace cement in the construction industries. The authors have suggested future studies in CO₂ capture and fly ash recycles (Shuangzhen & Xiaochun, 2012).
Shouquat et al., (2013) developed a statistical model for producing hydrogen through water electrolysis using wind energy. The authors argue that wind energy is one of the renewable energies and it is clean. It is available freely and abundantly. The study found that a few countries like Denmark, India, etc. have explored the wind energy to the maximum. The study also revealed that the wind energy is not most efficiently used in most of the countries world over. The authors have insisted for developing a statistical model to gather the information on the direction and speed of wind to generate energy. They suggested that, based on the direction and speed of wind, the windmills could be installed to maximize utilization of freely available wind energy for development of environmental friendly, eco-efficient energy system (Md. Shouquat, Adarsh, Moshin, Jeyraj, Ali, & Kazi Enamul, 2013).

Nadia and Nicola (2015) stated that energy efficiency improvements mitigate green gas emissions. The authors have estimated that 30 per cent of energy is consumed by the household sector in most of the OECD countries which leads to CO₂ emission. They argued that households play a decisive role in lessening green gas emissions. They are of the opinion that the socio-economic characteristics of households play an important role in the adoption of technology. The information pertains to cost and benefits of energy, amount of energy use, returns from the energy efficiency measures, etc. affect the adoption of energy efficiency technology. The authors have used Bayesian Model Averaging (BMA) for estimation. They found that tenants are not more interested than the owners in energy efficiency improvements. They suggest that direct subsidies, rebate, credit, etc. should be given to low income households so as to enable them to invest in energy efficiency improvement (Nadia & Nicola, 2015).

Praveen and Premakumara (2017) in their study made an effort to estimate the impact of eco-efficient energy on sustainable development in south Asian countries. The authors have used secondary time series data on energy parameters. They have also used econometric techniques and impact models for their analysis. They found that energy intensity in South Asian countries has increased over the years. The results revealed that the shares of renewable energy and renewable electricity in total energy have declined. The authors have proposed for restructuring energy policies in South Asian countries in order to attain sustainable development and green growth. They
argue that sustainable development and green growth in the economy depend upon the use of eco-efficient green energy (Praveen & Premakumara, 2017).

Saba (2017) has attempted to study the causal relationship between GDP, energy use and carbon emissions. The author has used time series data over the period 1971-2013. The GDP has been treated as an indicator of economic growth in the analysis. The author has defined the relationship between environment degradation and economic growth as inverted U-shaped environment Kuznets curve. The author has used the standard EKC regression model in the analysis. The Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) unit root tests have also been applied in the study. The Co-integration test results indicate that there is a long-run relationship among economic growth, energy use and CO2 emissions. The estimated results of expectation hypothesis indicate that CO2 emissions increase in the early stages of economic growth, but tend to reverse beyond certain levels of income per capita. The estimated results in aggregate terms reveal that CO2 emissions is elastic with energy consumption, in which a 1 per cent increase in energy consumption will increase CO2 emissions by 1.58 per cent and 1.24 per cent in India and China respectively. The results in per capita terms, also reveal that CO2 emissions is elastic with energy consumption, in which 1 per cent increase in energy consumption per capita will increase CO2 emissions per capita by 2.30 per cent and 1.32 per cent in India and China respectively. The Granger Causality Test results indicate unidirectional causality running from energy use to GDP growth in the case of India while reverse is true in case of China, i.e. a unidirectional causality from GDP growth to energy use. The author recommends for switching over to less carbon-intensive fossil fuels. Furthermore, the study also suggests that developed countries must share technology with India and China to produce clean energy (Saba, 2017).

Premakumara and Govias (2017) have estimated the green growth in Indian industries. The time series data from 1991 to 2015 have been used by the authors. They checked the stationarity of data. The results revealed that the industrial income in India is relatively green, clean and also eco-efficient. The growth of manufacturing sector in India is relatively green, clean but not eco-efficient. They argue that the process of green growth in India is not absolute and significant. They summarize by
Sarkar (2017) has analyzed energy and emission intensity of thermal power plants. The authors have chosen four thermal power plants in West Bengal, namely, Bandel Thermal Power Station (BTPS), Budge-Budge Generating Station (BBGS), Titagagarh Generating Station (TGS), and Kolaghat Thermal Power Station (KTPS). The authors have considered adjacent area of above said power plants, as the catchment zone of their study. The other zone which lies outside the catchment zone were was considered by the author as control area. The author has obtained data for the analysis through a field survey, based on contingent valuation method (CVM) questionnaire, within a 10 km radius for catchment area and between 15 and 20 km radius for control area. The author has collected data on respiratory illness directly from the field study. Data have also been collected to get an estimate about medical expenses for illness. The author has also collected data from the field survey based on the framed questionnaire, for calculating the work day loss due to illness caused by air pollution, and victim’s willingness to pay for a cleaner environment, in monetary terms. The results of the study revealed that fly ash causes a detrimental effect on income of individuals who resides in the vicinity of thermal power plant. The results also revealed that not only loss of income is much higher for those who reside near the thermal power plant, but also the social cost in terms of annual loss of income only for illness caused by emission from thermal power plants is huge. The author has insisted that proper measures should be taken to check the release of toxins from the ash pond and subsequent mixing with the ground water. The author has also suggested for the establishment of thermal power plants far away from populated area (Mriganka, 2017).

2.6 Reviews on Energy Efficiency:

Energy efficiency refers to use of less energy to produce more. There is an inverse relationship between use of energy and energy efficiency. Reducing the use of energy and decrease in the energy intensity leads to energy efficiency. The energy efficiency is different in different countries, sectors and processes. Accordingly, energy efficiency has been determined by number of factors. The economic
development, structure of the economy, technology, income, energy policy, environmental regulations etc., determine energy efficiency. In this context, the following reviews have been presented related to energy efficiency.

Patterson (1996) had made an attempt to review a wide range of energy efficiency indicators. The author argues that physical thermo dynamic indicators of energy efficiency are more useful, but are restrictive as thermo dynamic indicators of energy efficiency. The author had stated that economic thermo dynamic indicators of energy efficiency indicators are more useful at the macro level planning. The author has found a large number of problems in the usage of economic thermo dynamic indicators of energy efficiency indicators. The author concludes by stating that the thermo dynamic indicators of energy efficiency have limited application at the macro level of planning (Patterson, 1996).

Howrath (1997) has made an effort to examine the hypothesis that energy efficiency improvements lead to more energy use in the long-run. The author applies a very simple model which separates role of energy and energy services in the production process. The results revealed that improved energy efficiency would not result in more energy use provided two conditions are fulfilled. They are: (i) if costs of energy dominate the total cost of energy services, and (ii) if energy services expenditure has a major share of economic activity. The author argues that both the assumptions empirically not reasonable. The author concludes by stating that energy efficiency improvements would result in energy reductions in the long-run under the assumptions of the model (Richard, 1997).

Adam et al., (1999) have argued that the factors such as population, energy use per capita, economic activity, etc. are responsible for greenhouse gas emission. According to the authors, the focus on technological improvements goes a long way in limiting carbon emissions. The substitution of fossil fuels by renewable energy sources reduces carbon intensity of energy. In addition, they suggest a large number of measures for reducing carbon intensity of energy. They are: tax credits for those who buy new energy efficient homes, electrical or natural gas pumps, water heaters, tax credits for fuel efficient vehicles, spending on R & D, etc. The public and private partnerships have also been proposed for the purpose of developing and using energy
efficient technologies. The authors have opined that the market barriers prevent the firms to adopt energy efficiency technologies (Adam, Richard, & Robert, 1999).

Einstein et al., (2001) stated that steam systems are used in the almost all the U.S. industries. The authors have estimated that 37 per cent of fossil fuel is burned in the U.S. industries to produce steam. The steam is used in the U.S. industries to distill liquids, etc. It is also used directly as feedstock. They stated that there are ample opportunities for undertaking energy efficiency measures in the U.S. industries. The energy efficiency measures would reduce CO₂ and greenhouse gas emission (Einstein, Dan, Ernst, & Marta, 2001).

Boyd (2005) had used a stochastic frontier regression for measuring energy gap between average and best practice in energy use. The parametric or statistical approach is the best practice measure for measuring energy gap at a plant or company, or all industry level. The author has used plant-level data and applied a stochastic frontier regression analysis to measure energy intensity. But, the Census Bureau, the Argonne National Laboratory, and the sponsoring agency did not agree with the research results obtained by the author (Boyd, 2005).

Ang (2006) has stated that the 1973 oil crisis had forced many countries of the world over to develop various energy efficiency indicators. The author has also stated that monitoring trends in energy efficiency has become one of the most important components of energy strategy. The author examined various classical indicators used for measuring energy efficiency in various energy studies. The author has used Index Decomposition Analysis (IDA) for measuring economy-wide energy efficiency. The IDA is based on bottom-up approach. The author argued that the IDA is superior to classical indicators that were used for measuring economy-wide energy efficiency (Ang, 2006).

Kanako (2008) in the study on energy efficiency has explained various ways to find out, whether energy is efficiently or inefficiently used in industries, companies or countries. The author has defined measures of energy efficiency performance as “ways of generating certain indices to express those efficiencies are called measures of energy efficiency performance (MEEP)”. The indices are: thermal energy efficiency of equipment, energy consumption intensity, absolute amount of energy consumption, and diffusion rates of energy efficient facilities. The advantages and
disadvantages of each and every index were explained by the author. The author has also suggested certain criteria which the policy makers should consider while adopting measures of energy efficiency performance. They are: reliability, feasibility, and verifiability. The author has carried out a case study on Japan’s iron and steel industry for the critical assessment of energy efficiency in industry (Kanako, 2008).

Mckane et al., (2008) have stated that more opportunities for energy improvement do exist in the U.S and the U.K. industries. The authors have opined that a large number of the U.S. industries neither know, nor motivated to save energy. The authors also opined that the U.S. industries can earn profits by managing energy. They stated that producers, suppliers, etc. lack knowledge to undertake various measures for achieving energy efficiency. The authors argued that the plant engineers play an important role in energy saving. The authors have recommended various measures for energy efficiency improvements in the U. S. industries. They are: Superior Energy Performance (SEP), the concept of Partner Plants (PP) and Certified Plants (CP). The adoption of these measures has resulted in achieving energy efficiency improvement in the U. S. industries which have supply chain world over (Mckane, Aimee, Paul, & Robert, 2008).

Zhou and Ang (2008) have estimated energy efficiency performance in 21 OECD countries. The authors applied Data Envelopment Analysis (DEA) for estimating energy efficiency performance. They included both desirable and undesirable outputs in their DEA models. The results revealed that energy consumption changes due to economic activity and energy intensity (Zhou & Ang, 2008).

Kankana (2010) argued that attainment of energy efficiency has become very vital for India. The author has estimated energy efficiency in Indian manufacturing sector. The author has used directional distance function to measure performance of major manufacturing states in India, when they have joint goals such as, conservation of energy and output growth. The results revealed that improvement of energy efficiency in manufacturing firms could reduce energy consumption and increase output by an annual average of 3.84 per cent (Kankana, 2010).

Gale and Joseph (2010) made an effort to estimate industrial productivity benefits due to energy efficiency in the two segments of glass industry. The authors
used plant level data for the analysis. The regression analysis was applied for estimating energy use per unit of production. The results revealed that the co-efficient for energy efficiency is statistically significant. The authors have concluded that there is a relationship between productivity and energy efficiency (Gale & Joseph, 2010).

Jenny and Patrik (2010) have tried to understand the policies and their implications on energy efficiency in Europe. The authors have combined engineering and social science approaches in their study. The authors found out that though the energy efficiency technologies are cost effective, they have not been implemented in many industries. The existence of energy efficiency gap is due to lack of information, tacit agreement, existence of particular values, etc. Accordingly, authors have argued to remove these hurdles to improve the energy efficiency in industries (Jenny & Patrik, 2010).

Tzu-Pu and Jin-Li (2010) have computed energy productivity change in China with the help of total factor energy productivity change index (TFEPI) The TFEPI was decomposed into the change in energy efficiency for further analysis. The estimated results have revealed that the energy productivity has registered decline of 1.4 per year during 2003-2004. The average total factor energy productivity has improved about 0.6 per cent per year. But, the total factor energy technical change declined progressively about 2 per cent annually (Tzu-Pu & Jin-Li, 2010).

Abdulkadir and Topalli (2011) have reviewed the literature on rebound effect. The authors have examined energy efficiency policies and programmes undertaken in Turkey. The authors while reviewing the literature have noticed two sets of arguments. They are: One group of economists has argued that the reduction in the amount of energy consumption is offset by reduction in real per unit price of energy. The other group of economists argued that the extent of the rebound effect is too small. The authors have argued that the consumers have inclined to consume more energy on account of some benefit which arises due to energy efficiency. They opined that energy efficiency and increasing energy efficiency would reduce external dependency rate. It would ensure energy safety in the economy. The authors have classified the rebound effects into direct, indirect and economy – wide effects. They found that the magnitude of the rebound effect would vary from country to country.
and also from sector to sector. The authors have concluded that the rebound effect is probably higher in developing countries (Abdulkadir Bulus & Topalli, 2011).

Xing-Ping et al., (2011) have made an attempt to estimate total-factor energy efficiency in 23 developed countries over a period 1980-2005. The authors have applied Data Envelopment Analysis (DEA) window, total factor energy efficiency with change trends for estimating total-factor energy efficiency. The results indicated that Botswana, Mexico and Panama had the best energy efficiency performance. On other hand, Sri Lanka, Kenya, Syria and Philippines had worst energy efficiency performance during the research period. There was little energy efficiency performance in seven countries. The energy efficiency performance had continuously declined in eleven countries. The total factor energy efficiency had continuously increased in five countries. China witnessed the most energy efficiency performance on account of the effective implementation of energy policies in the country (Xing-Ping, Xiao-Mei, Jia-Hai, & Xiao-Jun, 2011).

Abdulkadir and Nurgeen (2011) in their study made an attempt to investigate theoretical and empirical literature about the rebound effect. The authors opined that energy is a basic input in the development process of an economy. Acquiring clean energy in adequate quantity accelerates the level of economic development. The authors have divided their study into various parts. They are: (i) Energy efficiency and policy, (ii) Definitions of Rebound effect, and (iii) Different policies which comprise the energy issues.

The authors argue that energy efficiency is closely related to energy safety. Energy policies not only aim at increasing the consumption of energy per capita but also setting up a system which enables maximum energy production, generation, distribution and consumption using minimum energy. The countries will be benefited positively from energy efficiency and efficient energy policies. The authors concluded that most of the governments are trying to find out the ways and means to improve energy efficiency in order to reduce the dependency on fossil fuels to achieve the target of reducing carbon emissions. They suggested implementing price policy of energy, carbon taxes and building regulations go a long way in increasing energy efficiency (Abdulkadir & Nurgeen, 2011).
Zhou et al., (2012) used parametric frontier approach for estimating economy-wide energy efficiency. They have also used Shepard energy distance function and stochastic frontier models in the analysis. It is found that parametric frontier approach has high discriminatory power in the estimation of energy efficiency than non-parametric tests (Zhou, Ang, Zhou, 2012).

Wu et al., (2012) have made an attempt to measure energy efficiency in Chinese industries. The authors have constructed static and dynamic industrial energy efficiency performance indices to measure industrial energy efficiency. They also used Data Envelopment Analysis (DEA) models with CO₂ emissions. They have decomposed dynamic energy efficiency performance indexes in two contributing components. They applied decomposed dynamic energy efficiency performance indexes to access the industrial energy efficiency performance in various provinces of China. The results revealed that there is energy efficiency improvement by 5.6 percent in China’s industries since 1997. The authors have concluded that the technological advancement was responsible for the industrial energy improvement in China (Wu, Fan, Zhou, & Zhou, 2012).

Shahiduzzaman and Khorshed (2013) have empirically estimated energy efficiency in Australia during 1978-2009. The authors have used sectoral and sub sectoral levels of data for their analysis. They have applied decomposition analysis in their study. They found that energy effect and sectoral decomposition effect are responsible for decreasing energy intensity in Australia. They argue that energy effect is more important than the sectoral decomposition effect. The studies also revealed that energy intensity and carbon intensity are positively related. The authors have concluded increasing energy efficiency would reduce carbon emission in Australia (Shahiduzzaman & Khorshed, 2013).

Henry (2014) has made an effort to examine the effects of rising and falling energy prices in the US economy. The author has used the factor proportions model for analyzing the effects of falling energy input and its rising price in the US economy. The model requires distinct interaction of energy and labour with capital. According to the author, in the general equilibrium, rising price of energy reduces the return to capital. The author has concluded that the energy has healthy comparative static elasticity in the manufacturing sector in the general equilibrium (Henry, 2014).
Chai and Baudelaire (2015) have made an attempt to investigate the obstacles that hinder energy efficiency in industries in Singapore. The authors have used partial least square method to find out the significance between the desires to cut operating costs. The authors found out that the reasons why the firms wish to implement energy efficiency. They found out the relationship between operating cost and energy efficiency measures is statistically significant. Their studies revealed that corporate social responsibility and opportunity to implement energy efficiency do not have any significant impact on energy efficiency outcomes (Chai & Baudelaire, 2015).

Kenneth et al., (2015) have critically reviewed the existing literature on rebound effect and its magnitude on the economy. The authors have redefined rebound effect. It is also known as backfire. They stated that rebound effect can serve as a guide for economists and policy makers. They argued that substitution and income effects would also emerge from energy efficiency improvement. They presented the magnitude of rebound effect of energy efficiency on the different sectors. They also argue that the estimation of the magnitude of rebound effect becomes extraordinarily difficult in different situations. They found from their studies that the existing literature does not support backfire hypothesis. Further, they also found that the existing literature does not support the claim that energy efficiency benefits are nullified by the rebound effect (Kenneth, David, & Gernot, 2015).

Ravishankar and Premakumara (2016) have empirically estimated energy efficiency in agricultural sector in South Asia. The authors have used secondary time series data on energy efficiency in agricultural sector. The econometric models such as ANOVA, Growth Models have been used for analysis. It has been found from the analysis that energy efficiency has improved in agricultural sector among South Asian countries. They suggested that energy has to be expanded along with suitable and efficient technology in South Asian countries like Bangladesh, Nepal, and Indonesia. They also proposed an improvement in energy expansion and technical upgradation in the Indian agriculture. The authors have argued that without increasing energy efficiency, it is not possible to attain sustainable development in South Asia (Ravishankar; Premakumara, 2016).
2.7 Conclusion:

The present chapter has reviewed fairly good numbers of previous literatures on energy policies, programmes, practices, management, methods, and interactions with development, efficiency and environmental issues. The Previous works have been reviewed and found that there are a good numbers of works on energy issues. It has also been found from the reviews that different countries have adopted different policies in their energy sector. The Most of the governments have not considered energy efficiency issues in the formation of general policies for development. At the same time, energy policies have focussed on increasing the availability of energy. Very recently, policies have given importance to energy efficiency. Energy relations with development are an important area of research and most of the previous works have studied the role of energy in development. The Estimation of the causality of economic growth on energy consumption was started in the early 70s. The Most of the early literatures on causation of economic growth on energy consumption have confirmed the causation by using uni-directional Granger- causality Tests. During late 90s, the economists have employed Engel-Granger Models to estimate the causation of electricity and energy on economic growth. Meanwhile, the co-integration techniques were also used to estimate long-run relationship between energy consumption and economic growth. However, some of the researchers have identified the long-run relationship and others have failed to prove the long-run relationship between energy and economic development. Some studies have failed to prove the bi-directional relationship between energy consumption and economic growth. The estimation of multi-dimensional relationship has also proved the role of energy in overall economic development. Recently, some authors have proved the influence of financial development on energy consumption. The ARDL bounds test was used to prove the causation of energy demand on export very recently. The increased pollutions and environmental concerns in the energy production and consumptions have also been analysed in many previous studies. Some of the studies have also developed the methods to measure the energy efficiency and security. As a matter of fact, works on energy efficiency were country specific and sector specific. However, there is no specific methodology to measure the energy efficiency in general and energy efficiency in the industrial sector in particular. No studies have attempted to
measure the energy efficiency in the industrial sector by using the macro level and the unit level data. The present study would fill this gap.
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